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TESI DI DOTTORATO

***Simplexity* to orient *Media Education* practices**

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A mio padre, fiero sannita

A mia madre, dolcissima siciliana

"What magical trick makes us intelligent? The trick is that there is no trick. The power of intelligence stems from our vast diversity, not from any single, perfect principle".

Marvin Minsky, *the Society of Mind*

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Sintesi

Il *Media Educator* è una nuova figura professionale che svolge un'attività educativa volta a far "comprendere", tra gli altri ai futuri cittadini ed agli insegnanti in formazione nonché a quelli in servizio, i *Media* approfondendone vari aspetti: la loro natura, le tecniche di trasmissione e ricezione dell'informazione e i linguaggi da essi utilizzati a livello sintattico e semantico.

È importante sottolineare che oggigiorno in molte università italiane e straniere, la formazione dei docenti include uno o più esami di *Media Education*; questo dato evidenzia che tale campo di studio non è più da considerarsi un elemento facoltativo nei percorsi di formazione, ma è divenuto parte integrante della routine educativa acquisendo lo status di funzione fondamentale per tutti coloro che andranno ad insegnare negli anni a venire.

Il presente lavoro di tesi dottorale è finalizzato ad indagare il seguente concetto: come la semplessità possa orientare le pratiche per formare i *Media Educator*, dotando questi ultimi di un bagaglio nuovo, nella loro cassetta degli attrezzi, di buone prassi che emergerà dalla messa in atto, nell'azione didattica quotidiana, delle proprietà e dei principi della semplessità.

Il lavoro è stato, dunque, strutturato in due parti: una prima parte, di carattere teorico, in cui saranno descritti, dapprima, i nuovi *Media* (in particolare, quelli che includono elementi robotici e d'intelligenza artificiale) e la didattica semplessa in relazione alla

Media Education; una seconda parte, di carattere pratico-operativo (o progettuale), in cui sarà analizzata la realizzazione di un laboratorio mobile di analisi video per le attività di formazione degli insegnanti. Più nel dettaglio, nella prima parte verrà esposto come la semplessità (teorizzata da Alain Berthoz, professore emerito al Collège de France, e declinata in ambito didattico dal Professore Maurizio Sibilio), attraverso la capacità umana di pensare creativamente, per agire in un mondo complesso, possa favorire i *Media Educator* nel loro lavoro quotidiano; nella seconda parte si approfondiranno le modalità attraverso le quali è stato realizzato un laboratorio di analisi video utilizzato come strumento didattico e di ricerca per la formazione degli insegnanti. Il concetto che ha "guidato" la realizzazione di tale laboratorio è stato quello di sviluppare un luogo di registrazione video "plug and play" che possa essere installato ovunque in meno di quindici minuti e da tutti. Infine, si vuole evidenziare che questo laboratorio è già stato progettato e testato; esso è composto da cinque telecamere, un software di regia e un software open souce di analisi video, da utilizzare in post-produzione.

Abstract

Media Educator is a new professional figure that performs an educational and pedagogical activity that aims people to understand mass *Media* (their nature, their techniques and their languages). Nowadays In many Italian and foreign universities, new teacher education includes one or more *Media Education*-related exams. In this PhD thesis will be explained how simplexity could orient *Media Education* practices.

More in details, this thesis is divided in two steps: 1) description of new *Media* (focusing on robotics and artificial intelligence devices) then simplexity declined in *Media Education*; 2) realization of a video analysis Lab for teacher education activities. In the first step it will be exposed how simplexity, defined by Alain Berthoz, Emeritus Professor at the Collège de France, and declined in educational contest by Maurizio Sibilio, through human ability to think creatively to act in a complex world, can help *Media Educators* in their daily work. The second step is how realized a new video analysis lab as a didactical and research "tool" for teacher education at the University of Salerno. Main idea of second step of the thesis is how design and implement a mobile video analysis laboratory for video recording real or simulated simplex didactic activities both for *Media Educators* and other teacher education courses. Concept that "drives" this lab is to develop a "plug and play" recording location that can be installed everywhere in less than fifteen minutes by everybody. This laboratory is already designed and tested, it is

composed by five cameras a directed control room software and an open source video analysis software.

Ringraziamenti

Tutti i campi di studio, tutti gli ambiti di ricerca, tutte le grandi Scuole esigono sacrificio perché il loro oggetto primario non è il mero utilizzo accademico, ma favorire la conoscenza e l'educazione. La vita di tali campi ed ambiti è mantenuta da coloro che perseguono una passione o curiosità per essi. Se questa passione o curiosità vengono meno, la loro tradizione svanisce. Tale premessa, tratta dal discorso di commiato all'Università di Oxford del professore John R.R. Tolkien, mi permette di riflettere sulla fortuna di essere entrato a far parte di una Scuola prestigiosa, quella del Dottorato in "Scienze della Comunicazione, Sociologia, Teorie e Storia delle Istituzioni, Ricerca Educativa, Corporeità didattiche, Tecnologie e Inclusione" dell'Università degli Studi di Salerno ed aver potuto collaborare con Professori e Ricercatori appassionati e curiosi.

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per vivere assieme viaggi istruttivi e meravigliosi. Inoltre, la ringrazio per avermi sempre sostenuto dal punto di vista scientifico ed indirizzato dal punto di vista metodologico.

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Ringrazio Iolanda Zollo a cui dedico questa citazione latina: *Firmissima est inter pares amicitia - Quanto mai salda è l'amicizia fra simili* - a lei sono grato per avermi preso a cuore dal primo momento, sostenendo il mio lavoro quotidiano, aiutandomi nella stesura dei miei primi articoli scientifici, migliorardo il lavoro di revisione che mi ha permesso negli anni di diventare autonomo e soddisfatto delle mie pubblicazioni.

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Introduction

Media Educator is a new professional figure that performs an educational and pedagogical activity that aims people to understand mass *Media* (their nature, their techniques and their languages). Nowadays In many Italian and foreign universities, new teacher education includes one or more exams related in *Media Education*. Science literature and reportage propose an idea a robot that is often wrong and far from reality but becomes part the imagination of the people. In science fiction, robots of the look like humanoids and they can act and things like humans.

In this context, *Media Education* "wants" to understand robotic, artificial intelligence and other technological devices to describe them to the future citizens that there will be able to understand the actual characteristics and are not based on incorrect information from cinemas. Some pertinent research questions highlighted in this work are therefore: 1) what does a *Media Educator* need to know? 2) What are the differences between a *Media Educator* and a computer programmer?

From the international literature review emerges some differences, as obviously, between *Media Educator* skills and computer programmer skills. To a *Media Educator* is not required to: know how to program devices (typical of expert programmers) or know how to perform complex configuration (as network system administrators use to do in their daily work hours).

In this thesis will be highlight that *Media Educators* won't be focused mainly on understanding devices and codes as computer programmers, but they will be focusing on other peculiar elements of the *Media* such as social, cultural, linguistic and semantic aspects (axes that generate the skills of a *Media Educator*).

As theoretical framework, this thesis started from my "curiosity" aroused by the book "The Vicarious Brain, Creator of Worlds" by Alain Berthoz, Emeritus Professor at the Collège de France and Director of the Laboratory of Physiology of Perception and Action at the Centre National de la Recherche Scientifique (CNRS). That book shows that the human ability to think creatively and function in a complex world is the core of our intelligence and it is important to ask if also a machine, in the future, will do it and how this fact of the future should impact on education.

Thus, if people try to build an intelligent machine they faced with the human ability to think creatively, and function in a complex world. Berthoz, in his books, also talks also about robots and highlights that humanoid robot must inspire confidence. Besides, the Professor at the Collège de France shows that each nations and culture have a different perception of robots. For example, in Japan, artificial creatures are perceived as benevolent while in Europe it is more difficult to admit that the humanoid can become a robot "mate". Berthoz hypothesis is that it could depend on the image of our past and literature such as the golem, a stone creature conceived to defend the Jewish community of Prague, who turned against his own people, or Doctor Frankenstein, persecuted by his own same (Berthoz, 2015, p.40) creation. Other explanations are obviously possible,

such as the fact that Western countries are dominated by the myth of man created by God, a man who does not have to equip himself with this power (Berthoz, 2015, p.40).

Another difficulty, emphasised by Berthoz, derives from an effect that robotics experts call uncanny valley, i.e. a "valley mysterious" (Mori, 1970). The problem is soon solved. The more we attribute a human aspect to a humanoid or one artificial creature (perhaps to a videogame avatar), the more it will be accepted and become familiar (Berthoz, 2015, p.40). But the unexplainable, uncanny valley phenomenon shows that from a certain threshold of resemblance, an inexplicable phenomenon arises: the character induces mistrust, even repulsion. However, if we continue to perfect it, it will become acceptable again. Mori (1970, 2012) wrote:

> "To illustrate the principle, consider eyeglasses. Eyeglasses do not resemble real eyeballs, but one could say that their design has created a charming pair of new eyes. So we should follow the same principle in designing prosthetic hands. In doing so, instead of pitiful looking realistic hands, stylish ones would likely become fashionable. As another example, consider this model of a human hand created by a woodcarver who sculpts statues of Buddha. The fingers bend freely at the joints. The hand lacks fingerprints, and it retains the natural colour of the wood, but its roundness and beautiful curves do not elicit any eerie sensation. Perhaps this wooden hand could also serve as a reference for design". (Mori, MacDorman, Kageki, 2012, p.100)

Mori published the same article twice, in 1970 like a very pioneering idea and then in IEEE Robotics & Automation Magazine in 2012, with new images, due to the relevance of the topic. This perceptual "valley" leads robotics experts to give them humanoids an

almost human aspect, but not too much, to stay within the confines of acceptability (Berthoz, 2015, p.41).

All consideration of Mori and Berthoz united with the resolution of the European Parliament of 16th February 2017 with recommendations to the Commission on Civil Law Rules on Robotics increased my curiosity on this theme and they made me start to write this PhD Thesis.

Chapter I: Artificial Intelligence, Robotics and *Media*

1.1 Robotics and digital age

In the last decade convert pictures, photos, texts, sounds, telephone call, mail, and videos into a digital form, processed by computers; it will be a conclusive part of a process of full digitalization of human information. Nowadays digital is an adjective very common but sometime a little bit difficult to understand from a technical point of view. The Oxford dictionary (*en.oxforddictionaries.com*) define the adjective "digital"

> "(Of signals or data) expressed as series of the digits 0 and 1, typically represented by values of a physical quantity such as voltage or magnetic polarization".

The Oxford dictionary gives immediately this further information:

> "Relating to, using, or storing data or information in the form of digital signals. A Digital TV, a digital recording".

This could be a proof that define something as digital is easier that describe the process of digitalization of an information. This distance, between how technology works and

how it is possible to use technologies devices, is always a problem for EU legislators that should elaborate new laws and recommendations for European Countries to decide how to deal with technological aspects such as artificial intelligence and robotics. Kaplan (2016), one of the “big” experts of robotics and artificial intelligence technology suggest:

> "Investments could be permitted and perhaps also certain expenditures, such as for the child’s education". (Kaplan, 2016, p.135)

For this reason, it is important to go deep into this work, to understand why, in the future, artificial intelligence and robotics should have interaction and impact on education. Kaplan also tries to describe and define artificial intelligence (that is also the software part of many robots) finding some correlation with Gardner (2002) studies, he asserts:

> "There are many proposed definitions of artificial intelligence (AI), each with its own slant, but most are roughly aligned around the concept of creating computer programs or machines capable of behaviour we would regard as intelligent if exhibited by humans. John McCarthy, a founding father of the discipline, described the process in 1955 as “that of making a machine behave in ways that would be called intelligent if a human were so behaving.” But this seemingly sensible approach to characterizing AI is deeply flawed. Consider, for instance, the difficulty of defining, much less measuring, human intelligence. Our cultural predilection for reducing things to numeric measurements that facilitate direct comparison often creates a false patina of objectivity and precision, and attempts to quantify something as subjective and abstract as intelligence is clearly in this category. Young Sally’s IQ is seven points higher than Johnny’s? Please find some fairer way to decide who gets that precious

> last slot in kindergarten. For just one example of attempts to tease this oversimplification apart, consider the controversial framework of developmental psychologist Howard Gardner, who proposes an eight- dimensional theory of intelligence ranging from “musical rhythmic” through “bodily– kinaesthetic” to “naturalistic”.” (Kaplan, 2016, pp.1-2)

This concept of making computer programs and robots able to behaviour as intelligent, when they are correlated people with ergonomic human-machine interface (Bonaiuti, Calvani, Menichetti, Vivanet, 2017) more in detail: the acquisition of knowledge in the ergonomic and cognitive field allows us to better understand the interactions that can be implemented through the technological interfaces and how the learning conditions can be manipulated with appropriate adaptations, enhancing important cognitive processes and inhibiting the factors that produce futility, overload and dispersivity. Furthermore, the history of cognitive technologies shows us that, alongside the dominant (extroflexive) trend that technology tends to exert on cognitive processes, opportunities may also arise to amplify cognitive and relational dimensions that are of interest for education to value (Calvani, 2017, p.12)

Although, this is not a thesis of information technology but it aims to focus *Media Education* for teacher education courses. Nowadays, thanks to the digital revolution before and the digital evolution after (just to split in two the first introduction of digital machines that was a real revolution and the second period of evolution of digital systems):

> “The profile of the *Media Educator* has been consolidated whose role is to interpret and use new *Media* to prepare students, more generally citizens, for challenges that technology

> poses for the future. More specifically, a *Media Educator* is requested to follow both technology trends and legal aspects related to sensitive topics that link technologies to health, privacy and the well-being of users with great attention. In addition, the *Media Educator* should aim at raising the attention threshold when those users are children, adolescents, disabled, elderly and in general everyone that while using technology they may find difficulty when faced with system malfunctioning or fault". (Todino, Di Tore, in press)

For these reasons this work concerns much more about pedagogical and ethical aspects of the introduction of robotic systems and it should be consider a *Media Education* thesis much more than an Information Technology one, using a subdividing of ICT point of view proposed by Rivoltella (2012, 2016a, 2016b).

Examples of *Media Education* school activities	Example of *Information Technology* school activities
UNDERSTAND WHY USE A TEXT, A HYPER-TEXT OR OTHER *MEDIA*	FORMATTING A TEXT IN WORD
UNDERSTAND IN AN INTERNET NEWS IS A FAKE ONE	UNDERSTAND HOW INTERNET SERVICE PROVIDERS REALLY WORKS (TCP, IP PROTOCOLS)
CREATE A WEB PAGE EASY TO USE FOR EVE-RYONE	PROGRAMMING HTML CODES
CREATE SLIDES EASY TO UNDERSTAND	HOW TO CREATE POWER POINT SLIDES (WHERE I CAN FIND EACH BUTTON IN THE GRAPHIC USER INTERFACE)

Table 1: list of activities: *Media Education* vs. Information activities.

Understand this comparison it is important to offer a guide to decision-makers to chooses future technological policies, in particular to define courses programs in the university ICT teacher education to "compose" a course that in the same time suggestion to give two different view about digital technologies: *Media Education* and Information Technology to be able after training to program ICT school activities in the daily work in a classroom. teacher education is fundamental, without it the research shows that the introduction of digital technologies does not in itself guarantee an increase in results and, indeed, as this often raises more problems than it solves (Calvani, 2017, pp. 11-14).

1.2 European Civil Law on Robotics

The European Parliament, having regard to the study on ethical aspects of robotics and artificial intelligence carried out on behalf of the Parliament's Science and Technology Options Assessment (STOA[1]) wrote a document called "The resolution of the European Parliament of 16th February 2017 with recommendations to the Commission on Civil Law Rules on Robotics" that should be the main topic of this paragraph. STOA is an import official institution of European Community; it studies scientific dimension and impacts of new technologies to explain each issue to EU parliament and each European country before they should apply new laws. STOA analysis European Parliament decision-makers

"Have a scientific or technological dimension to them. Scientific and technological advances lie at the heart of economic growth, and it is necessary to understand the impact of new and emerging technologies and how to best support technological innovation. In this context, there is a growing need for legislators and policy-makers at national and European level to rely on independent, impartial and accessible information about developments in science and technology, the opportunities they offer, but also the risks they entail and their ethical implications"[2].

EP explains that, through these recommendations, that it is important to face with assumption that:

"Now that humankind stands on the threshold of an era when ever more sophisticated robots, bots, androids and other manifestations of artificial intelligence ("AI") seem to be poised to un-

[1] http://www.europarl.europa.eu/stoa
[2] http://www.europarl.europa.eu/stoa/cms/home/panel/rules

leash a new industrial revolution, which is likely to leave no stratum of society untouched, it is vitally important for the legislature to consider its legal and ethical implications and effects, without stifling innovation." (EP, 2017)

Based on this assumption the EP suggests a detailed analysis of future robotics and artificial intelligence to guide Member States in their decisions. STOA and EP show that these systems could have a significant social impact and mat tend to be extremely pervasive with a high social, economic and cultural, impact (Todino, Di Tore, in press) and

> "This recommendation can give us the opportunity to reflect on this theme that *Media Educator* is invited to meet. This institutional necessity highlighted by the European Parliament emphasises the importance of a continuous political, economic, cultural and social monitoring of robotics and this activity requires the support of educational research because recommendation includes a section called "Education and Work"". (Todino, Di Tore, in press)

In accordance with previously studies:

> ‘‘To reduce the field of discussion and focus on some of the characteristics that can be analysed, it will be used a vision of robotics as a communication medium capable of performing as a mediator of information, data, activities and process automation. Although Robots should be also controlled directly by a human, such as remote-controlled robots remotely, but in this article, we will focus on those managed through artificial intelligence software or they should be not at all "intelligent machine" there will be used the definition of Robots

as electro-mechanics devices managed through Artificial Intelligence software". (Todino, Di Tore, in press)

More in detail, humankind robots:

> "Stands on the threshold of an era when ever more sophisticated robots, bots, androids and other manifestations of artificial intelligence ("AI") seem to be poised to unleash a new industrial revolution, which is likely to leave no stratum of society untouched, it is vitally important for the legislature to consider its legal and ethical implications and effects, without stifling innovation". (EP, 2017)

people have fantasised about the possibility of building intelligent machines, often androids with human features (*ibidem*) and many scientist and writers use robotic as a topic to explore human sensibility to go deep in the core of this problematic of our future. Some famous examples are: 1) Mary Shelley's Frankenstein's Monster (*ibidem*); 2) the classical myth of Pygmalion (*ibidem*); 3) Prague's Golem (*ibidem*); 4) Isaac Asimov Robots (Menichetti, 2017, pp. 166-167). Each example above tells peculiar aspects of artificially "animated creatures", but it is only in Asimov's work that the problem of modern robot's looms. Many interesting (for ethical and pedagogical aspects) are the 3 laws of modern robots proposed by Asimov: 1) a robot may not injure a human being or, through inaction, allow a human being to come to harm (Menichetti, 2017, p. 167); 2) a robot must obey the orders given it by human beings except where such orders would conflict with the First Law (*ibidem*); 3) a robot must protect its own existence as long as such protection does not conflict with the First or Second Laws (*ibidem*).

Figure 1: Jean-Baptiste Regnault: Pygmalion (1786), Trianons's Museum.

This wish, to produce intelligent apparatus, was instinctive for people as need to find a support in daily work activities. To create these apparatus people must think about what intelligence is first. There are two extreme approaches, and all kind of possible shades in the middle: 1) "Brain in a vat", such as a epiphenomenon, proposed by Putnam, approach used in psychological experiments proposed to draw out certain features of human conceptions of knowledge, reality, truth, mind, consciousness and meaning, in this approach mind and body are divided such as Descartes philosophy; 2) "embodied mind" approach used in physiology (Berthoz, 2011) as described in Merleau-Ponty philosophy, this philosopher describes the mind as a process that is biologically constituted in the body during people' life time. Merleau-Ponty was influenced by the intuitions of the philosopher Husserl, from the studies of neurophysiology of Pavlov and from the psychology of Gestalt on the perception[3].

[3]http://www.portalefilosofico.com/Liceo%20Classico/Martini/INTRODUZIONE%20ALLA%20Fenomenologia%20di%20Merleau.pdf

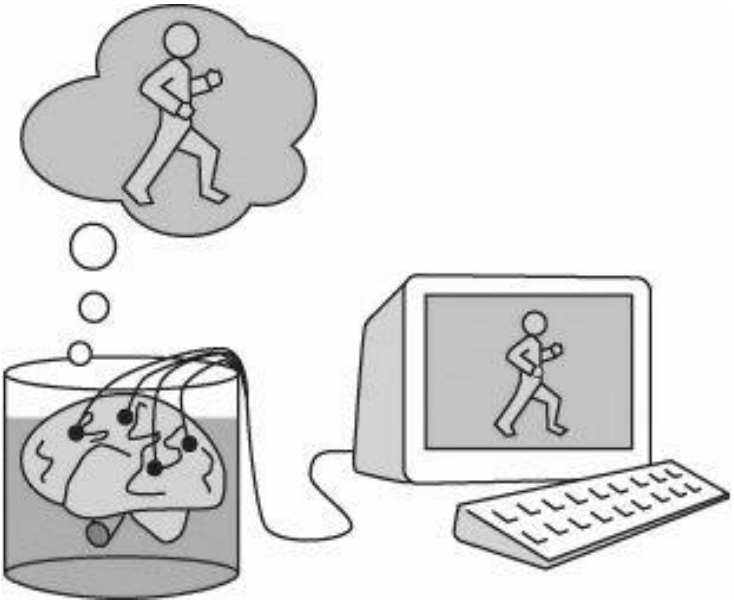

Figure 2: "Brain in a vat" model of intelligence proposed by Putnam.
SOURCE: Wikipedia's image.

However, whatever the nature of intelligence is (Putman model, Merleau-Ponty model or a mix of them), create intelligent machine is considered a dream that became real.

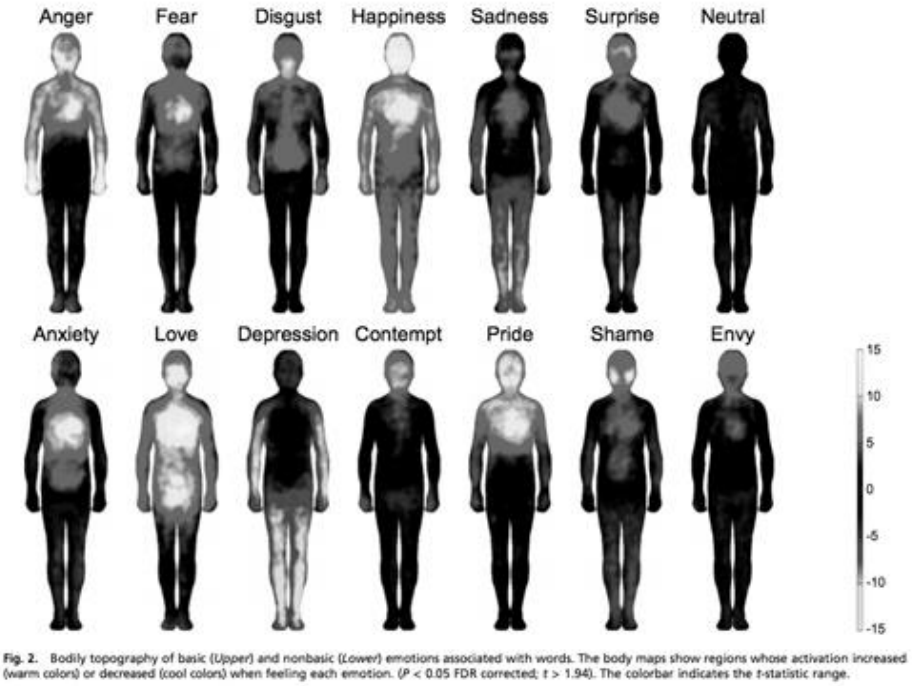

Figure 3: "Embodied mind" approach of intelligence. SOURCE: Amsterdam, Amsterdam Centre for Cross-Disciplinary Emotions and Senses Studies, Dutch, Embodied Emotions, Vrije Universiteit Amsterdam[4]

Based on these considerations:

> "The European community warns that the development of the robot could start an epochal change that affects all levels of our society, life and culture. The European Parliament, to motivate these considerations and to pay attention to this issue, notes that the economic importance of robots and Artificial Intelligence market is increasing; this public and private economic investment, to introduce robotic systems, will affect European population and its lifestyle [...] These European considerations, which are directed to the Italian Parliament and MIUR (Ministry of Education, University and Research), invite to examine the relationships that established between robotics, education school system and *Media* education [in these ways:] in primis, the development of robotics requires a flexible education and training systems, in each Member country, to ensure a correspondence between educational system and robotics benefits (EP, 2017); in secundis, educational system must know and teaches the im-

[4] https://emotionsandsenses.wordpress.com/2014/05/25/emotiecentrum-vu-ontvangt-beurs/

portance of including robotics in our society, considering possible effects of development and diffusion of robotics and artificial intelligence (EP, 2017); in tertiis, the importance of applying strict standards to the interactions between humans and robots to ensure the health, safety and respect for fundamental rights, both in the workplace, both in the school context (EP, 2017)". (Todino, Di Tore, in press).

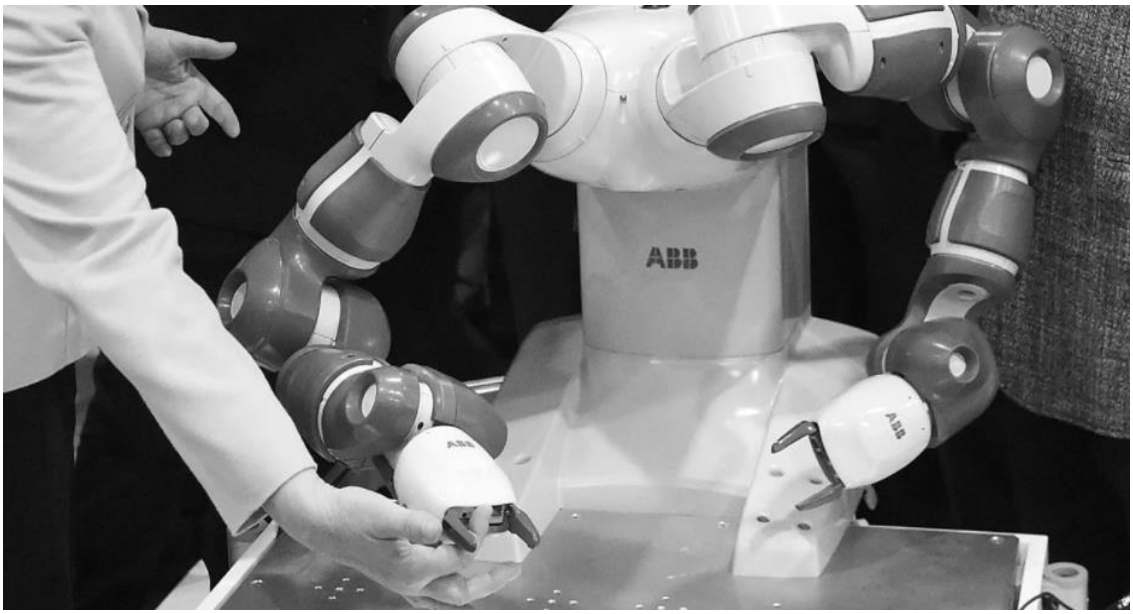

Figure 4: The Yumi robot exhibited in Hannover in 2015. Angela Merkel's hand is between pliers. SOURCE: http://www.linkiesta.it/it/article/2017/05/24/ecco-il-cobot-il-robot-che-non-sostituisce-i-lavoratori/34365/

EU recommendations emphasize civil or criminal responsibility of robot's produce (Todino, Di Tore, in press). Beside they contain many ethical principles (recommendation's points 10, 11, 12, 13, 14) to follow, in Europe, to use and develop these kinds of "intelligent" devices

"10. Notes that the potential for empowerment through the use of robotics is nuanced by a set of tensions or risks and should be seriously assessed from the point of view of human

safety, health and security; freedom, privacy, integrity and dignity; self-determination and non-discrimination, and personal data protection;

11. Considers that the existing Union legal framework should be updated and complemented, where appropriate, by guiding ethical principles in line with the complexity of robotics and its many social, medical and bioethical implications; is of the view that a clear, strict and efficient guiding ethical framework for the development, design, production, use and modification of robots is needed to complement the legal recommendations of the report and the existing national and Union acquis ; proposes, in the annex to the resolution, a framework in the form of a charter consisting of a code of conduct for robotics engineers, of a code for research ethics committees when reviewing robotics protocols and of model licences for designers and users;

12. Highlights the principle of transparency, namely that it should always be possible to supply the rationale behind any decision taken with the aid of AI that can have a substantive impact on one or more persons' lives; considers that it must always be possible to reduce the AI system´s computations to a form comprehensible by humans; considers that advanced robots should be equipped with a 'black box' which records data on every transaction carried out by the machine, including the logic that contributed to its decisions;

13. Points out that the guiding ethical framework should be based on the principles of beneficence, non-maleficence, autonomy and justice, on the principles and values enshrined in Article 2 of the Treaty on European Union and in the Charter of Fundamental Rights, such as human dignity, equality, justice and equity, non-discrimination, informed consent, private and family life and data protection, as well as on other underlying principles and values of the Union law, such as non-stigmatisation, transparency, autonomy, individual responsibility and social responsibility, and on existing ethical practices and codes;

14. Considers that special attention should be paid to robots that represent a significant threat to confidentiality owing to their placement in traditionally protected and private spheres and because they are able to extract and send personal and sensitive data". (EP.2017)

In this document arise also that “ICT systems hold data and centralize information with economic, social and political value” (Todino, Di Tore, in press) and this document was opened many big debate involving many field of disciplines included pedagogy, sociology, philosophy from soft science side and electronic, electromechanical, computer programming from hard science side. In the next years, European countries laws including those that involve school systems and *Media Education*, moreover “this EU document tries to draw a path as a first reaction to the theme robotics and educational and work social impact” (Todino, Di Tore, in press). In these debates, *Media Education* drives these studies toward this perspective: first of all consider pedagogy and didactic needs.

1.3 Media and Artificial Intelligence

Science fiction and TV broadcasting offer an idea of a robot that is frequently incorrect, but this idea becomes part the imagination of people (Todino, Di Tore, in press) thus *Media Education* should teach to students how to find fake news about AI and robotics to understand better the present and the future of ICT and our world. For this reason, *Media Educators* should

> “Not only learn about these technologies but also be able to teach a correct vision of them that is often incorrectly described from movies, books and television. This happens with most impact on robotics due to science fiction. Often happens that television and newspapers propose robots, through two antithetical approaches: 1) robots improve human life by automating processes; 2) robots increase unemployment. On these two points can be discussed

> analysing the last 40 years of technology evolution, although robots have increased unemployment in certain professional sectors, they have created a lot of work in the computer engineering sector field, which was pioneered invaded by people who have understood their potential ahead of time. At the same time, it is possible to confidently say that the robotic systems (domotic and home automation, automotive systems, computer controls on trains etc.) have increased the safety and comfort of places where we live and transports with which we move, and this means that robots improve human life by the introduction of automating processes". (Todino, Di Tore, in press)

Media Educators can also introduce the two parts that composes a robot, hardware and software, in a poetical way to their students using a charming, fancy and metaphorical approach used in the American lessons, writer Italo Calvino that highlights the need to explore deep into concepts of the double nature of robots (*Ibidem*):

> "It is true that software cannot exercise its powers of lightness except through the weight of hardware. But it is the software that gives the orders, acting on the outside world and on machines that exist only as functions of software and evolve so that they can work out ever more complex programs. The second industrial revolution, unlike the first, does not present us with such crushing images as rolling mills and molten steel, but with "bits" in a flow of information traveling along circuits in the form of electronic impulses. The iron machines still exist, but they obey the orders of weightless bits". (Calvino, 1988)

Reflecting on these considerations, one of the issues that will face *Media Educators*, in the future years, should be how to synthesise, using this word such as used in Hegel philosophy, harmonically two contrasting positions, regarding technology from

> "Form one side there is a position that sees technology as a viral element, in which individuals and organizations suffer from the introduction of new electronic devices. In this vision, there is a technological innovation that changes environment and society (Rivoltella, 2016). On the other side, there is a critical position in which users decide for each new device its framework of use (Rivoltella, 2016). However, any of these two positions someone prefers, teachers are called to deeply know technology, regardless of the discipline they teach". (Todino, Di Tore, in press)

This synthesis will be one of the big deal of *Media Educator* daily work and *Media Educator* theoretical research. In the next chapter it will propose a "black-box" (to see what is inside Artificial Intelligence software that controls a robot); to understand an approach is possible to introduce this concept with a simple case: a human versus computer game match.

> "In this example, at each step, the machine, after having analysed the position of pieces on the board, decides the best move to make and executes it; then waits for the new move by the human player. The machine thus recursively, divides and subdivides the sub-moves to decide which is the best, and trying to bring the game to checkmate and his victory. Observing this chess game between man and machine from a different point of view, it may appear not as the result of the interaction between human and artificial intelligence, but as the game played between two people that are a human player and the deferred intelligence of another man, the programmer. Who writes computer code, for example who programs a chess-videogame, must make three choices. Programmer outlined a chess strategy, for example how to defend its king by checkmate and decide heuristics (Grooten, 2015); Programmer must decide a coding strategy that means a well-defined software development environment, starts an analysis of software requirements, decides man-machine interface, choice a pro-

> gramming language and a cyclical review, debug and test its software (Ghezzi, Jazayeri, Mandrioli, 2004). Programmer bets that video game when it runs win the chess game. The two men, player and programmer, tipping the scales involved in the game on one side: player can change its strategy in real time, but has a lower probabilistic anticipation (to determine the future effect of his moves), programmer freezes its strategy in an algorithm that can predict a number of situations, but when completed and executed It is no longer editable in run time". (Todino, Di Tore, 2018)

In accord whit previous quotes, Odifreddi[5] at the "L'intelligenza artificiale e la mente MINDset" scientific conference in 2016[6] suggest many points correlated with AI, Robotics, ethics and topics that can be important to study for future *Media Educator*. First, some *Media Educators* are, and teach, from a luddism point of view because they "hate" machines and believe that new *Media* are dangerous for humanities. This point of view is very close to "apocalyptic" people describes from Eco (1964). Luddism was a labour movement started in Great Britain, in the 19th century, reacted violently to the introduction of machines in industry, considered to be the cause of unemployment such as new is held up robots. Luddism takes its name from the worker Ned Ludd, who in 1779 would have broken a loom[7]. Organized groups of Luddites came into action for the first time in Nottingham in 1811; the revolt extended into Yorkshire, Lancashire, Derbyshire and Leicestershire. Serious incidents that occurred in 1812 caused severe repression, with hangings and deportations of the rebels, and the organisation seemed dissolved. In 1816, however, similar tumults took place, always with a centre in Not-

[5] Professor of mathematics and logic
[6] https://www.youtube.com/watch?v=FrWX9d-uLaI

[7] http://www.treccani.it/enciclopedia/luddismo (in Italian)

tingham and then extended to almost the entire Kingdom and new repressions took place; the improvement of the general economic situation put an end the agitation[8].

This author at the MINDset conference, which is not a didactic and pedagogical conference, but highlights that the teaching-learning process must be inspired by the machines they learn. We must not forget that we have always been the people to program the machines (this concept will be repeated many times in this text). This author show that there is teaching human learning that "should not" leave room for intuition or arbitrary interpretation. In fact: let's imagine for example having to explain to the primary how the multiplication is carried out. This author also points out that a "positivism" to the same degree of reason, can't in fact, exist the mathematics of the twentieth century to show that mathematics itself has impassable limits and clear, limited and impassable horizons. In a very short time the Gödel theorem "there are improvable verities" also in mathematics, ergo even the mathematic cannot "do and say" everything.

It is possible to synthesise a harmonized point of view about *Media* and intelligence to trace for *Media Educator* follow Daniel Kahneman in his Nobel Prize Lecture[9] that take place on December 8, 2002, at Aula Magna, Stockholm University where it is pointed out that long-term reasoning is mathematical and short-term reasoning is instinctive and this statement can have an effect on our idea of machines that sometimes we will believe are our allies for our reasoning, and people feel them close to us and helpful, and sometimes machines start to be enemies.

[8] Ibidem
[9] https://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2002/kahnemann-lecture.pdf

Chapter II: Open the “box”

2.1 Strategy inside a white-box

A white-box approach is used in computer science when it will be trying to learn and test a system knowing its internal functioning. For this reason, it is also known as clear box, glass box, transparent box, etc. This contrasts analysis black-box where everything is obscure. *Media Educator* could have more information using a white-box approach to Artificial Intelligence that could improve teaching-learning process. Choose a strategy, planning it and implementing it are the first steps to create an Artificial Intelligence, if it will open the “box” of an Artificial Intelligence system it is possible to identify them inside it and this seems to remind the paradigm ecological action (Morin, 2000), which describes through the concept of the second and third Viaticum. For Edgar Morin strategy is more than a simple program and this binds to the concept of a typical meta-program of the machine learning, although both can use scheduled items and algorithms. A program is determined a priori, it is a sequence of actions to achieve a goal (Morin, 2000).

A program is effective when there are certain and stable external conditions that are accurately determine but minimal disruption in these conditions break program’s rules in and sentence it to stop (Morin, 2000). Instead, even the strategy is established in view of a goal, such as the program, but it prefigures action scenarios, and chooses one of them, depending on what it knows of an uncertain environment (Morin, 2000).

The strategy brings together much information, verify it, and change its action according to the information gathered and cases encountered along the way. Finally, there is a meta-programmatic process, Morin call it the third Viaticum that is when we bet on something: the challenge is the integration of uncertainty in faith and in hope (Morin, 2000). These processes, starting from choose a strategy to bet on it, are typical of the various theories of human decision, which are true as well for processes that programmers insert into intelligent machines.

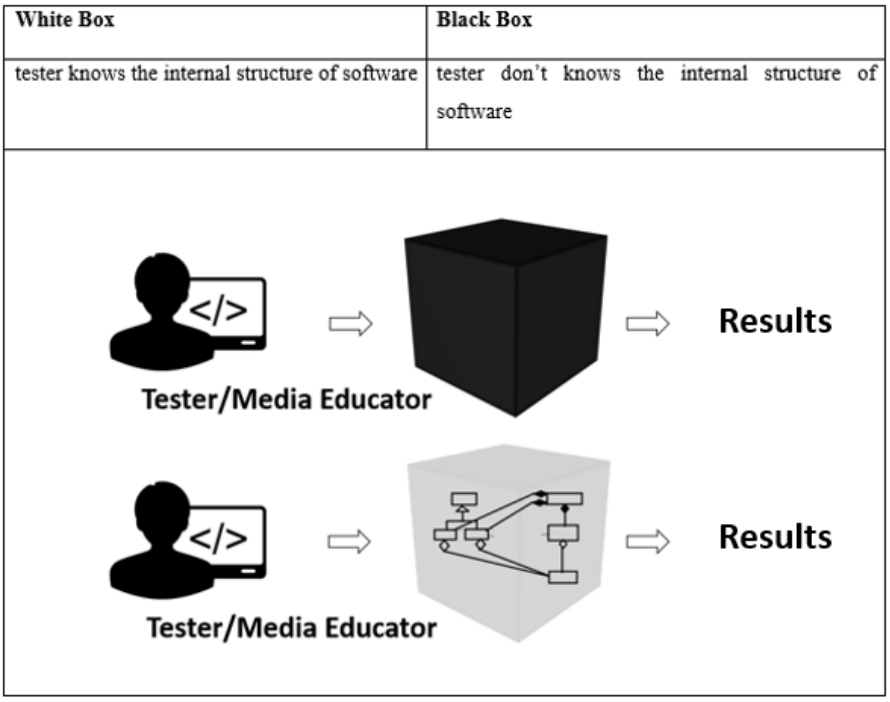

Figure 5: Typology of software testing: white box vs. black box.

Returning to the game of chess, after these considerations, the problem of the next choice, it is not easy to solve, neither for the human player nor for the programmer. If one tries to anticipate probabilistically various chessboard scenarios, that are generated

in cascade, the possible configurations of the board, to predict become too many not only for a human but also for a computer (is a typical problem of computation in which the possible moves generate a huge tree of possible combinations too big to manage). For information purposes in 1996, Deep Blue (designed and developed by IBM) was the first computer to win a chess game against a current World Champion, Garry Kasparov, with time intervals between successive moves in according to specifications of world tournament.

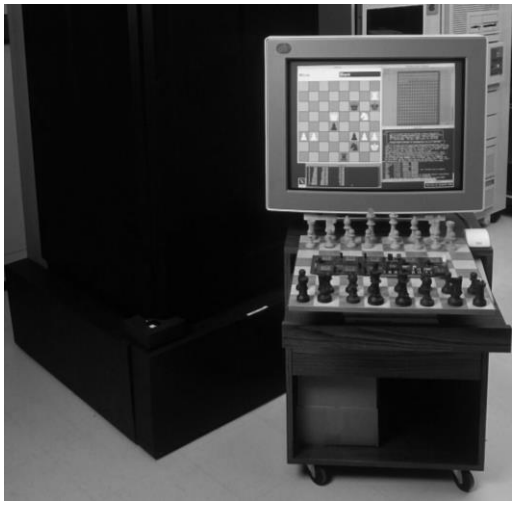

Figure 6: IBM Deep Blue. SOURCE:https://mashable.com/2016/02/10/kasparov-deep-blue/#d9WH9sKvvEq5

Strategies, programs and schedules, such as every human mental activity include in them creative and rational elements that can used both on an artistic side (hearing about "the art of schedule", "the art of programming", "programming as art and craft") and on a rational and logic support. Planning versus freedom of make real-time decisions cannot have a winner or a loser. However, it is important to know both and have a set of tools to be able to apply one or the other depending on the problem, the context and the scope.

In conclusion, opening robot's "black-box" to understand how its software really works allows people to distinguish and rethinking about their position on Artificial Intelligence and technology excluding that it is only a problematic aspect for people and understanding that society can decide for each new device its framework of use giving a wise and positive connotation of Artificial Intelligence. Artificial Intelligence software contains a "deferred intelligence" of those who have programmed it. It does not include many special cases to deal with the surroundings is therefore generally performs faster routine actions but bad irregular situations. As the European recommendations have proposed to member states is important to monitor that this "deferred intelligence" installed inside machines is coded in the respect for all.

Chapter III: Categories of AI and *Media Education*

3.1 Categories used by Russell and Norvig

Several times, it was shown that the "intelligent" element underlying the robot is determined by software that governs them. In this regard, the Artificial Intelligence definitions can be divided into four categories.

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think ... machines with minds, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning ..." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole et al., 1998) "AI . . . is concerned with intelligent behaviour in artefacts." (Nilsson, 1998)

Figure 7: Some definitions of artificial intelligence. SOURCE: Russell, Norvig (2003).

In computer science, it is important for a user to be aware of what type of hardware-software system his is using and its internal operating logic. In general, if it is known the inner logic a system is called white-box otherwise it is as a black-box system (term

already used previously). Therefore, there is a similarity with education field: to study a robotic system black-box will remind us behaviourism while a white-box model reminds a cognitivist approach.

3.1.1 Thinking and acting humanly

Russell and Norvig organized into four categories Artificial Intelligence and accordingly robot types starting from a collection of definitions in the literature. Robots that thinking and acting humanly are the most futuristic but as has been described in previous paragraphs they longer fall within the context science fiction than in ICT sector. Machines included in this category should be able to pass the Turing test (which currently it has never been "won"). That is:

> "Computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer". (Russell, Norvig, 2003)

This category of machine, which highlights the human desire to create sentient machines, already described in the preceding paragraphs and in the European document, has not yet been realized (and perhaps will be never realized (Rawling, 1997)), it has as its peak to programming robotic machines indistinguishable from human such as synthetic humanoid. To build this type of machines it would be necessary to analyse and model human mind:

> "If we are going to say that a given program thinks like a human, we must have some way of determining how humans think. We need to get inside the actual workings of human minds". (Russell, Norvig, 2003)

This type of machine, to the present day, is not achievable even with the use of more sophisticated technologies such as artificial neural networks and expert systems that extract information from huge data aggregates (big-data). Nevertheless, it is permissible to note, again, that when it is commonly spoken about robot often it is implicitly to refer to this group of avant-garde machines that think and act like a human being. Russell and Norvig describe these machines and skills that they should have to be capable to thinking and acting humanly.

> "Natural language processing to enable it to communicate successfully in English; knowledge representation to store what it knows or hears; automated reasoning to use the stored information to answer questions and to draw new conclusions; machine learning to adapt to new circumstances and to detect and extrapolate patterns". (Russell, Norvig, 2003)

If thinking as the man requires to development cognitive and meta-cognitive models of the human mind not yet achieved the realization robots it is more liable that act as man (which includes an advanced hardware with biomechanical characteristics). Besides, in a human-machine interaction, man expects that machine behaves in the most appropriate (and natural) way of doing, in according to the situation that involves them (how another person can do). For example, if people are faced with an automated highway toll collector, a driver expects to perform the same payment procedure that would follow if the highway's toll collector was human; and the same is true for the automatic

cash machines in supermarkets and drinks and coffee machines (which are examples of simpler robotic systems).

3.1.2 Acting and thinking rationally

The rational action has always been one of the possible modes of behaviour of people. Robots can act using this kind of way for their decision-making process. Much of the researches on robotics have focused on this trend that has already brought great successes. In the interaction human-robot the ability of a machine to act rationally (and predictable) has always increased confidence associated with such robotic systems, increasing their spread, their success and their use in many contexts. For example, a robot system for automatic landing gear in airplanes has allowed their installation in each airplane model. Often, in this category of Artificial Intelligence software, it is contained the expert systems that emulates decision-making process of a human expert and mobile agents' systems applied in many areas such as the management of databases and operating systems (Todino, 2009), in Artificial Intelligence an agent is:

> "Just something that acts (agent comes from the Latin agere, to do). Of course, all computer programs do something, but computer agents are expected to do more: operate autonomously, perceive their environment, persist over a prolonged time, and adapt to change, and create and pursue goals. A rational agent is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome". (Russell, Norvig, 2003)

Again, to program a rational machine that acts as a human expert or through a series of agents who decide together what to do, it would be faced to the limit of cognitive and

metacognitive modelling of human mind. Nevertheless, to produce a machine that acts in a rational way is definitely an achievable goal thanks to long studies carried out on logic. In this regard, it is important to consider that:

> "The Greek philosopher Aristotle was one of the first to attempt to codify "right thinking," that is, irrefutable reasoning processes[...] There are two main obstacles to this approach. First, it is not easy to take informal knowledge and state it in the formal terms required by logical notation, particularly when the knowledge is less than 100% certain. Second, there is a big difference between solving a problem "in principle" and solving it in practice. Even problems with just a few hundred facts can exhaust the computational resources of any computer unless it has some guidance as to which reasoning steps to try first. Although both of these obstacles apply to any attempt to build computational reasoning systems, they appeared first in the logicist tradition". (Russell, Norvig, 2003)

Summarizing, we can divide the machines in two types that collect in pairs the previous categories (Searle, 1992):1) strong Artificial Intelligence: Thinking humanly or rationally; 2) weak Artificial Intelligence: Acting humanly or rationally. In strong artificial intelligence, machines should really "think" while in weak intelligence machines only "simulate" human behaviour.

3.2 AI and human teaching-learning process

The human teaching-learning process has a characteristic linked to memory: as one learns one can forget. In some cases, we can forget little information, but we cannot "overwrite" memory as it happens on computer hard drives.

In some cases, a man learned something wrong and this man remembers to have corrected the information contained in his memory and keeps track of this entire path. He remembers the incorrect information as well as he remembers the new one.

Let's take an example: first case: I mistakenly believe that the capital of Germany is Cologne, and then I learn that it is Berlin and I remember that before I thought it was Cologne. Second case: I learn that the capital of Germany is Berlin; I do not remember what I previously believed.

Now the point is: a neural network and other artificial intelligences, if they learn through wrong data sets what do they do when they store wrong information? Massachusetts Institute of Technology proposes to program neural networks that are able to "learning what to remember and what to forget" because:

> "Memory is a precious resource, so humans have evolved to remember important skills and forget irrelevant ones"[10].

This is in another way talking about: "Learning to learn" a feature well knows in the pedagogical and didactical research. In fact, the "recommendation of the European parliament and of the council" of 18 December 2006 on key competences for lifelong learning (2006/962/EC) this skill is well known and explore this human-key competence should drive a line to "create" i.e. program machine able to learn to learn. In this document there is clearly defined that:

[10] https://www.technologyreview.com/s/609710/neural-networks-are-learning-what-to-remember-and-what-to-forget/

‘Learning to learn’ is the ability to pursue and persist in learning, to organise one's own learning, including through effective management of time and information, both individually and in groups. This competence includes awareness of one's learning process and needs, identifying available opportunities, and the ability to overcome obstacles in order to learn successfully. This competence means gaining, processing and assimilating new knowledge and skills as well as seeking and making use of guidance. Learning to learn engages learners to build on prior learning and life experiences in order to use and apply knowledge and skills in a variety of contexts: at home, at work, in education and training. Motivation and confidence are crucial to an individual's competence. Essential knowledge, skills and attitudes related to this competence: Where learning is directed towards particular work or career goals, an individual should have knowledge of the competences, knowledge, skills and qualifications required. In all cases, learning to learn requires an individual to know and understand his/her preferred learning strategies, the strengths and weaknesses of his/her skills and qualifications, and to be able to search for the education and training opportunities and guidance and/or support available. Learning to learn skills require firstly the acquisition of the fundamental basic skills such as literacy, numeracy and ICT skills that are necessary for further learning. Building on these skills, an individual should be able to access, gain, process and assimilate new knowledge and skills. This requires effective management of one's learning, career and work patterns, and, in particular, the ability to persevere with learning, to concentrate for extended periods and to reflect critically on the purposes and aims of learning. Individuals should be able to dedicate time to learning autonomously and with self-discipline, but also to work collaboratively as part of the learning process, draw the benefits from a heterogeneous group, and to share what they have learnt. Individuals should be able to organise their own learning, evaluate their own work, and to seek advice, information and support when appropriate. A positive attitude includes the motivation and confidence to pursue and

succeed at learning throughout one's life. A problem-solving attitude supports both the learning process itself and an individual's ability to handle obstacles and change. The desire to apply prior learning and life experiences and the curiosity to look for opportunities to learn and apply learning in a variety of life contexts are essential elements of a positive attitude"[11].

"Goals" remind us goals-functions that are included in many intelligent machines. Although comparing this human key competence to robots and artificial intelligence could see extreme in this paragraph it was assumed that machines must act and think like men. Thus, this should be their arrival's point.

3.4 AI forecast: market and jobs

It is important to carry out forecast about the possible trends of Artificial Intelligence industry, in order to better interpret the European recommendations for making future scientific research. Tractica's 2016 report[12] (that combines qualitative and quantitative research methodologies) provides a prevision of these trends, which are summarized in the figure below (Artificial Intelligence Market Forecasts 2016-2025).

[11] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32006H0962
[12] https://www.tractica.com/wp-content/uploads/2016/08/MD-AIMF-3Q16-Executive-Summary.pdf

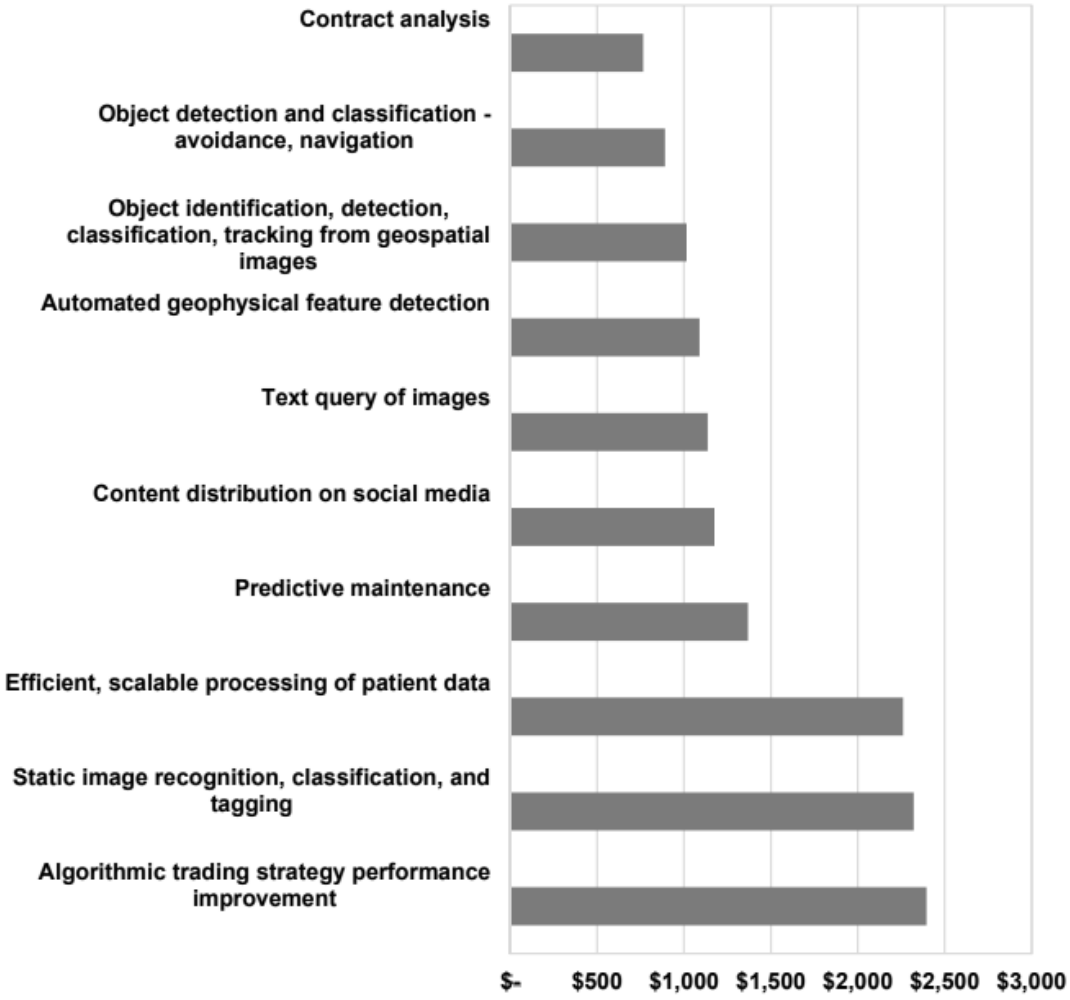

Figure 8: top 10 AI Revenue World Markets in 2025. SOURCE: Tractica's 2016 report.

It is possible to note that Tactic's forecast can be inserting in the context of a weak Artificial Intelligence i.e. acting humanly or rationally. In fact, in recent years Artificial Intelligence produces have been left the idea to create Artificial Intelligence systems to reproduce the human mind, through models that simplify our cerebral system (Rossi, 2011). From Tactic's forecast, it is possible to understand that producers are promoting expert systems and artificial neural network trained by users able to adapt themselves according to the choices of their users to learn from their habits and to offer better services in search engines, in webmail, social networks, in web applications, standalone

applications, in operating systems, etc. (Ng, 2016; Rawlins, 1997; Searle, 1992, Todino, 2009; Volante, Babu, Newsome, Ebrahimi, Fasolino, 2016). A *Media Educator* should know these trends to be ready to understand what the *Media* challenges of the future and their impact on will be didactic and pedagogy (Rivoltella, 2012, 2016a; 2016b; Di Tore, 2016; Sibilio, 2014, 2015, 2017; Todino 2016). Besides it is important to highlight also that actually "Machine Learning Engineer" is the fastest-growing job.

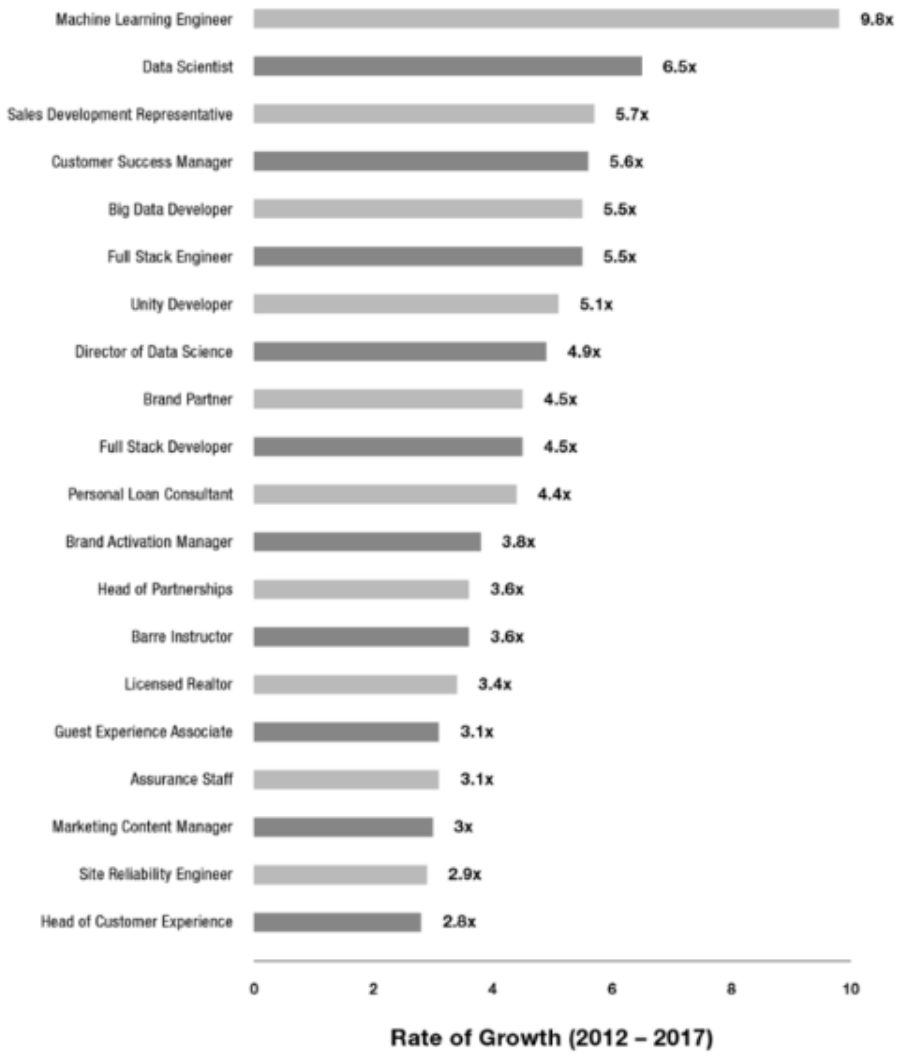

Figure 9: fastest-growing job. SOURCE: LinkedIn's 2017 U.S. Emerging Jobs Report[13]

[13] http://news.codecademy.com/what-is-machine-learing/?utm_source=customer.io&utm_medium=email&utm_campaign=fortnightly_2-22-18&utm%E2%80%A6

3.5 Different AI approaches

This Artificial Intelligence review should be useful to better understand what is "in the box" of a robot and to better target future researches and read with more “tools” the European recommendations.

In this work it was addressed the issue of robotics starting with the EU recommendations that are a useful tool to each member state to monitor and legislate on this topic. Through a series of descriptions, robots were analysed from many points of views. Looking in detail the operational mechanisms of robots (with a white-box approach) it is tried to decrease the position in which technology as view as viral element, in which people suffer from the introduction of new electronic devices to improve a position where users decide how to use a new ICT object. This consideration invites educational research and the education school system to increase the path of awareness in the use of robotics and future technologies.

This awareness serves to avoid a model of social organization conditioned by robotics, to propose a balanced man-machine relationship, which is able to safeguard human interaction directionality, limiting the risks of any possible adaptation induced by the machine and not by people. Teachers are called to drive this perspective, so they should improve their *Media* skills (regardless of the discipline they teach) in order to help to advice and to guide their students, about a conscious use of any ICT devices and systems.

At the same time, it would be advisable, that numerous studies, both industrial, educational and pedagogical would allow, aggregating them, to bring out a number of theo-

ries and practices useful for robotics management, at school, at work and in daily life but at the same time are our daily needs changing robotics, as a “market” where supply and demand chasing each other and fit together. This cyclical process is often carried to excess in the ICT market (in which development time, time to market and obsolescence of the devices is stressed, sometimes for real reasons technological overtaking, sometimes for business decisions) and it becomes a negative element. It serves, therefore, an "ethical" monitoring by the educational research because, often, this dimension is not considered by manufacturers of electronic and electromechanical devices; but it is highlighted by the European recommendation which instead emphasizes the ethical necessity, which has to play the European community and educational institutions.

Widening the vision concerning the future, Educational research can surely follow, at least tree trajectories on the topic of robotics.

From artificial to reality trajectory, where a robotic system is a new *Media* that can be studying to test and to use it in human teaching-learning processes.

From reality to the artificial trajectory: where educational researchers help ICT sector to improve machine learning processes based on their studies about human teaching- learning process, which has been investigated, understood and faced from many ontological and epistemological ways. The studies, reported in artificial intelligence, can bring out human elements (modelisable, extensible, generalizable, and testable) in an artificial learning process.

Find an adequate level of "transparency"[14] in technological knowledge for a *Media Educator*: Start a further study on theme of the white-box approach for an educator who will not usually have a white/black (known/unknown) vision of technology but related through infinite levels of "transparency" and "opacity" due to educator's technological skills and knowledge.

[14] "Transparency" In terms of technological knowledge, Should not be confuse with the concept of "opacity" of a Media device (Di Bari, 2009), in which the interface masks the technology (Such as the Kindle® e-book reader that It's opaque because it behaves like a printed book, where a finger touch is enough to turn page).

Chapter IV: Simplexity for *Media Educators*

4.1. Strengths, Weaknesses, Opportunities, and Threats

Media Educator is a new professional figure that performs an educational and pedagogical activity that aims people to understand mass *Media* (their nature, their techniques and their languages). Nowadays In many Italian and foreign universities, new teacher education includes one or more exams related to *Media Education*. Some pertinent research questions are therefore:

1) What does a *Media Educator* need to know?
2) What are the differences between a *Media Educator* and a computer programmer?

To be able to answer, let's start analysing what a *Media Educator* should do. First, every day *Media Educators* the use of new *Media* and explain them to their students' functionality and much more. Thus, a *Media Educator* studies a *Media* and its characteristics, functionalities and much more to better understand: Strengths, Weaknesses, Opportunities and Threats from many points of view (i.e. SWOT Analysis).

Figure 10: SWOT matrix (a possible use) to highlight Strengths, Weaknesses, Opportunities, and Threats of new *Media*. SOURCE: Wikipedia

Consequently, it is important to emphasize that each *Media* is a very complex communication phenomenon (Rivoltella, 2012, 2016a; 2016b; Di Tore, 2016) moreover; technological aspect of each *Media* plays a central role in defining their nature and their functioning. However, a simple technological analysis of internal operation (open the box to see inside) and interfacing with the outside world (input and output analysis) it would not be exhaustive, and it would not give importance to the role of *Media* in individual and social communications (Ciotti, Roncaglia, 2000). Besides it is important to show links between technological factors and other aspects such as: languages, content, emission and fruition characteristics (Ciotti, Roncaglia, 2000).

4.2. Digital technologies and their impact on "the world of learning"

Nowadays, the literature reviews show that digital technologies have an important role in education has been consolidated (Laurillard, 2014). Besides, it is important to remember that *Media Education* and education technology can be two points of view of the same object (a Media) and they regard the study of technologies, and at the same time they are two areas of study and research partly superimposed (Rivoltella, 2012, 2016a; 2016b; Di Tore, Aiello, Di Tore, Sibilio, 2012). Digital technologies in the last thirty years had an incredible impact on "the world of learning" but it is possible to believe that “the educational system" has not been imbibed them yet and this have created a big "shock" Still not absorbed by "the educational system" (Laurillard, 2014).

In fact, the amount of new technologies in numerical terms and the vastness of the fields of use of devices and codes cannot be easily incorporated from the educational system that should be changing to include all of them (Laurillard, 2014) to achieve a harmonization. More precisely, according to Laurillard, since the effect of digital technologies has certainly impact on education (not just about *Media Educators* and their education and training) it is crucial for teachers to be in a position to manage properly each technology and *Media*, to explore their potential and use them for education purposes (Laurillard, 2014). Starting from these considerations, an open-the-box approach should be useful to better understand and explore *Media* and its subsystems and use it for education purposes.

This methodological approach is a gradual increase of skills in the field of education technology and information technology but useful to understand, in deep, a *Media*, the main limit is time (often there is no enough time to open one box after another in a *Media Education* and training course). According to Laurillard, if we have confidence in our technological capabilities, we can go beyond simple knowledge, until a full use of new opportunities provided by digital technology; In other words, technical knowledge generally has a positive impact in terms of use of the *Media*. Laurillard also invites to following this consideration: for every new technology it is reasonable to ask what its possibility and opportunity should be to reach educational goal used it and that this technology has been realized in other areas and sectors, generally for other purposes and it is not optimized for the teaching-learning process (Laurillard, 2014).

Each *Media* is being like a box and a *Media Educator* should open the box to see inside how it works then it is appropriate to ask what level of "transparency" of technological knowledge would be adequate to prepare *Media Educators* to their job. In fact, computer systems are composed from subsystems that can be seen, again, as new small black boxes to open and understand. In conclusion, an open-the-box approach increases the technological knowledge of a *Media* and promotes its adaptation for educational purposes (Sibilio, 2014, 2015, 2017a; 2017b; Todino 2016).

4.3. Digital skills summary

Accordingly, with this brief description, pronounced above, of what a *Media Educator* needs to know, it is immediately possible to notice that some differences from a *Media Educator* with a computer programmer include that It is not required to: know how to program devices (typical of expert programmers), know how to perform complex configuration (typical of network system administrators). In conclusion, *Media Educators* won't be focused mainly on understanding devices and codes as computer programmers, but they will be focused on other peculiar elements of the *Media* such as social, cultural, linguistic and semantic aspects (axes that generate the skills of a *Media Educator*). In short, the skills could be summarized as follows:

a) Learning about and coming to appreciate[15] *social* aspects of *Media*.

b) Learning about and coming to appreciate *cultural* aspects of *Media*.

c) Learning about and coming to appreciate *linguistic* aspects of *Media*.

d) Learning about and coming to appreciate *semantic* aspects of *Media*.

e) Learning about and coming to appreciate *an open-the-box approach* to better understand and explore *Media* and its subsystems and use it for education purposes (a basic computer science view less deep then for computer programmers or

[15] "Learning about and coming to appreciate" is a typical expression used by Paul Gee (2013) in his book

network system administrators but deep enough to understand the underlined logic).

f) Learning about and coming to appreciate *ICT trends and forecast* (for examples: robotics, Artificial Intelligence, etc.) to be ready to understand what the *Media* challenges of the future and their impact on will be didactic and pedagogy.

4.4 Teacher education and digital skills

The Italian parliament, as well as other EU countries, promotes the development of digital culture, and it defines new policies (Italian law 107/2015 and further integrations) for improve digital services and favours computer literacy. Consequently, in the European Community it will be necessary to have digital-skills and *Media Education* specialized teachers able to use this knowledge in every kind of school. Agreeing with these premises, Italian and European teacher education systems should include a course, and an exam, of *Media Education* to include these skills in future teacher curriculum.

More in details, in 2015 a new Italian law (107/2015) changed school scenario in many directions, one of these it will be focused on this work: *Media Education* skills. According to this law future teachers are called to teach many ICT e *Media* elements, knowledge, abilities and skills. For example, in Italy according with this law, they should teach *Digital skills: coding and development of computational thinking at primary schools and Digital Makers Plan at high school*, this proof that teachers should include in their curriculum expertise typical of a *Media Educator*.

Thus, this thesis tries to highlight that teacher education systems should include a course, and an exam, of *Media Education* to include these skills in future teacher curriculum. For these reasons many Universities are evaluating a possible implementation of courses for *Media Educators* to include inside the teaching technologies courses provided for 24 CFU (university training credits) necessary for access to initial training internship for new teacher's recruitment (in according with new Italian Law D.M. 616/2017).

Chapter V: Simplexity and ICT in the context of primary school

5.1. Simplexity and education

In this thesis there will be showed briefly the starting point that moved a simplex approach of didactics and it is possible to read a lot of work about this paradigm proposed by Professor Maurizio Sibilio (2014, 2015,2017b) of the University of Salerno, based on the concept of simplexity (Berthoz, 2011).

> "In his book Simplexity: Simplifying Principles for a Complex World (2012), Berthoz suggests a preliminary list of basic characteristics of life that constitute the tools for life for the creation of different patterns of interaction among the constitutive parts of a system. In other words, these provide the theoretical underpinnings for the interpretation of the behaviour of complex adaptive systems". (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

Sibilio's starting point shows that there is a collection "of significant contributions in scientific literature which investigated the possible application of the concept of complexity in the field of education and didactics (Sibilio, 2015, p.484). At the same time didactics fields of interest are plural and they are composed of a variable number of interacting elements that create a complex system. Thus:

"As a consequence, – the didactic phenomenon can be considered as the union of various parts; – the observer shaping the system is able to extract specific subsets of relationships among the components which can define the organization and identity of the phenomenon of didactics; – the identity of this didactic system is linked to a specific class of systems and may be investigated through the conceptual tools used to study the specific class of systems to which it belongs; – different subsets of relationships among the components of the didactic structure can be isolated by the observer as possible organizations. According to these relationships identified by the observer, the didactic phenomenon can be defined as potentially belonging to different classes of systems". (Sibilio, 2015, p.485)

Besides:

"The recognition of the didactic system as a complex adaptive system leads to the reflection on the possible application of the properties identified by Alain Berthoz to the interactions which occur among its elements, stimulating a debate that involves the scientific community called to find answers to the different kinds and levels of educational complexity. If the didactic system is a complex autopoietic system, the simplex properties and principles define the patterns of interaction which allow deciphering and facing complexity through specific schemes of action. The properties and principles of the didactic system, taken from a simplex perspective, create the adaptation on the basis of that which emerges from the internal and external interactions of the system itself, stimulating a perspective of educational research which, emerging from praxis, solutions of simplification could be found. These solutions are not normative and prescriptive in a linear way, but are intended for the reformulation of the theory of teaching". (Sibilio, 2015, pp. 477-493)

Now we can start to have a look to create a correlation between ICT didactics (focus on *Media Educator* “educational need”) and a simplex way to teach it, remembered that to all information about simplexity and didactics there are a lot of book in which it is well described (Sibilio, 2014, Aiello, 2012a) and article (Sibilio, 2015, 2017b).

However, it is possible to justify this choice of content and clarify that simplexity arises as a response to the complexity descriptive drift of national and international educational research. Based on Berthoz's proposal, simplex didactic proposes properties and principles that can be applied to teaching and will be quoted in this chapter according to the scheme proposed by Sibilio (2014) and further study (Pace, Aiello, Sibilio, Piscopo, 2015). In this way each reader can autonomously understand how simplexity real works in a generic and ICT contest.

5.2. European key competences and simplexity

Nowadays, Computer science is entered completely into primary school, as a tool to support teaching in many ways: ICT instruments, web applications, web quests and also as metacognitive activates such as computational thinking, rational thinking and the use of technologies for the resolution of problems (Todino, 2016). Besides, Italian national guidelines for the curriculum (for early childhood and early education) in 2012 (and reinforced in 2018 from new guidelines), clearly state that the study and the exercise of technology encourage and stimulate the general human attitude to pose and treat problems, making dialogue and collaborating cognitive, operational, methodological and social skills. It is important for technical culture to mature an ethical and responsible tech-

nological practice, far from inappropriate reductionism or specialism and attentive to the human condition in its entirety and complexity (MIUR, 2012, 2018)

In this prospective, the technology deals with the interventions and transformations that a person should do towards the environment to guarantee survival and, more generally, to satisfy their needs. These Italian national guidelines (MIUR, 2012, 2018) are the continuation of a long legislative process expressed in Italy through the Ministerial Decree No. 139 of 22/08/07 and, previously, in Europe through the Recommendation 2006/962 / EC Information technology has ancient roots. This view is linked to: logic and strategic planning, ensemble vision, use of proportion as an instrument of investigation and statistical vision of events (Todino, 2016) to improve computational thinking, rational thinking and the use of technologies for the resolution of problems and this vision is one of the 8 points that each future EU citizen should have to live well, find a job and create his future. More in details the 8-key competence are the following[16]:

1. Communicating in a mother tongue: ability to express and interpret concepts, thoughts, feelings, facts and opinions both orally and in writing.
2. Communicating in a foreign language: as above, but includes mediation skills (i.e. summarising, paraphrasing, interpreting or translating) and intercultural understanding.
3. Mathematical, scientific and technological competence: sound mastery of numeracy, an understanding of the natural world and an ability to apply knowledge and technology to perceived human needs (such as medicine, transport or communication).

[16] http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=LEGISSUM:c11090&from=EN

4. Digital competence: confident and critical usage of information and communications technology for work, leisure and communication.
5. Learning to learn: ability to effectively manage one's own learning, either individually or in groups.
6. Social and civic competences: ability to participate effectively and constructively in one's social and working life and engage in active and democratic participation, especially in increasingly diverse societies.
7. Sense of initiative and entrepreneurship: ability to turn ideas into action through creativity, innovation and risk taking as well as ability to plan and manage projects.
8. Cultural awareness and expression: ability to appreciate the creative importance of ideas, experiences and emotions in a range of *Media* such as music, literature and visual and performing arts.

Computer science skills are directly related with competence 3 and 4 (this means 25% of total) and indirectly to each of all, as a tool and with all kind of possible support applications. More in details EU define point 4 as:

> "Digital competence involves the confident and critical use of Information Society Technology (IST) for work, leisure and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet. Essential knowledge, skills and attitudes related to this competence: Digital competence requires a sound understanding and knowledge of the nature, role and opportunities of IST in everyday contexts: in personal and social life as well as at work. This includes main computer applica-

> tions such as word processing, spread sheets, databases, information storage and management, and an understanding of the opportunities and potential risks of the Internet and communication via electronic Media (e-mail, network tools) for work, leisure, information sharing and collaborative networking, learning and research. Individuals should also understand how IST can support creativity and innovation and be aware of issues around the validity and reliability of information available and of the legal and ethical principles involved in the interactive use of IST. Skills needed include the ability to search, collect and process information and use it in a critical and systematic way, assessing relevance and distinguishing the real from the virtual while recognising the links. Individuals should have skills to use tools to produce, present and understand complex information and the ability to access search and use internet-based services. Individuals should also be able use IST to support critical thinking, creativity, and innovation. Use of IST requires a critical and reflective attitude towards available information and a responsible use of the interactive Media. An interest in engaging in communities and networks for cultural, social and/or professional purposes also supports this competence.[17]

ICT skills are configured, in the theoretical framework of multiple intelligences (Gardner, 2002), in particular that defined mathematics, inserting themselves into possible metacognitive strategies. This intellectual "field" must be set in motion, training and well exercise, in this way it allows us to find new and original solutions in problems to be faced daily (Todino, 2016).

More in details, in this work it is possible to go deeply and see that The Recommendation 2006/962/EC, of the European parliament and the European council, determines a starting point for a new way to thing about every school of Europe. Thanks to this

[17] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32006H0962

recommendation (that it is not a low but a way to follow by any countries) the school must design (project etc.) paths aimed to have key citizenship skills. These skills should be achieved years by years during the time that a student spends at school.

Italy agree to take these recommendations through a low wrote by Ministerial Decree (D.M. no. 139 of 22nd August 2007) entitled *Regolamento recante norme in materia di adempimento dell'obbligo di istruzione* that talk about regulations containing education roles for the first period of studies that every citizen has ably to follow. In these years, to six to sixteen years old, every citizen has to receive many knowledge, abilities and skills in according with 2006/962/EC and others Italian low.

Although many Italian researchers have questioned if the D. M. no. 139 of 22nd August 2007 is really a correct transposition of the document 2006/962 / EC and also if the key European competences are in univocal relation or not with those proposed by the Italian legislative document of 2007, what emerges surely is that every teacher is called to be sure that their students know: 1) Communicate or understand messages of different complexity, transmitted using different languages and/or using different *Media* (paper, computer and multimedia); 2) to acquire and interpret information, i.e. to acquire and critically interpret the information received in the various areas and through different communication tools, evaluating their reliability and usefulness, distinguishing facts and opinions (D.M. 139 del 2007). Thus, 2006/962/CE clearly said that this includes "computer applications" and "communication via electronic *Media* (e-mail, network tools) for work, leisure, information sharing and collaborative networking, learning and research".

This key competence in according with EU Recommendation would contribute to the development a qualified ICT education able to join the needs of European society (2006/962/CE) and EU member states school systems should offer all young people the means to develop this ICT digital key competence to a level that "equips them for adult life" (2006/962/CE), in this case to equip means to give someone the skills needed to do a particular thing, in this case be able to use digital technology for every aspects of his life: free time, at work, etc.

In order to do this a primary school's teacher who is faced with these recommendations needs to analyse them and then put all these key competences into everyday work at school and convert a low in everyday work action and activities.

In this process (convert key competence in activities and actions), simplex didactic, that will be introduce soon in details, can be a useful interpretative tool to act through clear and practical principles, based on a consolidated methodological approach. Thanks to these principles, a teacher can implement a series of strategies that allow their students to achieve excellent results.

What simplexity is? And what simplex didactic refer to? To give and answer it is necessary to start to studies proposed by the engineer and physiologist of action Alain Berthoz, Professor at the College de France, Director of the Laboratory of Physiology of Physiology of Perception and Action of CNRS. Alain Berthoz published about many categories, in particular: 1) Theory of Action; 2) Intrinsic Basis of Action; 3) Funda-

mental Actions and 4) Locomotor Actions. In 2011 Alain Berthoz propose a framework call simplexity to unify many properties, features, roles, patterns typical of any organism and group of organisms that can be extended to many kind of complex system, Berthoz proposes a list of characteristics that will be proposed in this work point by point. More in details it is possible to say if a system is or not a simplex system verified many parameters and, for example didactic system and a school classroom can be describes as a simplex system. So now is time to give a definition of simplexity.

> "The concept of simplexity is an ensemble of solutions that appeared in the course of evolution to allow living organisms to survive despite the complexity of natural processes. These biological devices or processes allow a complex adaptive system, as is the human being, to "process complex situations very rapidly, elegantly and efficiently, taking past experience into account and anticipating the future" (Berthoz, 2012, p. 3). Furthermore, by means of a fundamental principle of intersubjectivity, individuals are able to understand the intentions of others. From a competency-based perspective, these solutions can be defined as a set of skills living organisms use to prepare actions and foresee their consequences. Berthoz outlines that principles and properties may not only be observed in physiological processes but may be applicable to all levels of human activity. As a matter of fact, although still relatively novel, simplexity theory has already been applied to various disciplines, such as education, to offer possible solutions to the complex and adaptive educational system. [..] Berthoz suggests a preliminary list of basic characteristics of life that constitute the tools for life for the creation of different patterns of interaction among the constitutive parts of a system. In other words, these provide the theoretical underpinnings for the interpretation of the behaviour of complex adaptive systems." (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

5.3 ICT and simplex didactic

This paragraph reviews some concepts seen previously to better understand simplex didactic (Sibilio, 2014). It was born as a didactic reflection of Alain Berthoz's theory of simplexity, derived through the study of living organisms that it has indemnified a series of properties and principles that allow them to survival. Simplexity states that these organisms face complexity of the environment around them through a series of operational modalities that aim to adapt to change and manage with situations around them. The theory of simplicity is founded on an axiomatic basis: if an organism presents a series of properties, it will have characteristics such that it will deal with the complexity (internal and external) through a series of guiding principles. Such kind of organism is defined simplex. Even a system that satisfies these properties by definition is simplex. By deduction (satisfying the properties) the scholastic system is simplex, the management of a class is simplex, etc.

An extensive literature explains in detail how to apply this type of didactic (Sibilio, 2014, 2015, 2017b). In this work, its properties and principles will now be described in ICT didactic, in the context of primary school. At the same time a series of software and online resources will be suggested to a *Media Educator*/teacher to use during a lesson. In fact, as it was explained a teacher should have ICT and *Media Education* skills, and then this teacher should be able to do a didactic transposition of these subjects. In this work it was underline that simplex didactic can be a useful tool to develop these skills first in teachers and later in their students. As it is well known, a teacher must have es-

sential computer skills, and then a teacher can be able to realize a didactic transposition of these ICT themes (Todino, 2016).

ICT didactic is a good field to experiment paths due to help the overcoming of some difficulties that can be found in the learning teaching process, promoting at the same time the teacher's aptitude to practice meta-cognitive processes. Technologies, in fact, “hold” resources (Berthoz, 2011), define properties, and introduce simple rules in the daily didactical action (micro vision) and in the design phase of a lesson or a period of many months of school activities (macro vision) (Todino, 2016). In this thesis, to summarize, the following exercises will refer to a double point of view:

Line 1: show many parallelisms present among the models of information processing (and/or telecommunication) and the human being;

Line 2: from the other solutions will be proposed information to be used in the classroom (Todino, 2016).

For each example it will be compile a table to show if it is used some of *Media Educator* skills described previously.

EXAMPLE NAME:	
USE	SKILLS (MORE USED)
☑☒	SOCIAL ASPECTS OF MEDIA
☑☒	CULTURAL ASPECTS OF MEDIA
☑☒	LINGUISTIC ASPECTS OF MEDIA
☑☒	SEMANTIC ASPECTS OF MEDIA
☑☒	OPEN-THE-BOX APPROACH
☑☒	ICT TRENDS AND FORECAST

Table 2: skills list for *Media Education* (list explored in this work).

5.4 ICT and simplex proprieties

5.4.1. Specialisation and modularity

Now, it is the moment to introduce simplex proprieties one after another to start to me familiar with them. First Berthoz proposed these characteristics "Specialisation and modularity" and it is present also in simplex didactic (consequently also in ICT didactic that adopt this paradigm). It is possible to describe it in according with this study (Pace, Aiello, Sibilio, Piscopo, 2015):

> "Specialisation and modularity, which is the breakdown of a complex task into various functions. This coexistence of diverse functions guarantees a simultaneous utilization of diverse adaptive schemes to facilitate better control of action (Sibilio, 2014). For example, in the human brain, different areas process specific aspects of perception, action, memory, and emotion, while in society, this modularity can be observed in the division of work". (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

Line 1: Is computer science, ICT, telecommunication etc. in line with Specialisation and modularity? Yes, it is possible to proof that they are. ICT and telecommunications are based on this principle. A teacher can explain practical and metaphorical parallel between living organisms and hardware and software element, if this teacher wants to highlight how simplex work or explain metacognitive elements using this parallel, or do it without do it in an explicit way, i.e. teach simplexity and use a simplex didactic while students don't know that teacher use simplex properties and principles. More in detail, it is possible to explain with an example: each computer is managed by an operating system and the various functions are subdivided into modules. These modules can be inter-

nal to the operating system as happened with embedded driver typical of Windows, Linux, and MacOS or external as happened with API function downloadable with many application and development kit. Although this last sentence is very technical it is possible to simplify it saying: Computer software is created united many blocks and the same it is for computers hardware.

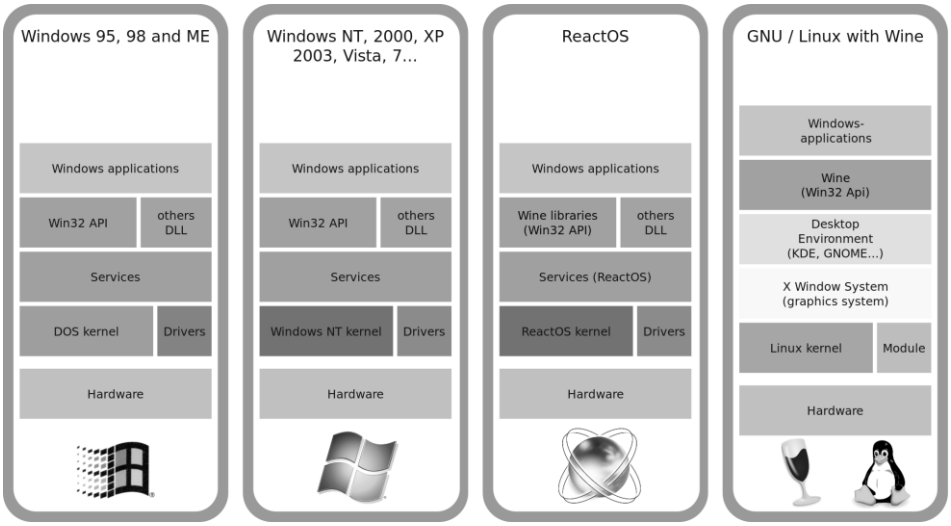

Figure 11: Operating-System blocks comparison. SOURCE: https://commons.wikiedia .org/wiki/File:Windows-like_comparison.svg

EXAMPLE NAME: **Operating-System blocks comparison.**	
USE	SKILLS (MORE USED)
☒	SOCIAL ASPECTS OF MEDIA
☒	CULTURAL ASPECTS OF MEDIA
☒	LINGUISTIC ASPECTS OF MEDIA
☒	SEMANTIC ASPECTS OF MEDIA
☑	OPEN-THE-BOX APPROACH
☑	ICT TRENDS AND FORECAST

Table 3: *Media Educator*'s skills and Operating-System blocks comparison.

Example number two: focusing on Telecommunications it is also possible to separate functions. For example, selecting the best, and appropriate, channels for exchange information (voice channel, data channel) and it is possible to use also modularity. Internet, for example, is a hierarchical structure. Internet is similar to a big web. But if it is studies in details is more like a mathematical network, which has fibre optic backbones that become little copper, wired that arrive to each houses and offices using ADSL technology.

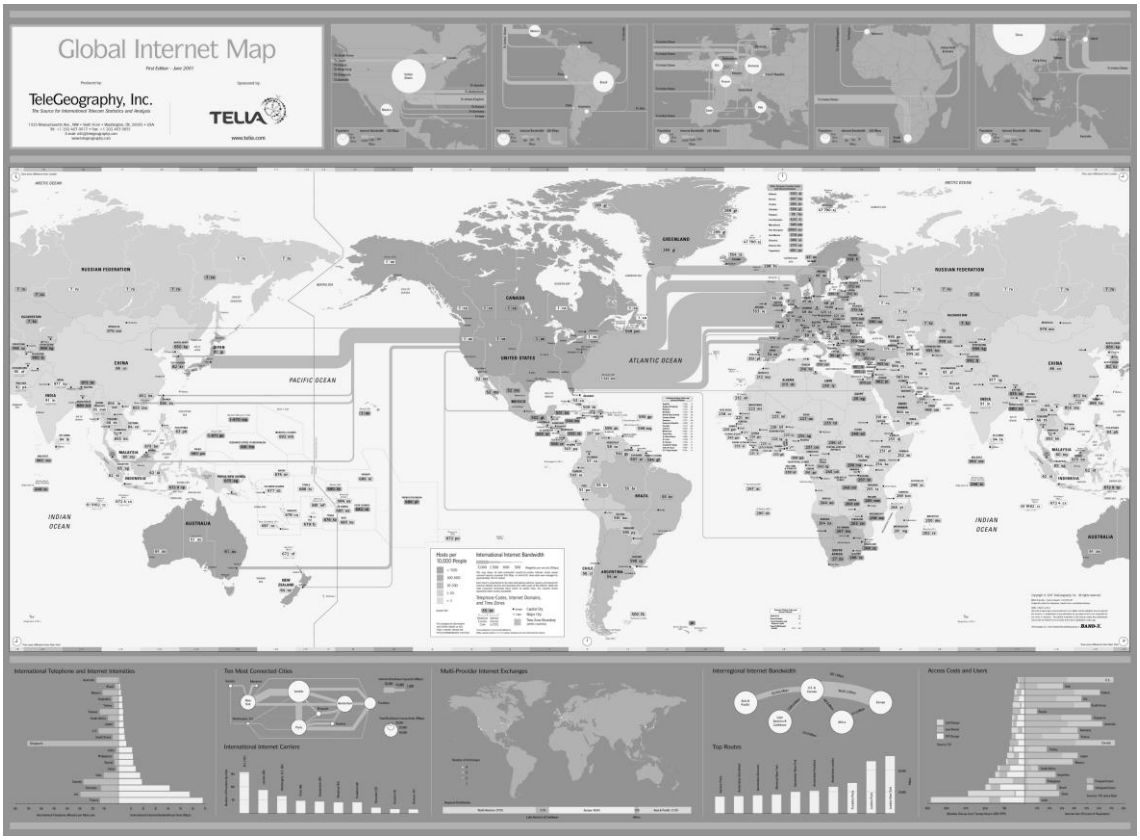

Figure 12: Internet Map. SOURCE: https://www.telegeography.com/assets/website/images/maps/global-internet-map-2001/global-internet-map-2001-x.jpg

EXAMPLE NAME: **Internet map and topology.**	
USE	SKILLS (MORE USED)
☑	SOCIAL ASPECTS OF MEDIA
☒	CULTURAL ASPECTS OF MEDIA
☒	LINGUISTIC ASPECTS OF MEDIA
☑	SEMANTIC ASPECTS OF MEDIA
☑	OPEN-THE-BOX APPROACH
☑	ICT TRENDS AND FORECAST

Table 4: Skills list for a *Media Educator* and Internet Map.

Line 2: Both these examples (of Line 1) can be used in many ways. As said before: explains applied and figurative parallelisms, shows metacognitive fundamentals thought simplexity and use simplex didactic.

Figure 13: topology of streets system at the time of Rome. SOURCE: http://www.romanoimpero.com/2010/07/le-strade-romane.html

There is a long history of networks similitudes: water and streets system in ancient Rome, trains system, highways system and in general network mathematical and topological skills that is important to improve in each student correlated with EU mathematical key competence. A typical example could be "The Seven Bridges of Königsberg[18]" that is a historically famous problem, in mathematics, solve by Leonhard Euler, famous Swiss mathematician, that understand and used to the foundations of graph theory.

[18] City under the Baltic see, it is today Known as Kaliningrad.

Figure 14: modularity of a network that can be view as nodes and connected by edges, arcs, or lines. SOURCE:https://it.wikipedia.org/wiki/Problema_dei_ponti_di_K%C3%B6nigsberg

EXAMPLE NAME: **modularity of a network that can be view as node and connected by edges, arcs, or lines.**	
USE	SKILLS (MORE USED)
☒	SOCIAL ASPECTS OF MEDIA
☒	CULTURAL ASPECTS OF MEDIA
☑	LINGUISTIC ASPECTS OF MEDIA
☑	SEMANTIC ASPECTS OF MEDIA
☑	OPEN-THE-BOX APPROACH
☒	ICT TRENDS AND FORECAST

Figure 15: *Media Educator*'s skills and modularity of a network that can be view as node and connected by edges, arcs, or lines.

5.4.2. Speed

Berthoz proposed "speed" as a characteristic typical of any living organism and consequently to any simplex systems such as didactical systems and daily teaching actions. Speed is a cognitive and embodied propriety. It is possible to refer to it in this way:

> "Speed referring to the ability of decision making by anticipating and predicting consequences of actions, through the capitalization of the results of past experiences and guessing and betting on the behaviour of others. These are not necessarily simple solutions, but need to be rapid, elegant and effective. They are very often taken in milliseconds as the reaction of a living organism when faced with danger, or during a negotiation meeting where anticipating the possible reactions to an offer becomes crucial". (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

Line 1: Speed, as defined in simplexity, is the ability of decision making by anticipating and predicting consequences of actions and it is included in many Internet router's strategies and protocols. Each router is a node of the network. It is possible to show that:

> "An "internet" is a group of interconnected networks. The Internet, on the other hand, is the collection of networks that permits communication between most research institutions, universities, and many other organizations around the world. Routers within the Internet are organized hierarchically. Some routers are used to move information through one particular group of networks under the same administrative authority and control. [..] Routing protocols used [...] are dynamic in nature. Dynamic routing requires the software in the routing devices to calculate routes. Dynamic routing algorithms adapt to changes in the network and automatically select the best routes" [19].

Speed is request to dynamic routing algorithms to make good decision making, anticipating and predicting how to exchange information on the network. Speed is important in a network because when information is switched on Internet nobody know at *priori*

[19] https://www.cisco.com/c/en/us/support/docs/ip/routing-information-protocol-rip/13769-5.html

the entire route of this information when the journey starts from a computer to another. Instead, at each stop, the next router hop is determined by matching the destination address; i.e. each router just forward information to the next one but they exchange tables to better do this job. Speed is important to propagate faster the information through the network.

EXAMPLE NAME: **Internet routing.**	
USE	SKILLS (MORE USED)
☒	SOCIAL ASPECTS OF MEDIA
☒	CULTURAL ASPECTS OF MEDIA
☒	LINGUISTIC ASPECTS OF MEDIA
☒	SEMANTIC ASPECTS OF MEDIA
☑	OPEN-THE-BOX APPROACH
☒	ICT TRENDS AND FORECAST

Table 5: Skills list for a *Media Educator* and Internet routing.

Line 2: As it was described before, Speed is the ability to make decisions quickly. This feature is important for a teacher and a *Media Educator*. In fact, every year in the technology field a big number of new software arrive to the ICT market. Thus, a *Media Educator* needs to understand which software, year after year, it could be considered the best to solve a specific kind of problem. First a *Media Educator* should know some alternatives then a *Media Educator* should choice the best software alternative with speed

if she/he must decide quickly during a lesson. Suppose she/he need to make a mental map. There are two opportunities: 1) use a software creator to make mind maps; 2) use software that can be used to do mental maps. A skilled *Media Educator*, that knows many software alternatives, will be able to use "speed" to quickly decide which one is better.

USE A SOFTWARE CREATED TO MAKE MIND MAPS	USE A SOFTWARE THAT CAN BE USED TO DO MENTAL MAPS
ONLINE SOFTWARE: MINDMUP.COM	POWER POINT, PHOTOSHOP, WORD ETC.

Table 6: Mind Maps vs. vicariant software possibilities.

This process can be used both in daily work and in the macro activities.

Figure 16: mind map: an online software. SOURCE: mindmup.com

EXAMPLE NAME: **mind map with different software.**	
USE	SKILLS (MORE USED)
☑	SOCIAL ASPECTS OF MEDIA
☒	CULTURAL ASPECTS OF MEDIA
☑	LINGUISTIC ASPECTS OF MEDIA
☑	SEMANTIC ASPECTS OF MEDIA
☒	OPEN-THE-BOX APPROACH
☒	ICT TRENDS AND FORECAST

Table 7: Education skill and mind map with different software.

5.4.3. Reliability

Reliability is the ability to reduce, in the best way, the margin of error in a system. Although there are stochastic and unpredictable elements, it is possible to design a system to minimize risks. In other words:

> "Reliability […] is needed to reduce the margin of error to a minimum. Within a complex world characterised by unpredictability, this characteristic becomes indispensable for any adaptive system, especially in multilevel systems, to augment the possibility of success". (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

Line 1: to measuring Many ICT products are measured of their performance on reliability. Nowadays, technology threats are related with reliability and its impact on network and devices security and mobility. Reliability of an ICT system can be correlated with internal problem, such as algorithms bugs and broke interfaces or human error,

such as bad configuration and mistakes. For this reason, many ICT systems are programmed and configured to be “Fault Tolerant”. Fault tolerance provides high levels of availability and reliability (Todino, 2009), for example in network connections.

> “Used with redundant network interface hardware, Fault Tolerant allows the user to maintain persistent sessions during a hardware failure or a routing outage or change. Redundant network interface hardware is required to use this feature”[20].

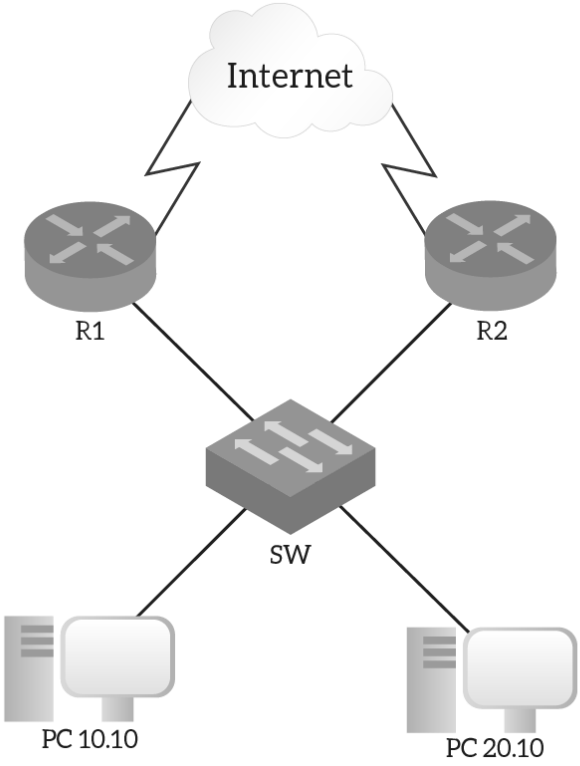

Figure 17: routers reliability and fault tolerance. SOURCE: https://www.ictshore.com/free-ccna-course/hsrp-configuring

[20] https://www.cisco.com/c/en/us/td/docs/ios/sw_upgrades/interlink/r2_0/custom/cgfault.html

EXAMPLE NAME: **routers reliability and fault tolerance.**	
USE	SKILLS (MORE USED)
☒	SOCIAL ASPECTS OF MEDIA
☒	CULTURAL ASPECTS OF MEDIA
☒	LINGUISTIC ASPECTS OF MEDIA
☒	SEMANTIC ASPECTS OF MEDIA
☑	OPEN-THE-BOX APPROACH
☑	ICT TRENDS AND FORECAST

Table 8: Skills list for a *Media Educator* and routers reliability and fault tolerance.

Line 2: For a *Media Educator*, reliability can be traced back to the ability to produce original but "reliable" solutions, to be able to store, retrieve and reuse solution and information. For example, creating a series of easy-access slides for your class uploaded to a virtual class of edmodo.com is reliable both for teachers and for their students, especially using Edmodo platform (or similar web sites). Especially Edmodo using a Facebook's like user graphic interface does not need to explain how to use it. This means that Edmodo does not introduce wall, i.e. time lost, before start to work on it.

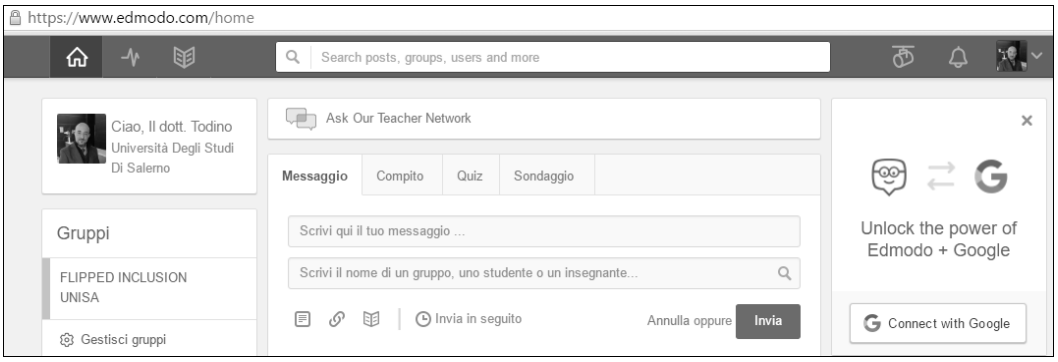

Figure 18: Edmodo.com virtual class and backups of file. SOURCE: edmodo.com

Reliability, as said before, is the ability to reduce, in the best way, the margin of error, from this starting point use Edmodo and other web platform, such as Google docs, it is useful for teachers that can also have many backups of their files: .ppt lessons, .pdf documents, links to useful videos etc. A *Media Educator* should appreciate backups and teach students to do many backups of important information, and do download of important information to be able to work also offline in case of network fault.

EXAMPLE NAME: **Edmodo.com virtual class and backups of file.**	
USE	SKILLS (MORE USED)
☑	SOCIAL ASPECTS OF MEDIA
☑	CULTURAL ASPECTS OF MEDIA
☒	LINGUISTIC ASPECTS OF MEDIA
☒	SEMANTIC ASPECTS OF MEDIA
☒	OPEN-THE-BOX APPROACH
☑	ICT TRENDS AND FORECAST

Table 9: Skills list for a *Media Educator* and Edmodo.com virtual class and backups of file.

5.4.4. Flexibility, vicariance and adaptation to change

Berthoz proposed an idea of "vicariance" with this meaning:

Vicariance is the possibility of substituting one mechanism or process for another to reach the same goal (Berthoz, 2015, p.12). More in detail:

> "Flexibility, vicariance and adaptation to change, which are essential to be able to select the right strategy from a repertoire of choices to resolve a problem, and perceive, capture,

> decide, or act depending on the context the system finds itself in. Hence all these are fundamental in decision making, problem solving, creative thinking, coping with stress and emotions, initiative taking and the spirit of entrepreneurship". (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

Line 1: Flexibility, vicariance and adaptation to change are typical characterises and skills of humans and living organisms. It should be possible investigate this line in brief, but this topic goes outside goals of this thesis. Could be an ICT system flexible, vicariant and creative? Can a machine have this kind of skills? In other work can a machine be "intelligent"? Or as Philip K. Dick, in 1968, wrote in a poetic way: "Do Androids Dream of Electric Sheep?"[21] This topic regards Artificial intelligence that nowadays is real hot one. In brief it is possible to state that Artificial Intelligence "needs" Human Intelligence to be programmed and ideas and creativity show from AI system is the mirror of the human's one. At the same time, it is also possible to state that Human Intelligence "needs" Artificial Intelligence to better works, query information and similar activities. More in details Artificial intelligence methods can simplify the process of creating and managing complex workflows and human's activities (Weld, Dai, 2011). In the first case AI really "needs" humans in the second case humans "need" AI to improve their performance and also to simulate human behaviour and cognitive processes. Machines are not intuition, common sense and an "embodied" plausible and critical thinking and they have been trained do to this. Beside a machine don't have a metacognitive brain to deal with inter and transdisciplinary approach to solve a new problem but it is good to generate inference in one field in deep such as algorithm to solve mathematical theorems.

[21] Blade Runner (1982) is an adaptation of this novel

EXAMPLE NAME: **Artificial intelligence Vs. Human Intelligence.**	
USE	SKILLS (MORE USED)
☒	SOCIAL ASPECTS OF MEDIA
☑	CULTURAL ASPECTS OF MEDIA
☑	LINGUISTIC ASPECTS OF MEDIA
☑	SEMANTIC ASPECTS OF MEDIA
☑	OPEN-THE-BOX APPROACH
☑	ICT TRENDS AND FORECAST

Table 10: Skills list for a *Media Educator* and Artificial Intelligence vs. Human Intelligence.

Line 2: Flexibility can help a *Media Educator* during a lesson. In fact, a *Media Educator* needs flexibility and adaptation to change referred to ICT markets. This means that ICT markets (software, products, devices, etc.) changes very fast, thus, a *Media Educator* should be fast and adaptive. *Media Educators*' careers and knowledge should fallow all these trends to better help their students. More in details ICT market's devices are designed sometimes to be "general purpose" items or in other words they are design to be used for a wide range of problems. A *Media Educator* should understand witch kind of device or software can be more helpful to solve problem year after year in an adaptive way of select them. For these reasons *Media Educators* should be flexible about their point of view on ICT decides to be possible for they to study new technology and be able to change items, devices etc., that day teach to their students. For example, nowadays it is important to teach Internet more that how a radio works or how to program in C++ more that COBOL (and maybe in 20 years it will be another). In conclusion a teacher must develop confidence with new technology and trends. For exam-

ple, a *Media Educator* should spend lots of time to research programs and apps for smartphone (Todino, 2016).

EXAMPLE NAME: **flexibility to ICT market's devices.**	
USE	SKILLS (MORE USED)
☑	SOCIAL ASPECTS OF MEDIA
☑	CULTURAL ASPECTS OF MEDIA
☒	LINGUISTIC ASPECTS OF MEDIA
☒	SEMANTIC ASPECTS OF MEDIA
☒	OPEN-THE-BOX APPROACH
☑	ICT TRENDS AND FORECAST

Table 11: Skills list for a *Media Educator* flexibility to ICT market's devices.

5.4.5. Memory

Memory is the ability, typical to many organisms, to preserve traces of the external experienced and lived stimuli and how organized these information inside themselves. More in detail, from a simplex point of view:

> "Memory [is] the characteristic on which present action relies to predict the future consequences of an action. There are multiple mechanisms of memory (explicit, implicit, episodic, verbal, iconic and effective)". (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

Line 1: electronic-computer's memory has been studied in deep. PC thanks to electronic memories enable people to create huge repositories of information. The birth of

such memories has determined an “epic” moment of history of humanity: “the birth” of writing, that Aeschylus, in the chained Prometheus, defines "the memory of everything". Wiener (1997) in cybernetics studies tried to create a relationship between the memories of computers and the human one (from a metaphoric point of view). Wiener believed that human as many kind of memories: long term, middle term and etc. thus also computer are built to have different kind of memories, that related dimension in space of data that can be stored and time to access to it. Nowadays every computer memories follow this schema. Every computer has three types of memory: a mass storage memory where it is possible to save information permanently (hard drives), a flying but fast memory that a computer uses to compute programs and solve problems (R.A.M.) and a write-only, un-modifiable to start-up the computer and to do initial diagnostics (R.O.M.). R.O.M. and R.A.M are called primary memories of a computer because they are embedded in the computer motherboard; there is also another faster that R.A.M. memory called “cache” embedded inside a microprocessor. Hard drive is called secondary memory or mass storage. There is also other kind of memories called secondary because they can add and remove easily from a computer: USB stick, DVD, CD, etc. Memories in a PC works like a hierarchy: the faster is littler and expansive. In the same way, a human memory follows an economic paradigm.

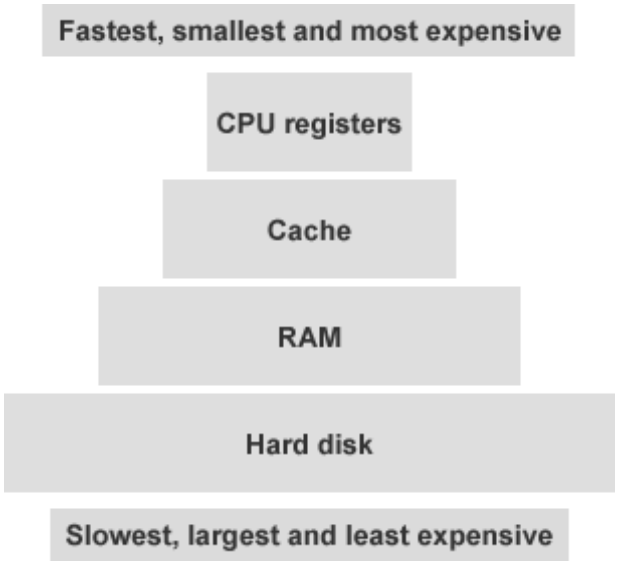

Figure 19: PC's memories hierarchy. SOURCE:https://www.quora.com/When-do-we-decide-to-retrieve-data-from-Redis-cache-system-

EXAMPLE NAME: **PC memories.**	
USE	SKILLS (MORE USED)
☒	SOCIAL ASPECTS OF MEDIA
☒	CULTURAL ASPECTS OF MEDIA
☒	LINGUISTIC ASPECTS OF MEDIA
☒	SEMANTIC ASPECTS OF MEDIA
☑	OPEN-THE-BOX APPROACH
☒	ICT TRENDS AND FORECAST

Table 12: Skills list for a *Media Educator* and PC memories.

Line 2: from an ICT didactics point of view memory could be correlated with techniques rated to improving teacher's memories and support teaching-learning daily activities. A teacher can use many tools to help memories for lessons: for digital mental-maps developed with power-point or other specific software (such as mindmup.com al-

ready seen). These maps can be useful to improves, highlights and underline the ability to retain and recall information is central to improving memory of each student.

5.4.6. Generalization

Generalization means extend a particular situation or feature to a whole group of things. From a simplex point of view:

> "Generalization, the final property of complex adaptive systems, which refers to the competency of capitalizing patterns of interactions, and transferring these from one context to another, even if they are not two completely analogous situations". (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

Line 1: this logical-mathematical metacognitive abstraction was useful to build "general purpose" computer to solve problems. Desktops, laptop, smartphones and tablets, are all examples of general-purpose computers. The term is used to differentiate general-purpose computers because they can run many kinds of software that can solve many different of correlated problems. General-purpose computer is also different from other kinds of machine called specialized embedded computers used to solve specific tasks such as car's engine control unit, or a digital camera that are optimized to do their tasks.

Figure 20: a general porpoise machine (laptop) and two specific porpoise machine: a digital camera and an engine control unit.

EXAMPLE NAME: **general and specific porpoise one.**	
USE	SKILLS (MORE USED)
☑	SOCIAL ASPECTS OF MEDIA
☒	CULTURAL ASPECTS OF MEDIA
☒	LINGUISTIC ASPECTS OF MEDIA
☑	SEMANTIC ASPECTS OF MEDIA
☑	OPEN-THE-BOX APPROACH
☑	ICT TRENDS AND FORECAST

Table 13: Skills list for a *Media Educator* and general and specific machines.

Line 2: Generalization is a typically metacognitive property. A teacher do it through systematization of problems, use block diagrams, flow diagrams, and sequence diagrams to be able to extrapolate the classical prototypes of computational thinking. There is a wide literature that concern on these topics. It is possible to state that:

> "Computer science education is not a new field. Much of what we know about the pedagogy and content for elementary students comes from Seymour Papert's research on teaching elementary students to code back in the 1970's and 80's. But, as we shift from labs and one-off classrooms to a broad expansion for all students in every classroom K-12, we are seeing changes to how computer science is taught. This means we are working in a rapidly evolving field (insert metaphor of building a plane while flying it). Over time, we have gone from a focus on coding (often in isolation) to a more broad idea of computer science as a whole, and now to the refined idea of computational thinking as a foundational understanding for all students"[22].

There is also a literature that support Computational Thinking for Kindergartners, more in deep, it is possible to define an algorithm as a sequence of instructions used to complete a task, thus a teacher can introduce how an algorithm works through easy and daily activities of our routine such as "brushing teeth, feeding a pet"[23]. Besides:

> "Ask children to create picture cards to sequence a "program" for that activity. Demonstrate what happens when the sequence is changed. Or read a picture book in which a character travels to a clear sequence of locations. Write a "program" for the character's movement,

[22] http://www.gettingsmart.com/2018/03/computational-thinking-elementary-classroom/
[23] https://www.edutopia.org/article/computational-thinking-kindergartners

and then, using a map and a doll, run the program by moving the doll to each location on the map"[24].

Many ICT companies are working to develop and go to the market with easy programming interface; one that can be become famous could be Nintendo's new coding game, Labo[25].

Figure 21: Nintendo's LABO "Coding Interface for Everyone". SOURCE: https://labo.nintendo.com/instead-of-database

[24] https://www.edutopia.org/article/computational-thinking-kindergartners
[25] https://www.fastcodesign.com/90164377/nintendo-debuts-a-coding-interface-for-everyone

EXAMPLE NAME: **Nintendo's LABO "Coding Interface For Everyone".**	
USE	SKILLS (MORE USED)
☒	SOCIAL ASPECTS OF MEDIA
☒	CULTURAL ASPECTS OF MEDIA
☑	LINGUISTIC ASPECTS OF MEDIA
☑	SEMANTIC ASPECTS OF MEDIA
☑	OPEN-THE-BOX APPROACH
☑	ICT TRENDS AND FORECAST

Table 14: Skills list for a *Media Educator* and Nintendo's LABO "Coding Interface for Everyone".

5.5. ICT and simplex principles

Simplex principles are the natural consequence of simplex properties already seen. These principles can help *Media Educators* to know what is right and wrong and that influences theirs actions. More in detail these principles are based on biological laws and fact of living organisms' nature that explains how they works, why their behaviours act in a specific way, moreover why thing happens around these organisms. A definition of simplex principles can be the follow one:

> "As a guiding framework to delimit the concept of simplexity, Berthoz (2012) enlists six simplifying laws and principles, implemented successively or in parallel, to govern a simplex process. The author points out that the terms „laws and principles" are used in the absence of anything better to describe simplex solutions, processes, architectures and even mechanical agents". (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

Simplex principles can be also applying to teach computer science, *Media Education*, etc. Simplexity can be a way to teach. This way passes through the application of simple rules these simple rules are the simplex principles that will be described in this paragraph.

5.5.1. Principle of inhibition and the principle of refusal

This principle represents when a teacher, a *Media Educator* etc., taking charge a choice (between many possibilities), both in design or real-time job phases, rather than others possible choice to face complexity. What thinking means? This is a hard question, this sub- paragraph want just highlight that thinking requires to inhibit and disin-

hibit a decision or a movement to solve a task. It is correlated with multiple intelligences styles (Gardner, 2002) learning styles and teaching styles. Design a lesson needs to inhibit some solutions in favour of others, considered efficient and effective at that particular moment, in that particular context and this is also reflected on the use of technologies.

> "Inhibition and the principle of refusal: In any thought process, whether it is a moment of reflection or when one is faced with an urgent decision to be made, selecting one action over another requires inhibiting all the actions one does not choose and disinhibiting the one acted. In creative thought, for example, one inhibits the automatic or learned solutions to make way for innovative ones". (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

Line 1: to inhibit other problem-solving strategies to use one, such as computational thinking, and then to take up what has already been said about the computational thinking of the preceding paragraph.

Line 2: For example, make a conceptual map to show our students how to use software.

5.5.2. Principle of specialisation and selection

It is possible to define Umwelt as the perceived world of a living organism (Berthoz, 2011). Umwelt includes the meaning of things that humans give around each of them to survive and to create relationships. More in detail:

> "The principle of specialisation and selection (Umwelt): Every species scans the world only from cues important to its survival, creating one's own Umwelt; a subjective universe. This principle is parsimonious in that it involves the selection of pertinent information needed to reach the goal of action. This selection is not only induced during a stimulus-response process. It is intrinsic to adopting a perspective, whereby a living, self-organising, autonomous organism projects its intentions and hypotheses onto the world (Berthoz, 2012, p. 14). The ability to filter information and select what is essential is paramount to deal with complexity". (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

Line 1: Umwelt can be considered as a sort of perceptive interface (Berthoz, 2011) and for this reason it can be related with: 1) cybernetic vision of humans (Wiener, 1997) and introduce concept of Human Machine interaction; 2) input-output vision of a computer or a telecommunication system.

EXAMPLE NAME: **Umwelt and ICT parallelisms.**	
USE	SKILL
☑	SOCIAL ASPECTS OF MEDIA
☑	CULTURAL ASPECTS OF MEDIA
☑	LINGUISTIC ASPECTS OF MEDIA
☑	SEMANTIC ASPECTS OF MEDIA
☑	OPEN-THE-BOX APPROACH
☒	ICT TRENDS AND FORECAST

Table 15: Skills list for a *Media Educator* and Umwelt and ICT parallelisms.

Line 2: Use this principle whenever, in front of a huge number of online sources, a *Media Educator* helps students to select these sources for: 1) priority; 2) authority etc. (Todino, 2016).

EXAMPLE NAME: **select source from Internet.**	
USE	SKILL
☑	SOCIAL ASPECTS OF MEDIA
☑	CULTURAL ASPECTS OF MEDIA
☑	LINGUISTIC ASPECTS OF MEDIA
☑	SEMANTIC ASPECTS OF MEDIA
☒	OPEN-THE-BOX APPROACH
☒	ICT TRENDS AND FORECAST

Table 16: Skills list for a *Media Educator* and select source from Internet.

5.5.2. Principle of probabilistic anticipation

Probabilistic anticipation is a brain/body process to image how will happen in the future. This speculation about the future can concern short, middle or long-time previsions. The brain uses all information that has done it. To make a prediction a human's brain can emulate and simulate the world around. More in detail:

> "The principle of probabilistic anticipation: Prediction is always probabilistic and hence, to take action, the brain has to make some hypotheses deciding on what probability that hypothesis has of being correct based on the information available in the present, as well as taking the memory of past experiences into account. This prospective and retrospective exercise, coupled with comparison of sensory data is key to innovation". (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

Line 1: For examples machine learning is about using a data set must make predictions, such as probabilistic anticipation. So many computer programs can help people to do forecast such as weather, finding petrol, etc. If a person knows this opportunity can use technology to make better forecasts and predictions. If the data set is huge (as a big data) forecasts and predictions start to be very close to the reality. Prediction is power, but the actual algorithms of machine learning can deal with easy task such as: recognition of a car number, find a face, win chess game. To deal with real world an intelligent machine should me a general-purpose machine. Anyway, there are some machine learning algorithms that can be very useful for special educational need such as handwriting recognition.

Actually, data analysis can understand and predict many phenomena's and behaviours. Social *Media* are sponsored and created to understand human nature. There are some researches that can describe this idea very well. Probabilistic anticipation of human being it is important for many fields from commercial reasons to political one. For example, Kosinski, Stillwell and Graepel in 2013 writed:

> "We show that easily accessible digital records of behaviour, Facebook Likes, can be used to automatically and accurately predict a range of highly sensitive personal attributes including: sexual orientation, ethnicity, religious and political views, personality traits, intelligence, happiness, use of addictive substances, parental separation, age, and gender. The analysis presented is based on a dataset of over 58,000 volunteers who provided their Facebook Likes, detailed demographic profiles, and the results of several psychometric tests. The proposed model uses dimensionality reduction for preprocessing the Likes data, which are then entered into logistic/ linear regression to pre-

dict individual psych demographic profiles from Likes." (Kosinski, Stillwell, Graepel, 2013)

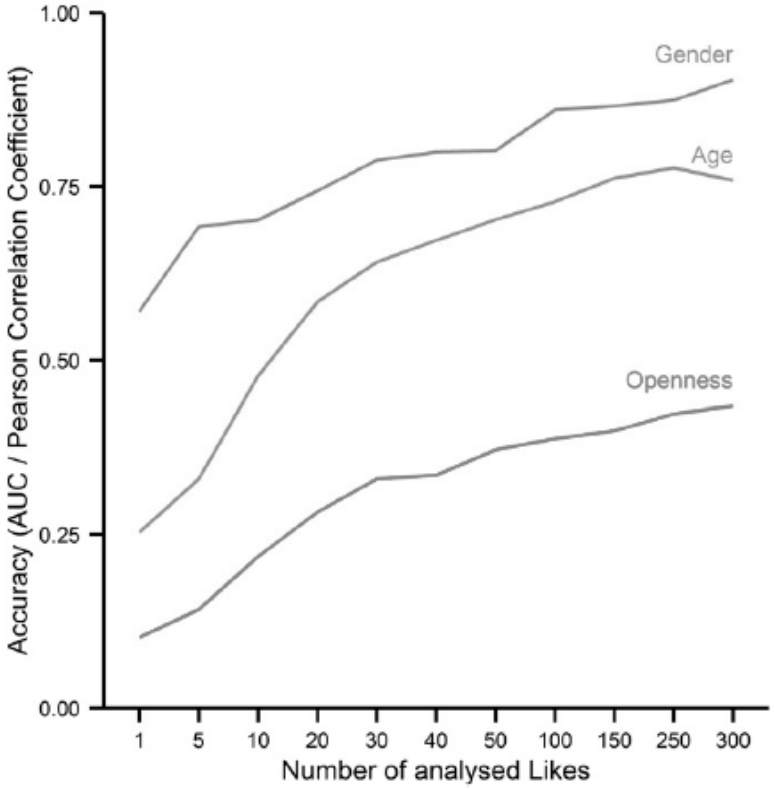

Figure 22: Accuracy of selected predictions as a function of the number of available Likes. SOURCE: Kosinski, Stillwell, Graepel, 2013

Also, if it is possible to belief that this research can overestimate probabilistic anticipation of computer algorithms of "Facebook like" data set it is possible to belief that all of these lines asymptotically will gone as this graph.

EXAMPLE NAME: **Facebook “likes” data analysis.**	
USE	SKILL
☑	SOCIAL ASPECTS OF MEDIA
☑	CULTURAL ASPECTS OF MEDIA
☑	LINGUISTIC ASPECTS OF MEDIA
☑	SEMANTIC ASPECTS OF MEDIA
☑	OPEN-THE-BOX APPROACH
☒	ICT TRENDS AND FORECAST

Table 17: Skills list for a *Media Educator* and Facebook Likes data analysis.

Line 2: Principle of probabilistic anticipation can be also refer to a teachers, based on their experience, or memory and the "repertoire" of software and online tools that they know and uses, will be able to understand what to apply to the lesson he has to face, to understand how much time he will need for create a multimedia product, which reaction will have their students in front of a software (Todino, 2016).

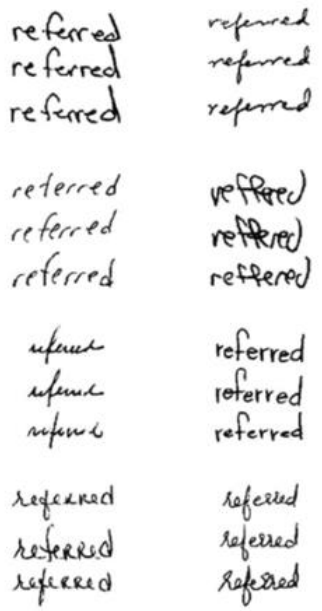

Figure 23: handwriting recognition used by postal service.
SOURCE:https://www.slideshare.net/danvy/iot-azure-the-field-of-possibilities

Obviously, handwriting recognition can be used to didactics' porpoise, and in particular in special educational needs field. In could be useful to anticipate specific learning disorders and monitor improvements. Handwriting recognition can be helpful for diagnostic and support to dysgraphia and dysorthography.

EXAMPLE NAME: **handwriting recognition.**	
USE	SKILL
☒	SOCIAL ASPECTS OF MEDIA
☒	CULTURAL ASPECTS OF MEDIA
☒	LINGUISTIC ASPECTS OF MEDIA
☒	SEMANTIC ASPECTS OF MEDIA
☒	OPEN-THE-BOX APPROACH
☑	ICT TRENDS AND FORECAST

Table 18: Skills list for a *Media Educator* and handwriting recognition.

5.5.4. The detour principle

In hard sciences, in a nonlinear system is possible to change an output whiteout a proportional change of an input. This premise is important to understand the detour principle. It is possible to state, in line with simplexity that:

> "The detour principle: Living organisms possess numerous mechanisms that, by means of detours, facilitate the solution of nonlinear problems. This nonlinearity is what makes this principle key for survival. Shortcuts do exist, but as modern GPSs help us understand, sometimes taking the longer way is more efficient in terms of time and fuel consumption to reach one's destination. Human beings often tend to think that the shorter way is the better solution. This may often mean resisting changing, or not considering alternative solutions which may well be more effective. Detouring, therefore, involves replacing a simple variable with a more complex mix of variables to simplify it". (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

For further details it is possible to overview how Berthoz (2015) define this principle referred to “the Vicarious Brain”.

Line 1: The history of software development, and ICT companies, is full of detours. Deviation is part of decision-making process and in evaluating other avenues to reach the final goal. Perhaps there are few areas that allow such a large number of roads to reach a result. Counting the number of software and tools online to create a multimedia product it is easy to understand immediately that there are almost unlimited, among them some will be paid products and others released under free licenses and open code (in this regard refer to the official website of Free Foundation software fsfe.org with headquarters in Boston, Massachusetts).

EXAMPLE NAME: **free software.**	
USE	SKILL
☑	SOCIAL ASPECTS OF MEDIA
☑	CULTURAL ASPECTS OF MEDIA
☒	LINGUISTIC ASPECTS OF MEDIA
☒	SEMANTIC ASPECTS OF MEDIA
☑	OPEN-THE-BOX APPROACH
☑	ICT TRENDS AND FORECAST

Table 19: Skills list for a *Media Educator* and free software.

Line 2: A teacher, thanks to his wealth of personal computer knowledge, can make a document, an image, music, a video through a virtually infinite combination of streets. Each teacher can decide types of licenses, free code and costs of software are aspects

that a teacher cannot avoid when he decides to introduce a new tool in his teaching, in fact these aspects affect both his finances and those of the institute school than on those of his students. In general, now a set of applications, typical for the school, are now standardized, at no cost, and teachers are invited to keep up - to - date on these trends. In the case of elementary schools, stood out on all scratch.mit.edu powerful, simple and versatile visual programming environment, designed at the Massachusetts Institute of Technology, to introduce the basic concepts of programming and computational thinking in primary school first degree and second degree.

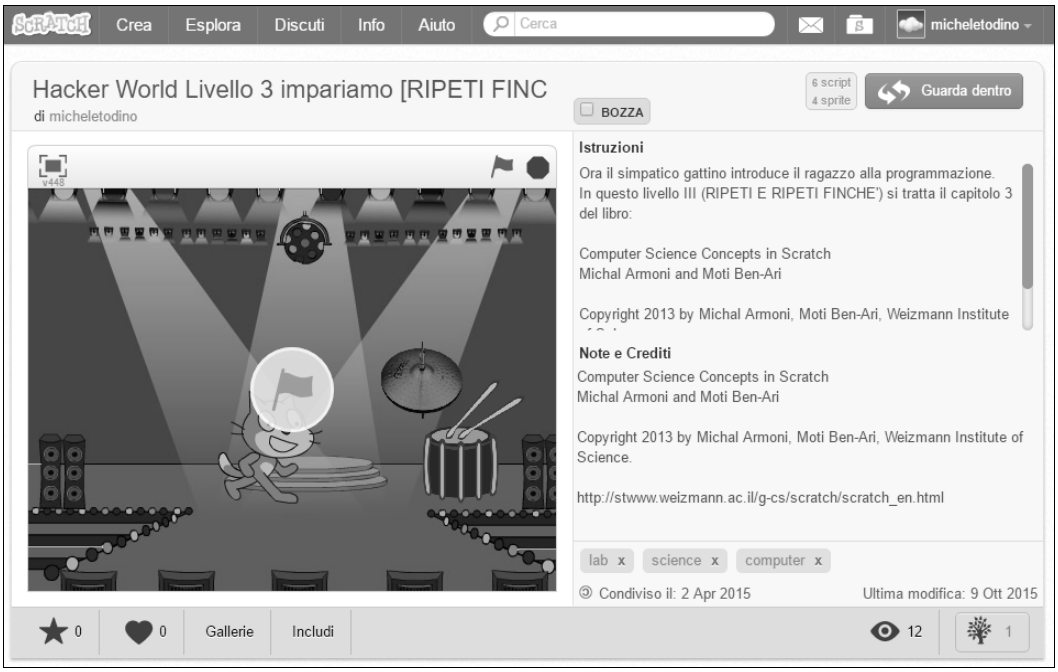

Figure 24: Computational-thinking's practical exercises. SOURCE: scratch.mit.edu (profile michele.todino)

EXAMPLE NAME: **computational-thinking.**	
USE	SKILL
☒	SOCIAL ASPECTS OF MEDIA
☒	CULTURAL ASPECTS OF MEDIA
☑	LINGUISTIC ASPECTS OF MEDIA
☑	SEMANTIC ASPECTS OF MEDIA
☑	OPEN-THE-BOX APPROACH
☒	ICT TRENDS AND FORECAST

Table 20: Skills list for a *Media Educator* and computational-thinking's practical exercises.

5.5.5. Principle of cooperation and redundancy

Cooperation is a simplex principle that highlight that a living organism to survive is composed in subsystems that works together for survive besides to do these use a back-up of these subsystems, such as two eyes, two legs and so on and this principle can be call redundancy. More in detail:

> "The principle of cooperation and redundancy: Cooperation refers to the process of combining the information available to ensure that the information is coherent and therefore reliable. The context, rules, points of view and previous decisions serve as frames of reference. Redundancy, on the other hand, refers to the duplication of components or functions of a system with the intention to increase reliability of the system to make it fail-safe. While selection (the second principle) reduces the number of available solutions, complex adaptive systems ensure they have several values for the same variable to mitigate the risk of error. Another example of cooperation and redundancy is looking at things from different perspectives

when making decisions, egocentrically and allocentrically". (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

Line 1: Reliability is a desirable feature for any computing system. To reach this goal it is necessary to have a system that has two principles: cooperation and redundancy of their subsystems. Reliability for a computer system can be correlated with "survive" for a living organism. For examples, important Internet connections such as banks, strategic offices, etc. use fault tolerance connection that to be reliable use many redundant routers connections.

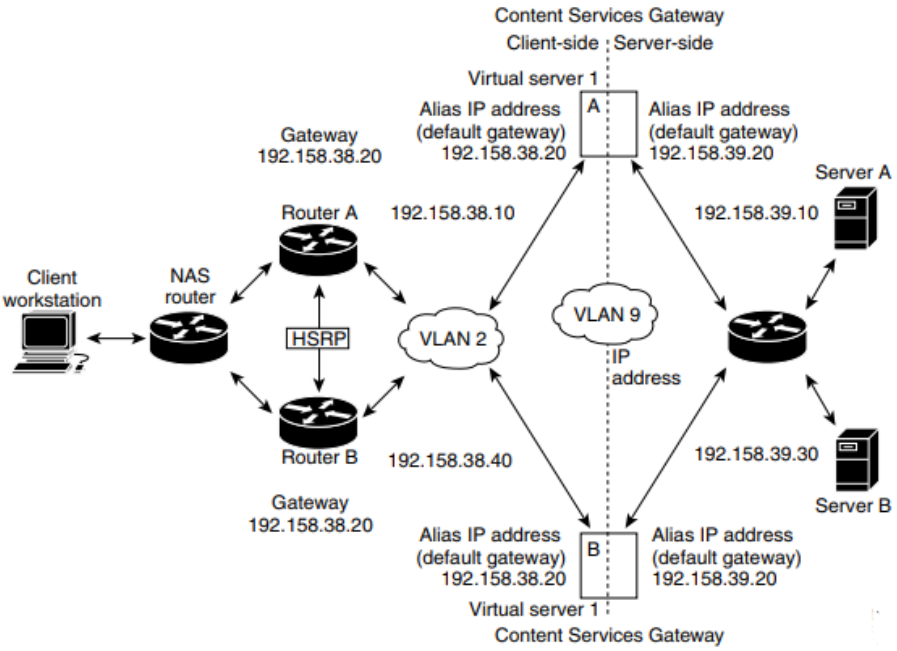

Figure 25: Internet WAN fault-tolerant Configuration.
SOURCE:https://www.cisco.com/c/en/us/td/docs/wireless/csg/6-2/install_configuration/guide/csgicmod.pdf

Line 2: From a didactical point of view, the time needed to reach a goal could be integrated from different systems that may cooperate for project's success. This happens continuously in computer science, especially if a teacher has mastered much software. If this happens, his work will become fast and effective. And his style of work will in turn become a model for students who will see him working in class. Let's take some practical examples. Often, we are faced with having to take text from a pdf file or from a website and have it reported and quoted in a document. A teacher who masters the PC will open the notebook, paste the content (which will be cleaned up by formatting) and then bring it to the file on which it must work. In this way many computer programs, together, solve the initial problem. Instead, in order to obtain redundancy, it is necessary

to have various software that perform the same task, perhaps with different nuances, we think about the modification of the images: surely Microsoft Paint (present as a basic application of Windows) allows a first, “rude”, edit. Adobe Photoshop allows professional editing. But there are other solutions, we mention just two: 1) we can decide to download and install open source software, free, for photo editing from the gimp.org site, whose performance does not reach Adobe Photo-shop but may be sufficient in a context school. 2) We can use PowerPoint, in vicariant mode, in fact if we insert an image on a slide and double clicking on it will open a series of options to change the format, including a series of artistic filters and the change of those. Another example of redundant and cooperating programs can be the capture tool present in Windows that allows you to quickly crop parts of the screen and then insert them (paste) into a document. Imagine if you want to have a web quest done by our students, or have a technical report done in Microsoft Word, we immediately realize the importance of co-recognizing the integrative collaboration of all these software tools.

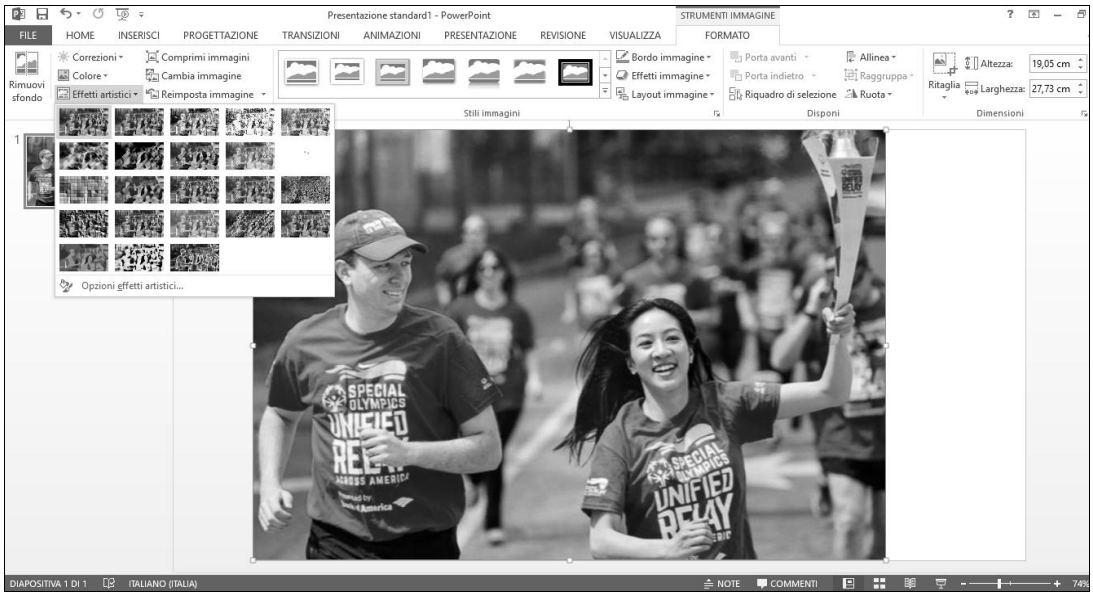

Figure 26: Hot to use Power Point instead of Photoshop.

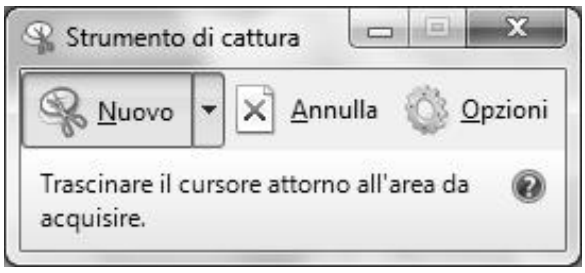

Figure 27: capture screen of Microsoft Windows.

5.5.6. Principle of meaning

"[This principle] corresponds to the law that establishes the link and the functionality between meaning and the act itself (Sibilio, 2014). Focusing the attention on the act implies affirming the principle of meaning whose foundations are in the act itself, since "simplex solutions are motivated by intentions, goals, or functions" (Berthoz, 2012, p. 21)". (Pace, Aiello, Sibilio, Piscopo, 2015, pp. 71-87)

Line 1: if Reliability for a computer system can be correlated with "survive" for a living organism meaning is the reason because this system exists. Facebook exists to connect people (give a communication platform) at the same time to collect data. Google exist to give a search engine and at the same time to collect data. A protocol such as IP and TCP exist to create fault tolerance communication https protocol to create safe and secure communication. It is possible to summarize that in stand of living system for computer systems it is always possible to understand the meaning.

Line 2: Principle of meaning is an end subtended to the didactic action, the sense that the teacher wants to give to his own lesson. Information technology is a technological

means that can support the latter principle, through products and artefacts that involve students and facilitate and speed up the tasks performed by the teacher in his daily actions.

5.6. Further studies and consideration

This chapter concludes with a series of insights.

5.6.1. CSTA and K–12 Computer Science Standards

To teach computer science in primary school *Computer Science Teachers Association (CSTA)*[26] web site can be very useful. CTSA teachers' task force indicate some standards to be followed to teach information technology, thus also *Media Educator*, to pupils aged 6 to 12. This document takes the title of *"K–12 Computer Science Standards".* CSTA proposes to:

> "The Computer Science K–12 Learning Standards and connected framework represent a vision in which all students, from a young age, engage in the concepts and practices of computer science to understand a world that is increasingly influenced by technology and to apply computing as a tool for learning and expression in a variety of disciplines and interests. From kindergarten through 12th grade, students will develop new approaches to problem solving that harness the power of computational thinking, while not only becoming users, but creators of computing technology [..] Many problems in science, engineering, health care, business, and other areas can be solved effectively with computers, but finding a solution requires both computer science expertise and knowledge of the particular application domain.

[26] https://www.csteachers.org/

Thus, computer scientists need to understand and often become proficient in other subjects"[27].

Combining K–12 Computer Science Standards with previous page of this chapter it is possible to combine *Media Educator*'s skills and Simplex Properties and Principle to "drive" didactic such as in daily work as well to project and plan macro activities.

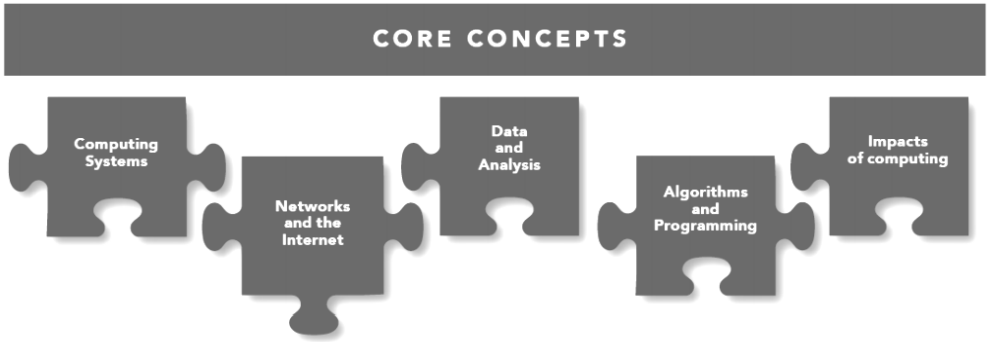

Figure 28: K–12 Computer Science Framework. (2016): Concepts. SOURCE: http://www.k12cs.org

27 http://www.k12.wa.us/ComputerScience/pubdocs/ComputerScienceStandards.pdf

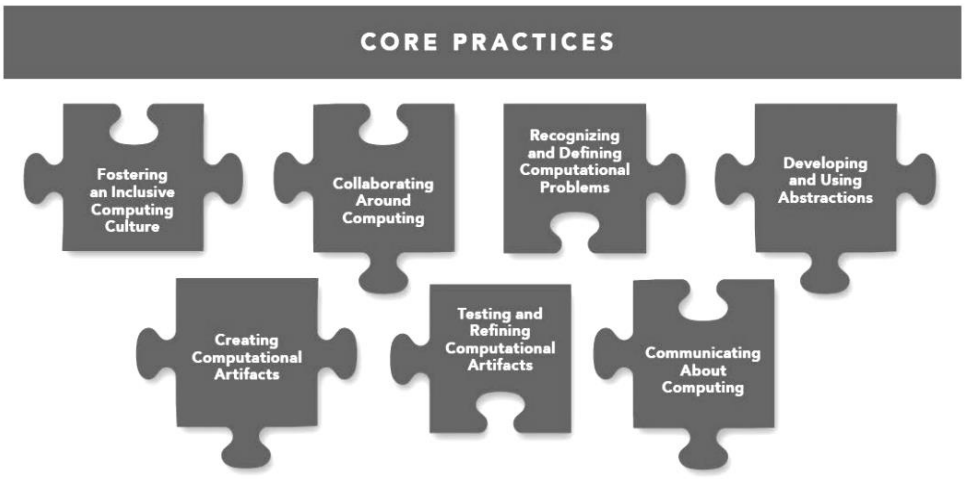

Figure 29: K–12 Computer Science Framework. (2016): practice. SOURCE: http://www.k12cs.org

5.6.2. MIT's Scratch getting started guide

Teachers who want to go deepen to teach computational thinking can use Scratch environment (Developed at the Massachusetts Institute of Technology) and in they can move their first steps through the guide *"getting started guide"*[28]. It is possible to create many interdisciplinary paths. For example, using Scratch cards.

[28] https://scratch.mit.edu/help/

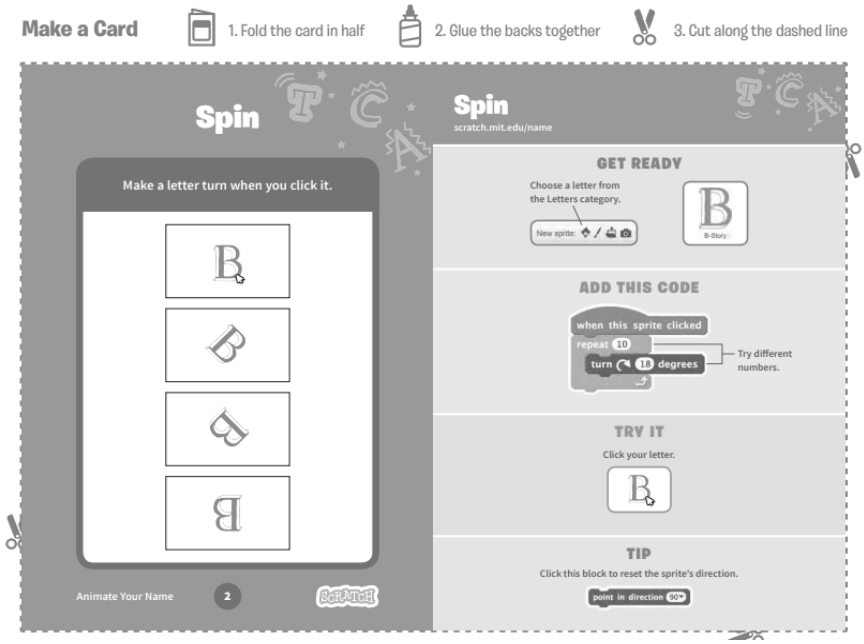

Figure 30: Rotation of a letter in Scratch.
SOURCE:https://resources.scratch.mit.edu/www/cards/en/ScratchCardsAll.pdf

5.6.3. Microsoft Online guide

Finally, Microsoft's online guide[29] offers many ideas for image-editing tools for Microsoft Office's application such as Power Point.

[29] https://support.office.com/en-us/article/video-get-design-ideas-for-slides-6f0ec776-cc58-4d0c-baab-051ba837b7a0

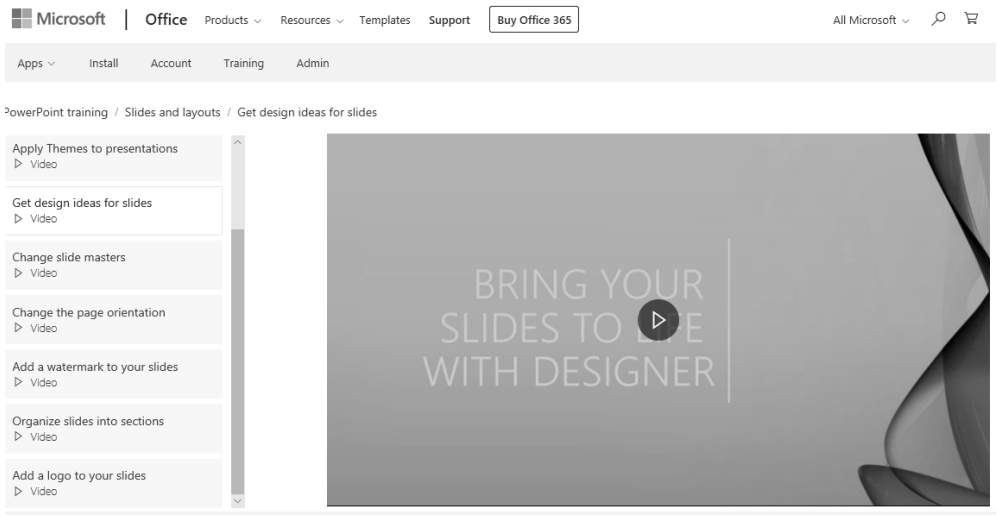

Figura 31: Microsoft's online guide. SOURCE:https://support.office.com/en-us/article/video-get-design-ideas-for-slides-6f0ec776-cc58-4d0c-baab-051ba837b7a0

5.7 Simplex didactic and ICT disciplinary didactic

In conclusion, simplexity can be correlated with simplex didactic and ICT didactic as it was evidenced in these pages. Simplexity tries to solve many complex problems and issues that a teacher must solve every day. John Dewey (1859-1952) already said at the beginning of the twentieth century that man is a complex "organism". Man is “composed” of a biological and cultural evolution that interact each other. This evolution of the organism consists in "reacting" to instability, dangers, risks, precariousness and uncertainties of the environment (natural, social and cultural). The reaction of the living organism re-establishes equilibrium in continuous man-environment feedback, through adaptation to change, ensuring the various functions of survival (Severino, 1986, p 188). This link between Dewey and simplexity reinforces the pedagogical and teaching “nature” of this mode of didactics’ action/interaction modality.

Chapter VI: Design and implementation of a new mobile video analysis laboratory

6.1 A new laboratory of video analysis

Main theme of this second step of this thesis is already explored in many international researches; it is how to use video analysis as a suitable tool for teacher education courses (Santagata, 2012; Felisatti, Tonegato, 2012; Rossi, Fedeli, Biondi, Magnoler, Bramucci, Lancioni, 2015). This theme improves in the last years due to the fact that there is a great technological positive trend about the quality of digital images, both fix and in movement, i.e. pictures and video-recorded, that made possible to manipulated videos in a low cost way. For this reason, context of this thesis is based on the assumption that the evolution of the use of images - both static and dynamic – could be used as a tool for teacher education courses. It is a theme that has been addressed, in the Italian didactical and pedagogical research context, by a wide range of studies (Bruni, 2012, p. 4). However, in this thesis, the emphasis is placed on the design and implementation of a mobile video analysis laboratory at the University of Salerno that can recorded "trial" simplex lessons and activities (Sibilio, 2014; Zollo, Kourkoutas, Sibilio, 2015; Zollo, 2017; Sibilio, Zollo, Di Gennaro, Girelli, in Press), in various contexts, ready to be analysed in a second phase. More in detail, the idea that drives this research is to create a laboratory, which is, in about fifteen minutes, fully useful (such as a plug-and-play technology) and allows a range of possible customizable modes of use offered by a pro-

fessional video recording system connected to five mobile cameras. Benefiting from the use of this mobile laboratory it is possible to: 1) create "ad-hoc" lessons by expert teachers to bring out standard and no-standard educational situations and settings; 2) record training teachers to revise their "acting". It is important to remember that the didactic action, videotaped, highlights both the "verbal language" and the "non-verbal communication" that directly involves the emotions of people and can provoke very different reactions from those that cause the words (Corazza, 2012, p. 19); therefore, video analysis becomes an opportunity to review one's non-verbal communication in the class context.

More in details, it is again important to highlight that the main idea of second step of the thesis is how design and implement a mobile video analysis laboratory for video recording real or simulated simplex didactic activities (Sibilio, 2014; Zollo, Kourkoutas, Sibilio, 2015; Zollo, 2017; Sibilio, Zollo, Di Gennaro, Girelli, in Press) both for *Media Educators* and other teacher education courses.

6.2 Mobile video analysis laboratory: goals and technologies

Teachers usually think that a laboratory is a room inside a building, a motionless space, where scientific research is “carried out” every day. More in details, a place where university researchers collaborate together to explore and practise a particular aspect of educational research. This idea is certainly valid and paradigmatic but at the University of Salerno it was assumed another type of mobile teaching laboratory that can be quickly transported and installed in a school classroom, a museum or any other place where a teaching-learning process takes place. A laboratory “created” in accord-

ing with this "philosophy" can extend the possible empirical and statistical observations, enriching the research to reach new goals. Main goals can be: 1) to record a simulated school lesson and then understand methodologies and strategies used to correct and renew them; 2) to watch lessons done by expert teachers. Both of them from a simplex didactic point of view (Sibilio, 2014; Zollo, Kourkoutas, Sibilio, 2015; Zollo, 2017; Sibilio, Zollo, Di Gennaro, Girelli, in Press). In the experimentation started at the University of Salerno, the mobile laboratory is provided with the following components: 1) a high-performance laptop computer, to support a video streaming in real time; 2) 5 HD Wi-Fi cameras, with brackets; 3) director's software for mixing and recording videos; 4) video analysis and post-production software. In the laboratory's design phase, it was considered to limit its price (less than four thousand euro); also its weight and size are quite small. In this way researchers can easily transport the easily. Besides, it is important to note that this laboratory uses minimally invasive devices, which can be easily camouflaged in a classroom setting.

Figure 32: use of the mobile laboratory in a classroom of the University of Salerno, in evidence a camera with bracket.

The laboratory has five cameras, four mounted on brackets and one mounted on special glasses. Through this configuration of video cameras, it is possible to obtain an egocentric, allocentric and heterocentric vision (Ate, Berthoz, Vidal, Roëll, Zaoui, Hou-

dé, Borst, 2016; Berthoz, 2000, 2004, 2011, 2015, 2017) of teaching-learning process that takes place in a classroom. Moreover, possibilities offered from video analysis in relation to the change of perspective, in teacher education activities are However, this mobile lab allows researchers to perform a wide spectrum of video analysis larger then "prospecting taking" fields. Scientific literature (Gola, 2018, 123-125) on this theme emphasizes that:

> "An active didactic action can be obtained if the teachers observe relevant events during teaching and interpret them appropriately. Teacher's awareness is both important and a necessary skill in didactic besides it allows to understand and reflect on teacher's actions and to manage the different events that occur in the classroom. [...] several studies have shown that ability to annotate and analyse the elements of teaching identifies the skills of an "expert" teacher" (Tripp, Rich, 2012; Calandra Rich 2015; Lussi Borer, Muller, 2016)"[30]. (*Ibidem*)

Specifically, a video recording can be done in many ways (micro or macro analysis). An example of micro analysis can be a recording used to recognize ocular tracing (eye-tracking) to count "meeting moments" from teacher's visual fields and student visual fields (which is possible thanks to cameras fields "triangularization"). An example of macro analysis can be a recording used to recognize typical phases of a specific didactic methodology, from a simplex point of view: identify simplex principles and proprieties (Berthoz, 2011; Sibilio, 2014).

[30] Translated by the author

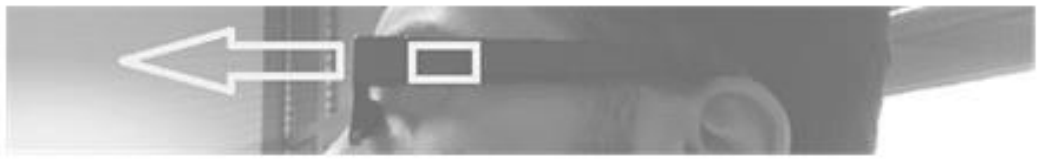

Figure 33: camera glasses used for video recording (egocentric point of view).

6.2.1. Directed control room software

Nowadays, video analysis software, present of ICT market, transfer audio and video through HTTP standard (Megliola, Sesana, Sanguini, 2015). HTTP means "Hypertext Transfer Protocol", this protocol is a convenient “way” to work through interfaces. All pc users continuously use this protocol because it is the data transfer protocol used on the World Wide Web. More in details “the Hypertext Transfer Protocol (HTTP) is an application-level protocol for distributed, collaborative, hypermedia information systems. HTTP has been in use by the World-Wide Web global information initiative since 1990”31. Among this video analysis software there is the directed vMix software, which is currently both “a state of the art” product and a de facto standard in director’s “world”.

[31] https://www.w3.org/Protocols/

Figure 34: vMix software, with real-time video streaming.

A real time video direction is an important factor for directors (in this case researchers), in fact, due to this software it is possible to immediately change the positioning of main camera and make a first video editing. In this way it is possible to configure an optimally setting, based on the needs of the research.

6.2.2. Open source video analysis software

Post-production video analysis is realized by Kinovea, free open source software, which is used for: 1) reproduction; 2) annotation; 3) processing. Main idea is to program XML tags (eXtensible Markup Language) to customize video annotations by this tool that allows integration of textual (or other) notes to videos.

Figure 35: workspace of software open source: 1) Main menu; 2) File explorer; 3) Video or photo; 4) Playback controls.

In this software, notes are usually anchored to a precise moment of video's scrolling, in this way, each note is inserted in correspondence of a specific sequence of images (Bonaiuti, 2012, p.72), and i.e. tags are combined with a specific event inside a recorded lesson such as application of simplex principles or proprieties.

DATA TYPE \ FORMAT	OPENDOCUMENT	MICROSOFT EXCEL XML	XHTML	SIMPLE TEXT
KEY IMAGES (TIME AND TITLE)	YES	YES	YES	NO
LINES (LENGTH)	YES	YES	YES	NO
ANGLES (VALUE)	YES	YES	YES	NO
CROSS MARKERS (CO-ORDINATES)	YES	YES	YES	NO
PATH TRACKING TRA-JECTORIES	YES	YES	YES	YES
STOPWATCHES (DU-RATION)	YES	YES	YES	NO

Table 21: Information exported possible file's formats. SOURCE: Kinovea official web page.

6.3 Recoding simplex actions

As any laboratory, there was a phase of testing; to be sure that everything works in a proper way. After this "debug" phase, when it is possible to consider calibration of each camera optimal, good light to record and no background noise the mobile laboratory is ready to work. For this mobile laboratory the experimentation phase proceed as follows: prepare this laboratory, record a teacher during classroom activities then review video-recorded to bring out awareness of didactic dynamics that have been recorded also in terms of metacognitive analysis to improve teacher education activity (Toci, Camizzi, Goracci, Borgi, De Santis, Coscia, Perrone, Cigognini, Pettenati, 2015). At the University of Salerno as already said, activity is, and will, be based on the properties and principles of simplex didactics (Berthoz, 2011; Sibilio, 2014). These properties and principles will be presented through videos already recorded and then reproduced by the learners in a real or simulated class. More in details, a first experimentation phase tries to verify if didactic actions, of a new teacher, is simplex by itself without knowing simplexity. Remembering that simplicity tends to decipher and cope with the typical complexity of any adaptive complex system (Berthoz, 2011). In other words, if people use simplexity such as a naive theory. In a second phase of experimentation there will be illustrated simplexity and simplex didactics and then tested (Sibilio, 2014; Zollo, 2017). More specifically, each properties and principles will be examined with a deconstruction method, focusing mainly on the vicariance (Berthoz, 2011, 2017; Sibilio, 2014, 2015, 2017a, 2017b) through recognition, in post-production video editing. There will be focused each element, more precisely: teacher's verbal and non-verbal activities.

Figure 36: Configuration of technological setting.

Conclusion

In conclusion, as highlighted in chapter III, *Media Education* should face at least tree trajectories:

- *From artificial to reality trajectory;*
- *From reality to the artificial trajectory;*
- *Find an adequate level of "transparency".*

As possible idea, for future work, starting from the first of these trajectories, it is possible to create paths for *Media Educators* to bring out these considerations in their students. More in detail, software ensures robot's ability to interface with humans and at the same time, it is the intelligent element of robotics systems. Despite this, it is important to remember that hardware makes it possible and it ensures robot's physicality impact thanks to interfaces to interact with external world and with people. *Media Educators* could create a series of lectures and tutorials to highlight similarities and differences between hardware-software versus body-mind relationship already addressed in detail by numerous studies of educational research (Sibilio, 2001, 2007).

Another future line of research it could be based on criteria that, educational research of ICT disciplinary didactic and Education Technology, provides a series of digital

skills which allow students to have an interpretive and emancipative relation to the *Media*; to have a positive effect on aspects of *Media Education* skills.

Besides, it can be useful to have addressed in this thesis each various categories of Artificial Intelligence proposed by Russell and Norvig and have a white-box vision of software that govern robotic systems. Each trajectory, highlighted in this paragraph, should be explored with responsibility as request by the resolution of the European Parliament containing recommendations on robotics. New experiments involving ICT systems, before being placed in contact with users (teachers, students, etc.), should be tested in a simulated environment far from human presence (for example, using computer virtual machines, special setting, etc.), to avoid denied effects on the real world.

At the same time, as it was explained, video analysis it is very “precious” for research activities because it allows a researcher to “read” (watch) verbal and non-verbal communication in a formal, non-formal or informal context (Pellerey, 2002, pp. 378-412). Therefore, during recording phase will be possible to confirm or refute any research hypotheses thanks to post-production activities and more in details thanks to reproduction, annotation and video-processing. Thus, post-production video analysis focuses to verify if a specific didactics’ methodology is used, which is before described to trainers and then is ask to then to "act" it in a pre-established didactic setting.

In conclusion, trained teachers, aided by mobile laboratory team (i.e. researchers), will be able to review their lessons and compare to understand better what happened

with students in a retroactive cycle theory-praxis-theory (Sibilio, 2014, p.4) that allows a multi-level analysis of educational action from a simples point of view.

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