The European Proceedings of
Social and Behavioural Sciences
EpSBS

www.europeanproceedings.com
e-ISSN: 2357-1330

DOI: 10.15405/epsbs.2021.03.02.32

# ERD 2020
## Education, Reflection, Development, Eighth Edition

# TECHNOLOGIES, LEARNING AND COGNITIVE MODELS

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## Abstract

The progressive increase in the use of multimedia and interactive platforms, including the world of social media, of mobile devices, which affects the new generations, must be considered. In particular, the prospect of integrating technologies into learning and teaching processes is not possible. In this paper, we intend to describe a research that has been done in this sense and develop the reflections it has aroused. In articulate this paper describes an experiment of introduction of software tools and technologies inspired by the principles of educational robotics to improve the learning level of middle school students. The research that is structured and implemented has as its central theme the use of technology to support learning-teaching processes. In particular, the central theme is how technological development strongly characterizes every section of people's lives. If technology enters the learning-teaching processes, it is certainly necessary to evaluate the problems and the potential to add value. In summary, the theme is to integrate technologies that are already pervading people's lives, in learning-teaching processes in formal teaching contexts. For the world of education in formal environments, we want to define how it is possible to establish a virtuous circle that begins with the training of teachers for the design and implementation of effective and virtuous processes from a cognitive point of view. The research has shown that the effective use of technologies in learning teaching processes is possible and that technology can be a transversal, technological and methodological competence.



*Keywords:* Learning, teaching, educational technologies, skills, cognitive models

https://doi.org/10.15405/epsbs.2021.03.02.32
Corresponding Author: Giorgio Poletti
Selection and peer-review under responsibility of the Organizing Committee of the conference
eISSN: 2357-1330

## 1. Introduction

Performing a critical and objective analysis of reality is always difficult, but when it comes to the world of children everything is complicated by a kind of nostalgia and impulse to confront what the age represented in our personal experience.

It is easy to expire in a moralistic reading of this mounting reality in our society.

I also believe that a local reading of the boys' world is lacking, because the widespread diffusion of the mass media and the consequent communication society has made this universe uniformly varied and more in need of valorisation than of continuous analysis.

We are witnessing the multiplication of initiatives that various organizations dedicate to young people, but all too often they satisfy the need of an adult world that needs to feel itself to be a proposer, rather than the actual need to enhance the creative strength of young people.

However, I think that, regardless of the motivation, the open spaces, so that the boys can express themselves, show that this world is able to amaze and question us, which every time we propose initiatives dedicated to them, both of an educational nature, recreational or cultural, today's reality, affirms its own vitality in its truest expression.

I believe that a careful look at the world of children can only lead us to a re-evaluation for what it is today and not in view of a future that will see them adults and then worthy of consideration.

The boys are not that mass of video-addicted, refractory to any reading or cultural stimulation as they have been defined in these years, but people with expressive canons and their own needs that try, rather than to develop, to channel into understandable canons an adult world, with a completely unilateral interpretation of adaptation.

It is therefore a question of noting the lack of spaces dedicated to the children but the need for their restructuring.

A restructuring for a protagonist less and less wanted by adults and more and more lived by the boys.

In this way, talking about the world of children will no longer have the impression of referring to an antechamber of reality, but you will have the certainty without such a component no reality can be said complete (Bulletin of the Diocese of Ferrara of September 1983, p. 3).

Rereading this small article that I wrote in 1983 (on the Bulletin of the Diocese of Ferrara of September 1983, p. 3) in relation to pastoral and catechetical actions I think that, subject to the modification and updating of some terms, it is opportune to reflect constantly on the relationship between technological reality and educational reality. It is also advisable to reflect on the guarantee that we can use every social change for an effective and constant didactic action, for an updating that of the teaching-learning processes, you know in the improvement aspects that in considering the risks they carry with behave.

Talking about updating does not mean following fashion or adapting to what is common feeling but maintaining a continuous attitude of research and innovation for an educational effectiveness of young generations, which are the object but also subject to social innovations.

The progressive increase in the use of multimedia and interactive platforms, including the world of social media, of mobile devices, which affects the new generations, must be considered.

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This continuous and widespread use has generated a habit and a culture of access to many different paths of use of information strongly connoted as information from transmedia and cross-media characteristics.

The use of technologies and of these multimedia and interactive platforms shows how it is possible to integrate different media and use them not only as a tool for access to information but as an added value of a strongly contextualized learning experience such as teaching-learning processes, making access to content in semantically defined ways (Abrami et al., 2015).

All, the importance of the theme of the introduction of technologies in the teaching-learning processes goes beyond a simple "modernization" of the school but it is in its nature to be "contemporary" of its students.

No tool can be adopted without evaluating the pros or cons, but certainly, the study of technologies to support training processes is fundamental because technologies are a present and necessary skill to interact with reality.

No technology inserted in educational contexts can ignore, but rather must draw effectiveness and meaning from the epistemological and cultural dimension.

It is acknowledged and recognized that every educational process is indispensable to the constant and significant interaction between the teacher and each individual learner; technology cannot ignore or worse make the fundamental human relationship seem useless (Toschi, 2016).

The OECD (Organization for Economic Co-operation and Development) recalled and continues in its relations to underline this "interpersonal" aspect in the teaching-learning processes.

We are called to build a vision of education in the digital age, through a process that allows students to face, interpret and support a logic of learning throughout life (life-long) and in every context that we live: formal, informal and non-formal (life-wide).

The challenge of education in the digital age can no longer only be a function of the number of available technologies (Campione, 2015); rather, it must combine the growing availability of technologies and enabling competences, the rapid technological obsolescence, and the new educational requirements.

Understanding this relationship means helping the school to acquire digital solutions that facilitate preparatory environments for active and laboratory learning, as well as for constructivist or project learning.

Technology changes the approach to processes and people's approach to the reality around them, to understand and interact with it.

The practical impact is to include technologies in teaching and not have a classroom for technologies.

## 2. Problem Statement

### 2.1. General overview

The research that is structured and implemented has as its central theme the use of technology to support learning-teaching processes.

In particular, the central theme is how technological development strongly characterizes every section of people's lives.

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Very often, we notice the changes highlighting the problems that have generated or exalting the news. If technology enters the learning-teaching processes, it is certainly necessary to evaluate the problems and the potential to add value.

In summary, the central theme is therefore how to integrate a technology that is already permeating the lives of people, particularly young people.

Both the theoretical part and the practical part of this thesis work refers to a cone of technology as a treatise on an art, to see which are the logics that are implemented and induced by new technologies.

All this because no new technology has supplanted the previous ones but has integrated them and often incorporated them from a logical, even if functional, point of view.

For the world of education in formal, informal, or non-formal environments, we want to reflect on how we can establish a virtuous circle that starts with teacher training for the design and implementation of effective and virtuous processes from a cognitive point of view.

The aim of the research is therefore to, starting from what are the “impressions” of how technology has influenced the teaching learning processes, to highlight what are the potentialities of technology in teaching.

The potentials that we seek to highlight start from the consideration of the perceived limits and risks, both real and hypothesized.

The technologies are too often seen from the perspective of a fashion, or a trend to which we must adhere, but it is not possible to imagine that there is a pure attractive effect of the technologies.

The reflection that guided the research is that technology must be considered from a functional "family" point of view to the students, so that overcoming a sort of instrumental obstacle we can exploit the increase of cognitive potential for effective learning.

The aim of the research is therefore, not binding on a specific technology that too often is identified with a hardware or software tool that is, to underline the possible improvement of teaching learning processes.

The research seeks to indicate a path for teacher training in the analysis and use of technologies and their use in training processes.

In particular, the aim is to underline the concepts of interaction, multimedia, and logical connections as indicators of the formative effectiveness of a technology.

The ultimate practical goal is to ensure that the tools and technologies come in as educational tools in an organic way in the school to enable them to become more and more effective in their training.

In practice, an attempt is made to ensure that the great stratification of information that the students must face turns into a learning model for content analysis for a continuous training and that includes all the years and environments that a person will find himself living.

### 2.2. Context and structure

The research, which starts from the hypothesis and the social evidence of the use and influence of technology in everyday life, is articulated in 2 points that act as a cornerstone for reflections and the definition of practical interventions:

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- **technology has changed cognitive styles** and highlighted the limits and potential of the person-technology-knowledge relationship; this first part is developed through an exploratory research of the teachers' feelings in relation to the modification of the cognitive styles of their students
- **technology is an integral part of children's** lives and they use technology as a privileged way of access to training, this second part is developed with the introduction of specific technologies in the didactic journey.

This new millennium, for didactic research, is an open construction site; a field of development and research that in these years presents a great variety of ideas and a ferment of innovation.

In all this set of ideas and processes it is possible to identify some fixed points that consider the didactic research and teacher training, actors of the teaching-learning process; teachers who are not only called upon to define educational processes but also to make a decisive contribution to the definition and creation of cognitive, resources or technical device an integral part of learning.

The theoretical support is connected, albeit derived from the microteaching point of view, with Bruner's education theory, as it developed it from the early 1960s.

Kim Romney and Dwight Allen (Stanford University 1963) coined the term microteaching. Microteaching aims to provide teachers with elements for the analysis of their teaching practices, to have “the possibility of acquiring the techniques and skills necessary for the best possible performance of the profession” (Allen & Ryan, 1974, p. 29) and also “considerably broadens the dimension of feedback” (Allen & Ryan, 1974, p. 26).

It can be affirmed that, in this context, it is possible to make surveys of teachers' practices and artefacts to make them understand their meaning and objective during classroom work and individual study (Damiano, 1999). When we talk about educational research, and in the field of pedagogy, we can apply a categorization that provides for the placement of research methods in two macro areas (Daniela, 2019), i.e., qualitative methods and quantitative methods even if in literature we can use the two types of investigation using an integrated approach (Daniela, 2018).

## 3. Research Questions

Such a broad reflection and debate that is involving many disciplines, such as the pedagogical sciences, passing through engineering and psychology not only arouses interest but the need to question whether and how these technologies "interact" and “condition” the processes of teaching learning.

It cannot be ignored that, although not in a systematic way, formal, non-informal and informal learning cannot be thought of without "technological" influences.

The focus of the interest of this work is certainly the formal, but aware that today more than ever the non-formal and the informal are part of the life of each and especially of the young people for whom many behaviours and cognitive styles are borrowed that technologies "They suggest ".

From this overall image, object of many analyses, observed from different points of view, a description of the BYO perspective is obtained.

Research and experimentation in the development phase consider the fact that, while innovation derives from the interactivity of the tools (De Mauro et al., 2015; Grimaldi, 2015; Marcianò, 2017; Sitta,

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2016). On the other hand, it now has the benefit of interaction and connectivity, potential that must however be transparent with respect to the device used by the student (Mimi & Mattei, 2015).

The fundamental questions that act as a plot and a watermark for research, and that arise from the reflections made so far can be summarized in 3 questions / reflections:

a. How much technology has changed or influenced the cognitive styles of young people in general and of secondary school students in particular? If you use hardware and software technologies to structure the learned topics, and technologies that can experimentally detect data, does it increase the level of learning?
b. How much the use of integrated technologies in learning-teaching processes changes their development, and what are its advantages / disadvantages. Do the technologies introduced among teaching aids modify, and to what extent, the level of learning by modifying the modalities of information processing?
c. How and how much the use of cognitive artefacts improves learning skills and allow secondary school students to acquire new skills. By incorporating physical tools and cognitive artefacts between didactic tools, transversal skills are increased, which make it possible to see technology as a competence applicable to every learning environment?

With reference to the research questions, it is good to specify what is meant by some terms that characterize these questions.

Particularly when we talk about the relationship between technologies and cognitive styles, we refer to the problems related to the analysis of cognitive fields and cognitive modifiability.

Habits, in fact, are "cognitive paths" (Cussins, 1992, pp. 651-658), experimental models of behaviour with which we relate to the world, are learning patterns that presuppose visual points. These paths outline the limits and potential of the cognitive field.

However, it is also true that they are likely to change, expand, interconnect, restructure or disappear with the activation of another fundamental knowledge.

In fact, the fundamental, basic knowledge that the school builds with its protagonists makes sense if all the subjects involved in the training game are aware that, while they build some knowledge, they activate a series of acquisitions that they will use, at least in part, in other contexts.

These are metacognitive learnings. When we talk about cognitive functions, we refer to basic cognitive and coordination processes.

## 4. Purpose of the Study

In this context, it can be said that we are talking about applied research because it is aimed at **identifying practical solutions and in the specific context of formal learning**, and how technologies and cognitive devices are an aid to teaching-learning processes.

The primary objective is certainly not to progress in a theoretical knowledge but to make the theoretical knowledge related to the relationships "fruitful" for the development of tools that can be integrated in the technical field of the relative technology.

This research, from a theoretical point of view, also relies on Dewey's (1938) reflection on the problem between pure science and applied science, a reflection that can be summarized:

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1. **knowledge** and **ideas** are the result of a method that was intelligently followed by the men who interacted with the environment;
2. **science** in a **technical sense** is a formalized processing of daily operations. Its meaning can be understood only by keeping in mind its relationship with attitudes and procedures that can be used by all people born with the ability to act intelligently;
3. **common sense** is relative and consists of both scientific attitudes and unscientific attitudes.

The purpose of analysing and identifying the possible practical solutions for using cognitive artefacts, from the Apps to educational robotics, is certainly a vast research horizon that has a "reasonable" number of objectives in the work to be developed.

In summary, three are the objectives of the research:

**1.test of a hypothesis:** the use of interactive technologies and cognitive artefacts as didactic tools allows increasing the level of learning; moreover, the use of technologies as a side effect makes it possible to generate collaboration processes (relational dynamics) in relation to the use of the technologies themselves.

**2.nomothetic objective**: to define parameters that evaluate the didactic efficacy of cognate artefacts, also as an extension of the concept of learning objects and inclusive of educational robotics methods and define the rules according to which these parameters can be used to categorize by use and effect cognitive artefacts.

**3.methodological objective**: we intend to identify, starting from the cataloguing of technologies such as that made by the pedagogical wheel, which are the types of technologies that can be integrated into the teaching process, both from the point of view of learning and from the point of view of the methods of teaching.

## 5. Research Methods

The research methodologies, it should be said that the research made use of tests and questionnaires and a statistical analysis of the data.

The tests and questionnaires were used to detect:

- attitudes and behaviours of students in their interaction with technologies;
- problems with the use and understanding of and solution methods used by students;
- verification of the level of understanding and learning of the topics introduced.

The collection and analysis of statistical data was used in terms of:

- **frequency**: absolute frequency was used to understand the dominant characteristics in the fields of analysis
- **percentages**: to understand the incidence of certain attitudes and learning outcomes of the didactic intervention
- Cronbach's alpha: to measure its reliability, or to verify the reproducibility over time of the intervention, under equal conditions, of the results obtained.

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### 5.1. Quantitative Research

The research can be defined quantitative is characterized by a low degree of interaction with the subjects involved to have a consequent lower risk of data contamination by the researcher.

Furthermore, the research is characterized by the quantitative analysis is the formalism of the procedures: the collection, the data processing, the use of the data matrix and the use of statistics follow defined and easily replicable protocols.

Although in the educational field, it is easy to imagine that replicability is subject to factors that change over time, the cultural background of students at secondary schools and teachers and the socio-cultural situation.

The high formalization allows the researcher to detect and store a large amount of information with highly standardized tools.

Since we intend to look for explanations of the values assumed by the dependent variables based on the values assumed by the independent variables, identifying relationships, not necessarily causal, between the variables themselves we will use the standard search, research based on the data matrix, descends from the tradition of quantitative research, which has its precursors in Galton, Wundt, and Thorndike. The name recalls the characteristic of this research strategy to have highly formalized phases and procedures.

Its high degree of formalization makes it in many ways simpler than other search strategies.

### 5.2. Research by Experiment

Since among the objectives of the research, there is, also the objective of identifying causal relations between factors, or relationships in which it is assumed that a supposedly dependent factor is properly caused by (at least) another supposedly independent factor we will also use the research methodology by experiment.

The research methodology can be classified according to different parameters; a classification criterion for scientific research methods is essentially based on:

- **possibility** (degree) of control that the researcher has on the situation in which the phenomenon under study is manifested
- **possibility of minimizing** the effects of disturbance (constraint level)
- With this approach, we can speak of degree of control:
- **maximum**: when the researcher himself "produces" the phenomenon (i.e., in the laboratory)
- **minimum**: when the nature of the phenomenon is such that it can be observed only in conditions that the researcher cannot influence in any way

The constraint level can also be considered and defined:

- high constraints: high degree of constraints imposed by the researcher
- low constraints: minimum or zero degree of constraints

In this structural panorama, during the research phases an experimental method was used, which normally guarantees maximum internal validity, which with structural validity is the best verifiable in this field of research (Nind et al., 2016).

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# 6. Findings

## 6.1. Experimental Phase

The experimental phase is the heart of the intervention within the school and work has been done so that the conditions of the normal learning path could be reproduced.

The choice of the school and the activities to be carried out was dictated by two factors:

- the school had equipment and technologies
- the school has two locations where the influence between the control groups and the sample group has been minimized and a homogeneous teaching group.

What we wanted to achieve was on the one hand the use of network technologies that implement logic and tools common to many of the software and virtual places frequented by students and on the other the use of "hardware" technologies to allow also instantiate, make the logic logical and understandable; it was intended to make a real virtual exchange to give concreteness and to highlight the common logics that govern the technologies that can be traced back to the same logical prototype of knowledge, the network, the graph where meaning is given by relationships and can be represented in different ways the same structure.

At this stage, methods were pursued to induce young people to develop problem-solving skills, to learn from errors and to understand the points of contact and the common logic between information systems and the logic of learning, sharing, and using the know.

The experimental phase will develop through interventions that will be divided into two types:

- use of online applications to approach and communicate historical topics in parallel with social and scientific events
- creation of cognitive artefacts, educational robotics, to understand the meaning of a scientific concept through data collection, the concept of acid and basic.

Starting from these two lines of experimentation, two interventions were made, the first aimed at using an interactive multimedia tool, which allows the creation of different multimedia tools to communicate contents related to the succession of historical, social, and scientific events.

The second experiment focused on the use of simple electronic artefacts for data collection and a consequent explanation and communication of the chemical concept of acid and basic.

The topics, although not integrated in the specific program of all the courses, the classes, for a total of 6 were two for each of the 3 years of the middle school represented a deepening.

The pedagogical intervention to support and found the research is based on a problem-based method, the pedagogical approach cantered on the student who uses the analysis of a given problem as a starting point for the acquisition of new knowledge.

After an introduction and explanation of the topics, the students were guided and actively encouraged to reason and solve the problem.

The problem, which for the part related to the humanities area, was identified with communicating and explaining the relationships between social events and scientific discoveries, obtaining, and drawing independently on all the information sources necessary for this purpose.

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For the scientific part, the problem was to measure the pH of liquids using the appropriate tools, after having understood the meaning and the methods of identification.

The implementation of this pedagogical intervention prefigured to obtain two closely connected results:

- **a better level of learning** (a better cognitive performance)
- **a structured learning**, that is, the knowledge became known in its logical fabric allowing it not a mnemonic but effective and continuously expanding knowledge.

### 6.2. Experiment Intervention Program

Introducing the intervention program, we remind you that the dependent variables referred to are those identified above:

- **content learning level**, using an evaluation scale, in relation to the objectives of the learning teaching process;
- **level of metabolization of the use of technologies**, of how technologies become transparent to students, to understand how technological "competence" becomes the ability to use one's own skills in a transversal way; the level of "metabolization" is evaluated during the observation phase through questionnaires and transforming the observations into a scale of values.

The intervention, which will be discussed below, provides that the teachers of the two areas concerned make a 20-hour speech (divided into 3/4 a week, for a period of 5/6 weeks).

This educational intervention includes a part of explanation in the classroom, of 4/6 hours and then laboratory work in which the students under the guidance of the teachers do exercises and use technologies to summarize what has been learned and prepare for:

- communication of the learned contents
- contents verification (classroom task)

The main content of the intervention from a content point of view focused on a scientific pH topic and a historical-scientific topic, the main socio-cultural-scientific events of the '900.

From a technological point of view, an electronic kit represents the content with acidity detection sensors and software that allow a semantically and logically defined structuring of the relationship between contents.

The research intervention program starts from the study and participation in experiences of teacher training and experimentation in educational robotics.

The experience of training teachers and future teachers has put me in contact not only with the need to teach the possible use of technologies in educational activities but also in front of requests for further information coming from the real school, from those who confronted each other day after day with guys.

The main stimuli came not so much from questions about how to use technologies but what skills they needed, what skills they changed and what skills they required.

Similarly, these questions were reflected on new demands and needs to train teacher professionalism.

The reflection and the preparation and delivery path of the training path for the students has led to hypothesize the need to imagine a path that does not chase the technological innovations but that would

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evolve the teachers' abilities to analyse and use the tools they become familiar for the students (Calidoni & Ghiaccio, 2015).

Reflecting on these stimuli, with the EURESIS Research Laboratory of the University of Ferrara, directed by Professor Gramigna, I thought that the starting point from which to derive research is the concept of cognitive style and how they are modified, in relation to the advent and spread of technologies (Gramigna, 2015).

This reflection gave rise to the setting up and administration, to a large sample of middle school teachers, of a questionnaire to understand if and how the influences of the use of technologies on cognitive styles and learning practices were perceived.

It was found that the same technologies could enhance those skills that seemed to have diminished. In particular, the capacity for analysis and synthesis that seemed to be delegated to technology but that the same technology could increase if one thought of using technologies as a tool for understanding reality and communicating knowledge (Gramigna, 2017).

Starting from this survey and hypothesis, the intervention program in schools derived its intervention logic from educational robotics experiments that in Italy was and is developed by Robocup Jr Italia, a network of schools recognized by the Ministry of Education, of the 'University and Research (MIUR), founded in 2008 and involving over 200 schools of all levels.

The challenge of educational robotics is to develop, through technologies, effective cognitive styles that draw their strength from problem solving and learning methods by mistake.

We are seeing that robotics at school, together with coding, allows revolutionizing teaching and learning methods, making both more enjoyable for teachers, children, and young people (Baldascino, 2015).

The research intervention aims precisely to see that in addition to the enhancement of learning skills, the interactions between students and between them and the teachers are also improved.

The research foresees a first questionnaire to find out what the teachers' perceptions about the influence of the use of technologies by young people are and how their skills are modified.

It was considered necessary to start the research a study on the repercussions of these changes and processes on training practices and their models, also considering the consequences, not always explicit, that both have with respect to behaviors and values.

We intend to do a first exploratory research; it is in the proposal of a school that aims at the enhancement of the talents of both teachers and students at secondary schools.

Yes, it is intended to do the survey of the thoughts of teachers, from their "feeling" of how the world of technologies and their pervasive use has influenced cognitive styles, and in any case on students, of secondary schools, skills, and attitudes, regarding learning processes.

The research intends to proceed by using cognitive artefacts and educational robotics interventions in the context of learning scientific concepts and problem-solving skills, doing the same training without the use of "integrated" technologies.

The whole research intervention program intends to develop and verify how the use of technologies allows improving on one hand the level of learning of the students but above all transforming the know-how into skills for a meta-cognition and a contextual use of acquired knowledge.

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In particular, the research intervention wants to prove that the level of learning improves and, that technologies allow addressing topics with high semantic densities, providing analysis and comprehension skills of the cognitive network underlying each topic.

The intervention also aims at transforming the use of technologies into competences, i.e., the ability to understand the use of similar technologies and to associate technologies and their uses in a "transparent" way, at a level of cognitive unconscious.

The talk is based on a series of theoretical lessons on history and sciences in which the teachers dealt with three themes:

- history of the '900, in terms of the main social and political events
- main inventions of the '900
- concept and measurement of pH

After these theoretical interventions, the experimental group had access to multimedia technologies to create documents and an online tool to assemble documents and produce a document describing the 20th century through political-social-scientific history and which could be presented both to comrades than lecturers.

As far as the concept of pH is concerned, the experimental group carried out a laboratory work with simple electronic elements, which allowed highlighting what implied from a practical point of view what were the simple notions acquired in theory.

This program of interventions aims to verify that this integrated methodology allows improving the level of understanding and the level of learning in general as it develops a focus on the relationship between data to build knowledge.

Furthermore, the purposeful use of technologies produces the ability to metabolize the tools to make them into skills, but regarding their logic and purpose, not strictly linked to the only areas in which they were used.

The intervention program described so far, and rivals in the light of its correlation between the research questions and the hypotheses that gave birth to this work, had as its backbone the technologies, not as a specific tool but as a methodological approach.

The intervention program implements the use of technologies as integration in the learning-teaching processes, inserting into the path of school programs to improve the level of learning, developing analytical and synthesis skills, not modifying the educational objectives but evolving the educational tools.

This introduction of technologies is guided by a learning logic - teaching in a formal environment in which interactivity, accessibility and usability of technologies use to increase the level of learning.

A learning book measured not only in terms of results in the verification tests but also in terms of communication of the acquisition that highlights the degree of analysis and synthesis acquired.

Level of learning, analysis and synthesis induced and made to grow by technologies as an archetype of cognitive style that is developing in young people.

Starting from the hypothesis of the relationship between technologies and learning, which governed the planning of the fundamental intervention program, it was the decline of this main flow through the key words that controls an evaluation and enhancement of technologies regardless of construction logics and closely related to 'electronics.

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Focusing attention on interactivity, accessibility and usability, and their regulation as independent variables means experiencing the effectiveness of:

- active student participation (interactivity);
- an inclusion and a path of "breaking down logical barriers" of educational tools (accessibility);
- an increase in endemic curiosity and perception of the learning path as a positive experience (usability).

The path of the research intervention can therefore be described as the development of a process inspired by what technology, understood as a relationship with data, information, and knowledge, declined in a relationship of growth between the characteristics which makes the technology "reliable" and the development of skills that makes training "effective".

Technology therefore supports learning processes - teaching is a support that not only increases the level of learning in the short term but increases learning skills through the features that identify from a logical point of view and of each technology.

### 6.3. Experiment Finding

The dependent variables that have been taken into consideration are:

- Interactivity of technology
- Accessibility of technology
- Usability of technology

In the light of the data collected by the experimental group, the tools and technologies used in the intervention program should be considered characteristic.

As far as interactivity is concerned, bearing in mind the number of functions that the boys have used and the high personalization that has been made of them, the frequency to induce an aware and meaningful use is fundamental.

Similarly, given the diversity of functions used and the management of communicative graphic information, it is important to measure the range of variability that helps to develop the ability to relate the instrument and purpose of use.

In relation to problem solving techniques (such as the use of sensors to detect pH), the Relief is an indication of the effectiveness of the technologies.

Which highlights the relationship between technological and instrumental choices with the solution of problems.

After this first part of the collection, the research intervention took place, in a first phase with a series of works following the explanation by the teachers of a series of historical social and scientific events of the '900.

A journey has been made according to the AUM (Approach, Use and Metabolization) approaching and using an online, standard, and free tool, the H5P environment an open-source plug-in that allows the creation, sharing and content reuse multimedia and interactive, such as presentations, games, tests, interactive videos and multimedia and interactive timelines.

This second phase has occupied 2 meetings for a total of 4 hours and is placed in a phase of use of the instrument.

https://doi.org/10.15405/epsbs.2021.03.02.32
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The last phase of metabolizing the 6-hour instrument was to give the children the task of using the Timeline tool to synthesize and communicate what had been learned during the teachers' explanation of a series of historical social and scientific events from the 1900s.

This last phase saw the different groups then use the tool created by another group, evaluating it with a simple numerical scale with respect to 5 parameters from 0, not at all to 4 totally; the evaluation was given individually by each individual boy, after he had been given an hour for viewing and browsing the contents.

Using Steve Krug's theories, for an empirical assessment each group was given a random product, created by another group to be evaluated.

It is interesting to understand the design and communication skills that students at secondary schools have implemented, and the following table summarizes the number of products that have achieved a value in a characteristic.

The hypothesis of the positive influence of technologies in the learning process is verified by the analysis of the percentage increase of the averages in the assessments and by the percentage of students who have understood the concept of pH and its implications like a structure of history.

Similarly, for the concept of pH 171 students 182 have understood the practical and theoretical aspects of the pH against 5 out of 54 of the control group (see Table 01).

**Table 1.** Assesses the level of understanding of the concept of acid and basic (experimental group

| **UNDERSTANDING LEVEL OF PH** | |
|---|---|
| ***Scale*** | ***Students at secondary schools*** |
| **0** Not understood | 1 |
| **1** Only the general structure happens | 5 |
| **2** The structure and the relationship between acid and basic are understood | 30 |
| **3** Understand in its theoretical aspects but not completely the practical consequences | 75 |
| **4** Understood in its theoretical and practical aspects | 71 |
| **Total** | **182** |

At this point, we believe it is necessary to summarize and recall the principles, processes and results obtained in the experimentation intervention. It may be recalled here that the work developed on a track of analysis of technology and its use in learning teaching processes.

Analysis and experimentation have tried to highlight the cognitive and learning logic that technologies have highlighted. Evaluating and reassessing the potentialities of using information, multimedia and network technologies is the aim of the research, not forgetting the critical points that the technologies themselves have introduced.

Critical issues that we are interested in as they sometimes seem to conflict with the potential of the tools themselves, but which once again highlight the need to train a professional teacher who deals with technology from a methodological point of view, understanding its logical-connective structure that underlies it. The research focused the focus on the learning outcomes of middle school students in whose program topics related to their study path were included.

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Their subjects of humanistic and scientific area have been explained; for the humanistic area, the main social, economic and scientific facts of the '900 and for the scientific area the understanding and the meaning of pH (a scale of measurement of the acidity or basicity of an aqueous solution).

For this reason, both the experimental group and the control group underwent learning-teaching processes.

The experimental group was provided with study and teaching tools that used software technologies for the humanities and hardware for the scientific area.

At the end of these processes, tests were conducted to verify the learning of the contents and to communicate the contents themselves. Among the skills that the middle school aims to develop in students is communication and communicating content is an indicator of their understanding; one often cites an aphorism that is attributed to Einstein: "I will know to know something when I know how to explain it to my grandmother".

We measured in terms of average increase of the evaluation both experimental group and of the research group, for the humanistic area and measured the level of understanding of the concept of pH.

This surely determines an extremely positive reading and a positive impact of the technologies in the learning processes.

The data determine that the hypotheses of the use of technologies produces a more effective knowledge.

Effectiveness is the result of logical reconstruction and a correlation between the notions, data and findings that are obtained from reality, from literature and from teachers.

To measure the reliability of the data the Cronbach Alpha was calculated in consideration of the fact that it is a statistical indicator used to measure its reliability in psychometric tests.

Cronbach Alpha is to verify the reproducibility over time, on equal terms, of the results from they provided and was designed by the American educator Lee Cronbach in 1951.

The formula is expressed as:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum_{i=1}^{k} \sigma_{Y_i}^2}{\sigma_X^2}\right)$$

where $k$ is the item number $\sigma_{Y_i}^2$ $\sigma_X^2$ is the variance of the total score and the variance of the item for the sample of individuals under examination.

For the evaluation, an EXCEL spreadsheet was used and by inserting the 6 items of the 182 students of the experimental group Cronbach's Alpha = 0.83 was obtained, an excellent result considering that high reliability values are to be considered those ranging from 0.70 to on.

Cronbach's Alpha = 0.59 obtained from the control group shows the greater "randomness" of the results and consequently a low correlation between the teaching method and the learning, more closely linked to factors due to the student.

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The empirical research as it is configured and the results that it has proposed even in the limit of the sample and of a well-defined reality in which it took place, presents an interesting relationship to the use of technologies and the effectiveness of teaching-learning processes.

Empirical research must certainly be extended so that technology, with its epistemological, cognitive, and relational implications, can become one of the cornerstones on which to develop formal training environments.

Surely, the research has also brought out the feeling of a strong inclusive factor that technologies can bring.

We could say with a phrase attributed to the physicist Edward Teller during a conference that today's science is the technology of tomorrow, so we should again have the knowledge of science of the past to allow children to build an effective technology for the future.

A last reflection on the collected data leads to report such data with the hypotheses formulated, hypotheses that can be said to be confirmed.

We can start from the main hypothesis: technologies, due to their ability to generate interaction and their pervasiveness in the lives of children, are a privileged way forever more effective learning-teaching process.

This hypothesis is certainly confirmed, because the results of the final tests show that it has a high and significant percentage of students who have improved their performance (in terms of the average of the evaluations. To confirm the main hypothesis the results of the control group they present data that underlines how the performance of the students of the control group maintains a trend in line with the past.

In addition to this, it is significant to note that by applying Cronbach's alpha, the calculated value shows that one can speak of reliability and reproducibility over time of the intervention as far as the experimental group is concerned.

For the control group, Cronbach's alpha detects the unreliability and reproducibility of the intervention, clearly linking the results to strong influences both individual’s capacity and of the environment from which he comes, without detecting a significant intervention of the process teaching. Similarly, in relation to the experimental group, the secondary hypotheses can be considered verified, considering the data that highlight the ability to use the tools and the ability to face and solve technical and logical problems, both individually and in groups.

Similarly, the results of the final verification tests, seeing excellent results both in terms of evaluation and communication of the contents. It confirms that technological skills are transformed into cognitive abilities, making both the capacity for synthesis and the ability to grow analytical skills.

## 7. Conclusion

The research work originated from the need to reflect on the improvement of learning-teaching processes.

The reflection was born from trying to understand if, the technology, whose negative influences have always been mainly highlighted, could be re-evaluated within formal training environments, in relation to the fact that in non-formal and informal environments it had a big impact also in relation to the diffusion of social systems.

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In formal environments, the hypothesis that the use of technologies could increase the level of learning arises from having detected, through an exploratory research on middle school teachers, that technology had changed cognitive styles, but that these changes could be well integrated into the learning-teaching processes improving the level of learning (Rivoltella, 2017).

By setting up the work, it seemed important to understand what could be some indicators that made the technology significant to increase the level of learning, inserting it into the teaching learning processes.

It was therefore decided to use as indicators that well described an effective use of technologies, of which measuring instruments were present and which were supposed to relate to the development of the level of learning.

The increase in the level of measured learning, through the results obtained in the verification tests and correlated to the previous results (both, experimental group, and control group) was found to be closely linked to the use of technologies in the learning-teaching processes (Bower, 2017).

The interactivity indicator, measured by the high level of exchange of information and actions between student and tools it has encouraged and increases student participation, as noted in the questionnaires, and the training and acquisition of knowledge, as noted by the reluctant verification tests.

The abilities of synthesis and analysis are the result of the accessibility of educational technologies that, by promoting and improving the inclusive dimension of teaching processes; generate processes of information exchange, which are optimized with the skills of analysis and synthesis induced.

It underlines how the tests of the arguments, also developed through knowledge communication tools (infographics), have shown how the accessibility of the teaching tools implements the satisfaction of the students, giving an impulse to the "pleasure" of knowledge as an intrinsic improvement of the person.

All the measurements made through questionnaires and observations have correlated the technologies to the attitudes aroused and generated in the class group, I become a learning community.

At the end of this arduous and limited journey of study and research, it is interesting to look back, to write a reflection on the structure of the research work and try to define a conclusion.

But, as we often find ourselves to be difficult to reach conclusions and if it is a question of reflecting on pedagogical processes, cognitive styles and the relationship with the reality that surrounds us in mode we could refer to the Maxim of Matz, written in the book of scientific semi-paradoxes “The law of Murphy" by the writer Arthur Bloch: "The conclusion is the point where you are tired of thinking”.

The project and the research may seem ambitious, and perhaps it is, but we intend to work in perspective and with the spirit that the Japanese-born American physicist Michio Kaku described in this way: “When an important but elderly scientist state that something is possible, he is almost always right. When he says of something that is impossible, he is probably wrong. The only way to discover the limits of what is possible is to go a little further and venture into the impossible. Any fairly advanced technology is indistinguishable from magic”.

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https://doi.org/10.15405/epsbs.2021.03.02.32
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