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Technological education challenge: A European perspective

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Abstract

This paper is a reflection on Technological education in the light of the changes that this subject has undergone recently. The first part of the paper provides a theoretical presentation of Technological education from a European perspective. Then a more specific exploration is developed focussing on the middle schools in two selected contexts (France and Italy), considered here as examples of curriculum. Finally, the implications of this subject on current society are explored.

Keywords: Technology; Curriculum; Middle School; Technological Education; Europe.

Technological Education in a changing society

The reality in which we live is becoming increasingly complex, with a central role given to technology. This technological environment has become particularly rich only recently, if we consider the long line of history (Lilley, 1970). The wide range of applications of technology, such as biotechnology, medical implants, and genetics innovation highlights the hybrid development of the high-technology environment in which we live (Johansson, 2009).

Despite the pervasiveness of technology in everyday life, there is a global trend of youth disaffection with the study of technological subjects (Ardies, De Maeyer & van Keulen, 2015). However, technological and scientific understanding and skills are key competencies for the future (Feinstein, 2010; Fourez, 1994), enabling students to think critically and creatively with respect to the twenty-first century problems and challenges (Bellanca & Brandt, 2010; Shamos, 1995;).

For this reason, in this paper it is considered that Technological Education can make an important contribution to students' understanding their relationship with the technological world which surrounds them (Ardies et al., 2015). The goal of this paper is to give some insight into the reformulation and development of the Technological Education curriculum in two close but different countries in Europe (France and Italy), highlighting the individual and social implications of this subject in each context. This contribution aims to continue the reflections on the contribution of this discipline to the compulsory school system. To reach this aim, it will begin with a discussion on the philosophy of technology and, then contextualise the reflection on Technological Education by considering the two European countries, with a common focus on middle school education.

From the philosophy of technology …

Focusing briefly on the philosophy of technology, it is characterized by a first classic phase in the 1920-1990 period, with thinkers like Heidegger, Ellul, Mumford, Marcuse, Ortega and Gasset who conceptualized technology in relation to the human condition (Lucena, 2009).

The current contemporary philosophy of technology gives more space to the context and social variable in which it is expressed (Brey, 2010). New social and ethical challenges emerge from the philosophy of contemporary technology, demanding new theoretical and applied efforts. According to Jones, Buntting and de Vries (2013), technological knowledge is characterized by a strong normative component and is still a relatively young field. In this more contemporary philosophy of technology, the technical object has a central role (Dusek, 2007). Pitt (2000) notes that the use of the instrument creates technology and emphasizes technology as "humanity at work" (p. 11), in cumulative technological development (DiGironimo, 2011).

Severino (1988), an Italian philosopher, suggests we live in a society where all the objectives of each individual become the means to achieving a common and global aim: the endless development of the technique. For example, the whole set of advanced tools owned by an enterprise becomes the fundamental purpose and core of potentiality of that enterprise. In this way, societies are oriented towards enriching the power of their tools: the wealth, which initially functions as a means, becomes a purpose.

In relation to the interdependence of science-technology-society (Layton, 1994), this general reflection on philosophy of technology leads to questions about the educational formation for future generations (Ineke, Sonneveld, & de Vries, 2010). An introduction to Technological Education is proposed in compulsory schooling, which starts in primary education and continues in middle school. If the subject of Technological Education is introduced in the curriculum, then, students can develop the study of this subject further in vocational learning institutes or in high school. The scholastic discipline of Technology– as it is generally called - invites a critical reflection on the technological world (Flick, 1992; Williams & Stables, 2017) and promotes a better understanding and heightened intelligibility of the technological environment (Ankiewicz, 2015; Ritz & Martin, 2013).

…. to the discipline of technology

Technological Education is almost globally present in school curriculum (e.g., see for Finland, Jarvinen & Rasinen, 2015; for Ireland, Leahy & Phelan, 2014). Recurrent teaching objectives in different national curricula consist of design and technical objects, industry, sustainable development, management of daily life, citizenship and the history of technology (Gumaelius & Skogh, 2015).

However, these topics are presented in different ways in the different national curricula across the world (Engeström, 2013; Jones et al., 2013). This variability in curricular approaches can be attributed to the lack of a global reference point which resides in the present academic discipline (Ankiewicz, De Swards, & de Vries, 2006). This discipline still lacks a clear internationally agreed identity and a substantial disciplinary educational research and teaching base (Mawson, 2007; Rauscher, 2011). Also, in international assessment comparisons - such as The Programme for International Student Assessment (PISA) - Technological Education lacks a specific evaluation, being incorporated into the sciences or mathematics sections.

Stemming from the many related social issues is a requirement for a new reflection on Technological Education (Brey, 2010). To place the reflection in a context, this study will make an analysis of two close but different countries in Europe: France and Italy. Considering recent reforms which have taken place in both countries, the paper will focus on the middle school level - called College in France (11-14 year old students) and *Istituto di Istruzione Primaria* in Italy (11-13 year old students).

The goal of this analysis is to develop a better understanding of the challenges of educating in Technological Education in the two European contexts, taking into consideration the peculiarities of each context.

Technological education in Italy: An old and new discipline

In Italy, Technological Education, currently called *Tecnologia* (Technology), competes with other disciplines and activities in the provision of a holistic education of students in the middle school, and it does not have a formal place in the primary school. The history of this subject in Italy is short (Limoncello, 2004). It began in 1962, and from then until 1977 the subjects Technical Applications for males and Technical Applications for females were taught. The subject was available for 16 hours per week, but was not compulsory - students could choose between the option of Latin or Technical Applications. In 1977, Technical Education was introduced, and became compulsory for three hours per week.

In 1979, a new programme introduced the concept of *execution* (more centred on the use of tools and instruments) to take the place of *manuality* (focussed on the use of hands) to provide for more effective learning. This terminological change was socially solicited: indeed, the specialist's use of the tools is considered more distinctive and privileged than a more general focus on the development of manual skills. At the same time, electronics and computer science aspects of technology were promoted massively in schools. This gave priority to teaching, organized in modular or didactical units, often corresponding to an in-depth study of a specific technology; for example, the steel industry from the production of steel to the use of the steel, from the resources to the economic impacts.

In 1989, the number of technological teachers was halved by the ministry, for economic reasons, against the protests of those concerned. In the same time, the curriculum was reduced. From this moment, the number of technological teachers would be always very limited, with three hours per week. In this action there is the decline of Technological Education, that can be traced back essentially to a failure by the Ministry to recognize the value and utility of this discipline in the school system (Limoncello, 2004).

Another significant change took place in 2003 with the reform called Moratti (so called from the name of the educational minister). This reform introduced the novelty of technology in primary and middle school and changed the name of the discipline from Technical Education (focused more on the industrial design) to Tecnologia (focused more on ICT topics and skills), as it is known today in Italian schools. However, this reform reduced the time available for Technology education to only one hour per week. Limoncello (2004), in his discussion, problematized some aspects identified in this reform as the value of the operative features of Technological Education was no longer present; it was proposed that Technology be unified with Mathematics and Science, and computer science was taught more as a teaching aid and not as an independent subject. This reform raised many debates and wide dispute from the teachers of Technology, who began various activities to support the discipline (for example, its promotion by the "National Association of Teachers Technological" - ANIAT).

In 2013, the most recent legislation affecting Technological Education, assigned it two hours per week. The ANIAT (2014) consider this subject in middle school is still not properly presented, in the light of contemporary society which is strongly imbued with increasingly complex technologies, with new urgent personal, social and environmental problems and needs to resolve.

Curriculum: Italy

Currently, the elements of knowledge and skills of Technological Education are related to three components in accord with the national indication of requirements for the middle school (Andreucci & Ginestié, 2012):

a) Main production sectors (primary, secondary and tertiary) relating to the basic needs of human society and the technologies used;

b) Methods, tools, processes, and scientific principles related to certain techniques and technologies, such as electronic and logic systems; resistant structures and buildings; graphic arts, textiles, ceramics, film; means of mass communication and information; information processing; and

c) General principles concerning the economy and its relationship with people and the environment, such as the structure of the machines and man-machine relationship; the measures in procedures; artificial languages; the relationship between the technological and natural environment; and the organization of work.

As a result, the knowledge and skills to be achieved in this area at the end of secondary school are related to observing, predicting and imagining, transforming and acting on technological reality; design, implementation and verification of operational experience; and technological knowledge and its terminology. At the end of compulsory education (at age 16), the student can be directed towards vocational education, which includes vocational schools or regional vocational training institutions, or can continue related studies at university. Vocational schools provide a curriculum of five consecutive years. At the end of the third year, the acquisition of a qualification is possible, and students are able to go on to a subsequent two-year course, called post-qualification, which ends with a state exam. Regional vocational training is a differentiated path oriented to some professions such as electrician, beautician and dressmaker.

Perspective: Italy

As suggested by Sacchi (2012), the increasing autonomy of schools (the freedom to choose activities and topics and become less dependent on the national instructions) may be an opportunity for Technological Education to establish its value and raise its profile in the Italian educational system. For example, schools may choose to [1]improve the relationship with the environment through environmental protection; ensure the best use of the artificial world created by man such as robotics and intelligent objects; make more explicit the relationship with science to find concrete solutions to problems through research.

All these suggestions have to be directed to the common goal to bridge the gap between the teaching about technology in the school and what technology is in the world (Famiglietti, 2007), by offering examples of research and training in innovation education practices.

Schematically, Ciampolini and Serra (2007) proposed technological action as the teaching activities that consider the availability and consistency of resources; makes use of all organised scientific and technological knowledge; identifies the most suitable methods and the appropriate tools; processes and defines the characteristics of the process; generates the product which is the objective of the technological education; and assesses and monitors the unwanted products of the process.

General and open proposals to improve teaching and learning of Technological Education in Italy are related to improving initial and in-service teaching training in the use of new technologies and encouraging research and experimentation in the field.

Technological Education in France: Ongoing redefinitions

Before 1985, Technological Education in France was called Manual and Technical Education. Technological Education was introduced in the French curriculum in 1985 as a part of science education in primary schools; as a new subject for all pupils in middle schools (ages 11 to 15) and as an optional subject in high schools (ages 15 to 18 for general education or 15 to 19 for vocational training). The general aim of this subject was to promote positive attitudes towards technology and the development of understanding of the social and professional world (Compton & Jones, 1998; Dugger, 2000).

The French national curriculum is presented in different historical phases (Ginestié, 2006): first the epistemological delimitation of the subject of Technological Education; followed by a phase of definitions with practical activities; and more recently, to a phase of applied sciences with a poor link to the initial epistemological definition. Currently, Technological Education in France is compulsory for all pupils from 3 to 15 years of age. At the elementary level (3 -11 years) Scientific Education and Technological Education are associated in order to guide the children in the discovery of the world in which they live. Later (for 12-15 years old) Technological Education becomes a separate subject, oriented towards exploring the existence of technical objects and the social organisations that produce and use them. After these two levels, Technological Education becomes optional in high school and refers to automated systems and, more recently, to engineering sciences (Ginestié, 2011).

Many French researchers have been interested in the definition, in comprehension, extension or practical use, of the concept of technical objects (Andreucci & Ginestié, 2002; Impedovo, Andreucci, & Ginestié, 2015; Séris, 1994; Sigault, 1990). This interest finds a prominent reflection in the works of the French philosopher Simondon (1958), who considers the essence of technical objects as a specific genesis that takes the shape of a concretisation of process, distinct from empirical developments but also of deduction from prior theoretical principles. The gradual evolution of the artefacts into instruments is a long and complex process that Rabardel (1995) calls instrumental genesis. Special attention is dedicated to the technical object in relationship to its social use. The study by Andreucci and Ginestié (2002) provides evidence of middle school pupil's limited knowledge of the notion of a technical object. Indeed, the study showed how the concept of a technical object become increasingly restrictive, leading to exclude less modern, ordinary and passive artefacts (like clothes, food, household utensils, buildings etc.).

The French research also analyses the relationship experienced by students, with the technical object in the centre of technological literacy education at school. For example, Impedovo et al.,

(2015) carried out research in order to understand how students (from 12 to 14 years old) related to technical objects. A questionnaire was administered to 202 students in French classes. The questionnaire was composed of three parts: 1) the detection of characteristics of objects; 2) the ability to create relationships between objects; and 3) the direct use of objects and personal interest in sciences and technology. The results show the complexity of the relationship with technical objects and the need for an educational mediated intervention of design and technological education.

Curriculum: France

Currently, the reorganization of the programming of the middle school curriculum has rekindled debate on the technological discipline (Lebeaume, 2015), oriented towards a more contextualized technology. The French national programme, called the "The common base of knowledge" (in French: "*Le socle commun de connaissances, de compétences et de culture*"p roposed by MEN-Ministère de l'Éducation nationale, de l'Enseignement supérieur et de la Recherche, France, 2016), for 12 to 14 year old children promoted an updating of the technological curriculum, to provide more continuity between middle school and high school, and with a stronger contextualized approach. The trend is to use different methods of analysis, design and implementation, allow the children to plan their own work, and search for multiple solutions to the same problem. The principal methodology is the investigative approach (called *Démarche d'investigation*), based on solving real problems (Monod-Ansaldi & Prieur, 2011). Nowadays, Technological Education is described through three main axes: social; industrial and engineering science; and practical sciences.

> *Social axis* in relation to the human and social sciences: meaning to discuss the conditions and implications of the transformation of the environment by socio-cultural systems. The activities being focused on the evolution of objects and systems in various contexts.
>
> *Industrial and Engineering science axis:* meaning to understand, simulate, and design contemporary systems in relation to the experimental sciences in investigative approaches and problem solving.
>
> *A practical sciences axis:* meaning to imagine, build, design, test and maintain contemporary technical objects and systems.

At the end of the middle school (year 14-15), students can choose to go to a Vocational High School, focussing on learning in professional and technological areas, attesting to the acquisition of knowledge and skills in a professional industrial field or service sector: or students can choose to attend a High School which focuses on humanities and technology.

Perspective: France

Currently, in France, the discussion about the curriculum of Technological Education is open, reflected also in international discussions (Chatoney, 2015).

The theoretical discussion on the nature of artefacts is still a theme of the discussions: artefacts - basically embedded in dualism (Kroes & Meijers, 2006) as such are mixed in the sense that they combine scientific properties, physical, chemical, geometrical, which have the potentiality to open to an interdisciplinary approach related to design, production, social and economic implications, so generating significant problems in the consumerist societies. The intervention of Technological

Education in a scholastic path should help to change and improve the meeting of students with the technical objects by presenting them in a context ascribed to the production, to the world of work, through the technological process.

Different tradition addresses the same challenges

In relation to the historical, theoretical and curriculum approach of Technological Education in Italy and France, we can broadly consider some similarities and differences.

First, the number of hours of technological lessons in the two countries is about the same. The teachers of Technological Education in both countries hold a master's degree followed by a specific teaching qualification. The teachers are mostly male, being linked to the engineering or architecture or surveying professions. Also, a related subject, ITC is not a subject of systematic study in the two countries but cuts across all subjects, without a systematic methodological and epistemological basis for teaching.

Both countries have associations for the promotion of the culture of technology: in Italy there is the aforementioned ANIAT and STS Italia (the Italian Society for Social Studies of Science and Technology) (see Coletta et al., 2014). The aim of the association is to build a network of researchers oriented to the study of science and technology, considering social and cultural implications. In France, since 2006, there has been an Academy of Technologies, with the role of observer under the supervision of the Minister of the Research, monitoring and improving the technological education.

De Vries (2012) highlights that the French tradition concerning technological education research has a particular focus on what is taught in schools, so in some way reflects technology as it is practiced professionally. In Italy, Berlinguer (2007) provides a strong basis for technological education. He considers teaching this subject is an urgent problem to solve the need to provide more connections between school and the productive sector. For this, he suggests it would be useful to give to schools the value of permanent laboratories which integrate experience and theory.

Finally, the role of the teacher in providing knowledge and supporting learning in technology for students is central in both the contexts considered (Jones & Moreland, 2005). According to Kruse (2013), it becomes necessary for the teacher to understand the nature of technology in order to better support students in their understanding of processes, characteristics, philosophy and content of technology. To make this process effective, in both contexts, the role of the teacher in must be stressed in initial training and teachers in schools need to be constantly in touch with technological communities, facilitating the effective implementation and understanding of technology.

New challenges for creativity

Finally, the spread of technology in society and the ingress of technology to the classroom has lead in both countries to a reflection on this discipline, asking the question of what Technological Education can add to students and to the society. An open question to consider is how this subject can play a role in the development of students' creativity.

Technological Education can help to reveal the genesis of technical objects, in relation to the production, distribution of industrial practices and contemporary technology (Ginestié, 2006; Lebeaume, 2000). The subject, anchored in the material of technical objects, can support a creative process, giving rise to new symbolic elaborations (Latour, 1991). Cognitive operations induced by designing activities (Bonnardel, 2009; Perrin, 2001) allow the subject to maintain a creative approach to problems in context. The design activity requires knowledge and skills adapted to the context of application (Borillo & Goulette, 2002), allowing the renewal of society through the design of creative solutions (Lubart, 2003). In this way, the students become able to reflect, develop ethical standards and demonstrate how values are expressed through technology, contributing to its further development. To be familiar with technology it helps to have a broader vision of technology in actual society and to conceptualize the technological world more critically (Borko & Putnam, 1996; Buckmiller & Kruse, 2011).

These skills are central in an open and constantly changing environment, made up of complex and unpredictable processes, sometimes difficult to explain. Engeström & Sannino (2010) use the expression of “runaway objects” to refer to objects difficult to control, contain and with contradictory extension potentiality. They can be either natural forces or technological innovations, with examples as diverse as Linux, global warming, and mobile phones. Also, the relationship between humankind with accelerated technological development implies new challenges. This ongoing process opens new *technoethics* issues, observes Findeli (1994), which deal with moral questions governing or resulting from the conception, production, distribution and use of complex, powerful and sophisticated artefacts, tools, and techniques.

Conclusion

This paper stresses the importance of reflection on Technological Education, focusing particularly on the curriculum and perspective of this subject in Italian and French middle schools. From this analysis emerges the necessity to continue reflecting on this matter to reconsider its usefulness and value in the educative system. In this way, Technological Education will continue to contribute to the knowledge and demands of a changing society, allowing a more conscious relationship with technology: Galimberti (1999) believes that the technique is a tool to which the human society holds the keys. He notes, however, how the technique has replaced the nature that surrounds the human society, becoming the main environment. So there is the need of new languages, models, and new expanding human resources able to compensate for the limitations in the relationship with such pervasive technology. A dialogue between different school situations in international Technological Education becomes a shared need in order to develop appropriate theoretical references, methods and strategies in the teaching practice of this discipline.

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References

Andreucci, C., & Ginestié, J. (2002). *A first overview of the extension of the technical object concept among college students.* Lyon, France: INRP.

Ankiewicz, P. (2015). The implications of the philosophy of technology for the academic majors of technology student teachers. *PATT Conference*, *7-10 April*, Marseille.

Ankiewicz, P.J., De Swards, A.E., & de Vries, M. (2006). Some implications of the philosophy of technology for science, technology and society studies. *International Journal of Technology and Design Education 16*, 117–141.

Ardies, J., De Maeyer, S., & van Keulen, H. (2015). Students' attitudes towards technology. *International Journal of Technology and Design Education*, *25*, 43–65.

Bellanca, J., Brandt, R. (2010). *21st century skills: Rethinking how students learn*. Bloomington, IN: Solution Tree Press.

Berlinguer, A. (2007). The Italian road to trusts. *European Review of Private Law,* 4, 533–553.

Bonnardel, N. (2009). Activités de conception et créativité : de l'analyse des facteurs cognitifs à l'assistance aux activités de conception créatives. *Le travail humain*, *1*(72), 5-22.

Borillo, M., & Goulette, J. P. (2002). Cognition et création. *Explorations cognitives des processus de conception*. Liège, Belgium: Mardaga.

Borko, H. & Putnam, R. T. (1996). Learning to teach. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 673–708). New York, NY: Macmillan.

Brey, P. (2010). Philosophy of technology after the empirical turn. *Techné: Research in Philosophy and Technology*, *14*(1), 36-48.

Buckmiller, T. & Kruse, J. (2011). Future school administrators' perceptions of gain and loss concerning technology adoption. Paper presented at the *Critical Questions in Education Conference, Kansas City*, MO, October 17 & 18.

Chatoney M. (2015). *Plurality and complementarity of approaches in design and technology education, Marseille*. France : Aix-Marseille Université Press. ISSN : 978-2-85399-994-6.

Ciampolini, A., & Serra, G. (2007). Un possibile schema per l'insegnamento della Cultura Tecnologica nella scuola. In M. Famiglietti (Ed.), *Tecnologia. Ricerca sul curriculo e innovazione didattica* (pp.85-97). Emilia-Romagna : Quadrerni *USR e IRRE*.

Coletta, C., Colombo, S., Magaudda, P., Mattozzi, A., Parolin. L., & Rampino, L. (2014). A matter of design: Making society through science and technology. Proceedings of the *5th STS Italia Conference.* Italia : STS Publishing.

Compton, V. & Jones, A. (1998). Reflecting on teacher development in Technology Education: Implications for future programs. *International Journal of Technology and Design Education, 8*(2), 151-166.

De Vries, M. J. (2012). Editorial. In M. J. de Vries & I. Mottier (Eds.), *International handbook of technology education: Reviewing the past twenty years* (pp. 387–397). Rotterdam, The Netherlands: Sense.

DiGironimo, N. (2011). What is technology? Investigating student conceptions about the nature of technology. *International Journal of Science Education*, *33*(10), 1337-1352.

Dugger, W. (2000). Standards for technological literacy: Content for the study of technology. *Technology Teacher*, *59*(5), 8-13.

Dusek, V., (2007). Philosophy of technology: An introduction. Oxford: Blackwell.

Engeström, S. (2013). The different faces of staging a technology lesson and a science lesson. In P. J. Williams (Ed.). *Technology education for the future: A play on sustainability. Proceedings PATT 27 Conference,* (pp. 160-165). University of Waikato, Christchurch, NZ.

Engeström, Y., & Sannino, A. (2010). Studies of expansive learning: Foundations, findings and future challenges. *Educational Research Review 5*(1), 1-24.

Famiglietti, M. (2007). *Tecnologia. Ricerca sul curriculo e innovazione didattica*. Collana "Quaderni dei Gruppi di ricerca USR e IRRE Emilia-Romagna", Quaderno, 5.

Feinstein, N. (2010). Salvaging science literacy. *Science Education, 95(*1), 168–185.

Findeli, A. (1994). Ethics, aesthetics, and design. *Design Issues, 10*(2), 49-68.

Fourez, G. (1994). *Alphabétisation scientifique et technique: essai sur les finalite´s de l'enseignement des sciences*. Bruxelles, Belgium: De Boeck-Wesmael.

Flick, U. (1992). Le sujet face à la technique. *Le travail humain*, 313-327. Paris, France: P.U.F.

Galimberti, U. (1999). *Psiche e techne*. *L'uomo nell'età della tecnica*, Feltrinelli: Milano: Italy. ISBN 88-07-10257-9.

Ginestié, J. (2006). Analysing Technology Education through the curricular evolution and the investigation themes. In M. de Vries & I. Mottier (Eds.), *International handbook of technology education: Reviewing the past twenty years* (pp. 387-398). Rotterdam, The Netherlands: Sense.

Ginestié, J. (2011). How pupils solve problems in technology education and what they learn. In M. Barak & M. Hacker (Eds.), *Fostering human development through engineering and technology education* (pp. 171-190). Rotterdam The Netherlands: Sense.

Gumaelius, L, & Skogh, I. (2015). Work plans in technology: A study of technology education practice in Sweden. (pp. 1-10). In *Proceedings PATT 2015, 7-12 April, Marseille.*

Ineke, F., Sonneveld, F. W., & de Vries, M. J. (2011). Teaching and learning the nature of technical artefacts. *International Journal of Technology and Design Education, 21*(3), 277-290.

Impedovo, M. A., Andreucci, C., Delserieys-Pedregosa A., Coiffard, C., & Ginestié, J. (2015). Technical objects between categorisation and learning: An exploratory case study in French middle school. *Design and Technology Education: An International Journal* 20 *(2),* 32-49.

Impedovo, M. A., Andreucci, C., & Ginestié, J. (2015). Mediation of artefacts, tools and technical objects: An international and French perspective. *International Journal of Technology and Design Education, 27*(19), 19-30. doi: 10.1007/s10798-015-9335-y.

Jarvinen, E., & Rasinen, A. (2015). Implementing technology education in Finnish general education schools: Studying the cross-curricular theme Human beings and technology. *International Journal of Technology and Design Education, 25*, 67–84.

Johansson, L. (2009). *Mathematics, science & technology education report*. Brussels, Belgium: European Round Table of Industrials.

Jones, A., Buntting,C., & De Vries, M. (2013). The developing field of technology education: A review to look forward. *International Journal of Technology and Design Education, 23*, 191–212.

Jones, A., & Moreland, J. (2005). The importance of pedagogical content knowledge in assessment for learning practices: A case study of a whole school approach. *The Curriculum Journal, 16*(2), 193–206.

Kroes, P., & Meijers, A. (2006). Introduction: The dual nature of technical artefacts. *Studies in*

History and Philosophy of Science, 37, 1-4.
Kruse, J. W. (2013). Implication of the nature of technology for technology and teacher education. In M. P. Clough, J. K. Olson and D. S. Niederhauser (Eds.), *The nature of technology: Implications for learning and teaching*, (pp. 345–370).
Latour, B. (1991). *Nous n'avons jamais été modernes. Essai d'anthropologie symétrique*. Paris, France: Editions de la Découverte.
Layton, D. (1994). *Innovations in science and technology education, 5*. Paris, France: UNESCO Editions.
Leahy, K., & Phelan, T. (2014). Review of Technology Education in Ireland: A changing technological environment promoting design activity. *International Journal of Technology and Design Education, 24*, 375–389.
Lebeaume, J. (2000). *L'Éducation technologique – Histoires et méthodes*. Paris, France: ESF.
Lebeaume, J. (2015). Industrial technology and engineering sciences in France. The disciplinarization process and its impacts on technology education. *PATT 2015, 7-12 April, Marseille.*
Lilley, S. (1970). *Technological progress and the industrial revolution*. London, UK: Fontana.
Limoncello, A. (2004). *Dall'Educazione Tecnica alla Tecnologia.*(pp 1-10). *Convegno nazionale CGIL "Scuola Media, la "terra di mezzo", un dialogo aperto con elementari e medie". Paestum,Italia (27 – 28 Apri).*
Lubart, T. (2003). *Psychologie de la créativité*. Paris, France: Armand Colin.
Lucena, A. D. (2009). Thinking about technology, but…in Orega's or in Heidegger's style? *Argumentos de Razón Técnica, 12*, 99-123.
Mawson, B. (2007). Factors affecting learning in technology in the early years at school. *International Journal of Technology and Design Education*, *17*(3), 253-269.
MEN- Ministère de l'Éducation nationale, de l'Enseignement supérieur et de la Recherche , France (2016). *The common base of knowledge*. Retrieved from: http://www.education.gouv.fr/cid2770/le-socle-commun-de-connaissances-et-de-competences.html
Monod-Ansaldi, R., & Prieur, M. (2011). *Démarches d'investigation dans l'enseignement secondaire : représentations des enseignants de mathématiques, SPC, SVT et technologie*. Lyon, France : IFé Press.
Perrin, J. (2001). *Conception, entre art et science. Regards multiples sur la conception*. Lausanne, France: PUR.
Pitt, J. (2000). *Thinking about technology: Foundations of the philosophy of technology*. New York, NY: Seven Bridges.
Rabardel, P. (1995). *Les hommes et les technologies: Approche cognitive des instruments contemporains*. Paris, France: A. Colin.
Rauscher, W. (2011). The technological knowledge used by technology education students in capability tasks. *International Journal of Technology and Design Education, 21*(3), 291-305.
Ritz, J. & Martin, G. (2013). Research needs for technology education: An international perspective. *International Journal of Technology and Design Education*, *23*, 767–783.
Sacchi, G. C. (2012). *Tecnologia e nuove Indicazioni.* Retrieved from http://scienzedellatecnica.blogspot.it/
Séris, J. P. (1994). *La technique*. Paris, France: PUF.
Severino, E. (1988) *La tendenza fondamentale del nostro tempo*. Milano, Italy: Adelphi.

Shamos, M. H. (1995). The *myth of scientific literacy*. City, New Brunswick: Rutgers University.
Sigault, F. (1990). Folie, réel et technologie. *Technique et Culture, 15*, 167-179.
Simondon, G. (1958). *Du mode d'existence des objets techniques*. Paris, France: Aubier.
Williams, P.J. & Stables, K. (Eds.) (2017). *Critique in design and technology education.* Melbourne, Australia: Springer. doi : 10.1007/978-981-10-3106-9.