

REMARKABLE MOMENTS IN THE EVOLUTION OF KNOWLEDGE

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Abstract

Technology, Innovation and Knowledge are three related phenomena and concepts that have been at the core of the worldwide economy evolution and the international business growth during the last fifty years. Technology refers to the tools and machines that are used to solve real-world problems. Innovation is a new idea, a more effective device or process. Knowledge is the familiarity with or understanding of something such as facts, information or skills. The paper focuses on a selection of these in order to emphasise that through successive rounds of learning and problem solving, the society can incorporate new knowledge to deal with problems at increasingly larger scales.

Key words: knowledge, evolution, innovation;

JEL classification: O31, O33;

1. Introduction

Much has been written about technology, innovation and knowledge in an international context. Certainly, the literature has matured to a point where we have seen numerous review papers and meta-analyses on these issues (Alavi and Leidner, 2001, Wijk et al., 2008 and Michailova and Mustafa, 2012).

The information age is already nudging the boundaries of traditional thinking. Today, the new knowledge is knowledge – power – so share it and it will multiply (Alee, 1997). But in order to have power we have to learn.

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Armitage et al. (2008) considered three learning theories as relevant to an ongoing social learning process. First, experiential learning is a process of creating knowledge through the transformation of experience, and learning-by-doing (Keen and Mahanty, 2006). Second, transformative learning is a reflective process that enables an individual's perceptions and consciousness to be altered (Mezirow, 1996); it includes communicative as well as instrumental learning (Sinclair and Diduck, 2001). Third, social learning is a process of iterative reflection that occurs when experiences and ideas are shared with others (Keen et al., 2005). All three theories are related to self-organized learning processes that have emerged as a major theme for collaboration, joint decision-making, and co-management.

In epistemology there are two meanings used in parallel which consider knowledge as either a product (as a noun) or as a process (as verb). We consider it is necessary to establish only one meaning for the important notion and that is: knowledge is a product (noun) even if it is the result of two or more processes: initiation in knowledge and consolidation of knowledge through repetitions of reproduction or application. If previous references contain knowledge associated processes then we distinctly add that particular process (as a verb) and its relation to knowledge as a product. Thus, at the knowledge acquisition process we will not call it knowledge but knowledge acquirement. We take up the definition which we will consider further on. "*Knowledge is holding in one's own cognitive systems (e.g. in the mind) of some structural-functional sets of information and data that allow its holders interaction with his or hers exterior systems with reciprocal beneficial results*". By structural-functional sets we refer to the entities that simultaneously have both structures and functionalities, meaning that in return they are - **systems and sub-systems** -. For coherence we also adopt the definitions of the notions *good* and *truth*.

First, being strictly necessary, the general and helpful notion of – **universal systemic** – needs to be adopted, it being defined as *The existential mode and the general sense towards the natural organization of the system of all entities, as interconnected structures with the purpose of having stabile and/or progress adaptable functionalities*".

The good is "the situation that matches – universal systemic -".

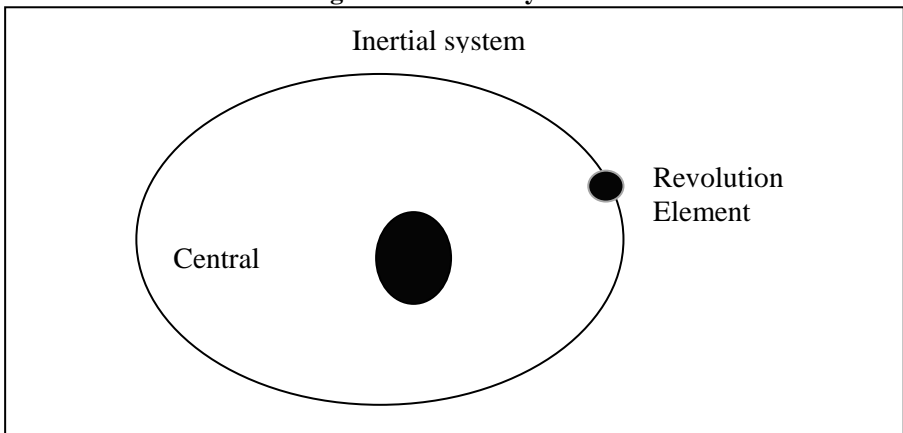
The truth is "the representation under communicable forms of situations, in full accordance with the – universal systemic-".

Evolutionary explanations of the human mind, with its apparently unbounded capacities and responsiveness to environmental influences, and of human culture, with its myriad creative diversity and transcendence beyond mere functionality, have been particularly contested (Carruthers and Chamberlain, 2000).

There are two general categories of systems: **-inertial-** systems and systems **- with supply -**. Belonging to the inertial systems category are: atoms, planetary systems, solar systems. Belonging to the systems with supply category are: live cells, live organisms, the man as an opportunity giver, the family, the motor, industrial productive units, complex production means, the departments of human society and as a superior step tending towards the perfection of the future – **the human society in its fullest** - as a whole.

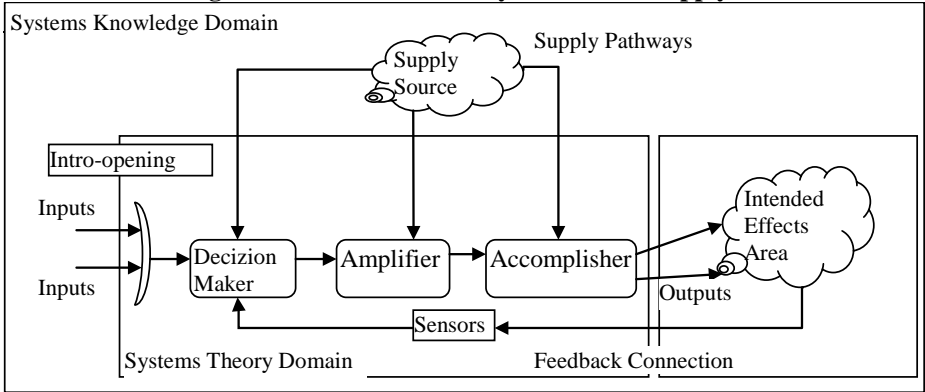
Inertial systems do not require supply and are based on the rotation of some orbital elements of revolution around some centers, as in figure 1.

Figure 1: Inertial Systems



The systems with supply, as in figure 2, have in their structure: the intro-opening, the decision maker, the amplifier, the accomplisher, the supply pathways, the feedback pathways.

Figure 2: The structure of systems - with supply -



2. General considerations

We start from the statement that the man is both a result of evolution, as a live organism with physical properties that he has, as well as a net result of the exterior superior intervention through which he was genetically implemented with mentality. Only from the moment in which the former biped mammal having hominid appearance was gifted with something new and unlimited programmable, as mentality, only afterwards did he became human.

As a live organism system, the hominid had a decision maker implemented on his primitive brain endowed with a reduced memory capacity and with information processors almost exclusively based on native neuron connections, the rational having but a minor role, because of a very limited communication language. The hominids endowment with execution means consisting of muscles, movement speed and teeth were relatively limited and inferior to many animals. The improvement of these executive endowments would not have ensured to many chances and then the only option left was his endowment with mentality through the implementation of some new possibilities of the brain, endowment genetically implemented from outside consisting of unlimited self-programming possibilities by using a developed articulated language. Such an endowment has allowed the newly surfaced man the self-organization of the brain on new functional basis, different from those of the hominids, based on structures of connected information processors and with cascade filtrations, operating through complex and repeated comparisons

in the brain modernized as mind, using the informational connections developed as images and/or communicable words, re-causable in a loop and being based on feedback connections for self-perfection through corrections.

To such possibilities of high perspective in information processing that the newly implemented mentality on the hominid's brain had, which thus became human, the maximum importance strategic problem arose: should the human have access to knowledge or not? Considering the fact that access to knowledge also involved risks. Either by chance and tacitly allowed with reproaches, or in a rebel way and with the assumption of all ulterior consequences, the decision was taken explicitly: the man should have and cooperate with knowledge.

Aiming at underlying the remarkable moments in the evolution of human knowledge, a tie-brake criterion was necessary. From the multitude of consecrated events registered by history we picked those that have radically changed the manner of representation in the human mind of the realities that were of interest to him or were regarded as challenges, this becoming the followed criterion: what has significantly changed mental representations.

The vision in which these aspects are going to be analyzed is that of the universal systemic and of the notions of *good* and *truth* defined at the beginning of the paper.

3. Selections of remarkable moments of knowledge, as case studies

The Eden Moment

There was a moment admirably and memorably registered in the history of humanity and it established that man will have access to knowledge through the criteria of good and evil, the decision taken being: "*your eyes will be opened [...] knowing good and evil*". It is a statement that underlies the importance of images, but not only those perceived by the eye, which were "opened" before as well, even with animals, but distinctly it was pointed out the importance of the representations in the human mental based on using one's own internal mental reproducing images, with parallel explanation in the form of words, allowing judgments based on comparisons with previous acquired criteria and held through memorization in the mental processors. After the moment of opening human access to knowledge, his subsequent mental representations differed in a radical manner to the previous ones through richness and through the efficiency of working with them, for it was

also possible to get them from the mental memory not only through re-living the experience. More so, being possible to explain them through words it was possible to communicate them to other individuals as well. For memorable underlying we give paraphrasing the Eden moment and an up-dated, challenging interpretation image of the knowledge tree.

The tool

The hominids, and even other live organisms used tools, but gaining access to knowledge man formed for himself mental images of the field of tools which allowed him the perfection of execution performances of the man-tool system, not only of the tool, which transformed the man in a tool manufacturer. This conscious human preoccupation of tool manufacturer followed him and will follow him throughout history, not only for increasing the number of tools but for their refinement. In our current age human knowledge has allowed important mutations in tool manufacturing, the novelty consisting in the achievement of tools as more and more complex systems that exempts the man from the tiring role of direct executor and even from the role of feedback pathway (insured by sensors), even from the role of decision maker (which is undertaken by the computer), the only role left for the man is that of the creator and conditions insurer (e.g. system supply) and the beneficiary of using tools that are more complex.

The wheel

Material transportation and human transportation being necessary, from experience it was noticed that sliding friction is quite inefficient in regard to movement on solid surfaces, but rolling friction of round objects allows smaller efforts on movement, man created a round helping mean for adaptation between two plane surfaces out of which one was in movement thus an easier movement being obtained. That round mean became more and more adaptable to the means of movement, of processing and to the means of obtaining energy from the exterior, the most used and most established being that of a disc perforated in the center or of a disc with axis. For a long period of time the wheel was considered man's biggest invention because the wheel had direct or indirect utility in all fields.

The fire

Observing it in nature, borrowing it and then making it, man appreciated its executive possibilities of improving his life conditions by heating his home, in the preparation of his food and in the processing of materials.

Archimedes

The floating of bodies was used for a long period of time for movement on water but after the discovery and the formulation of Archimedes' Law, human knowledge had at its disposal a clear representation of the equivalence of the size of the force that pushes upwards a body sunken in liquid and it was used in floatability calculations.

Pythagoras

Observing and studying very much, he gave a mental representation of numbers, considering the number as the essence of things and the Universe as a harmonious system of numbers and the relations between them. The mental images explained through mathematical relations and through geometrical figures have allowed him a visual mental representation of both the Earth and the Universe, considering the Earth as a sphere which rotates around its own axis and that there exist other worlds such as the Earth.

Primitive Astronomy

Seeing the change in the position of the celestial bodies on the sky man created for him a representation based on visual impressions, representation in which the Earth was a plane and the sky another parallel plane, up high and populated with lights that changed their position like a projection on a screen. Man actually used these repetitive images for measuring time and orientation at sea. These mental visual imagistic representations served human knowledge through their systematic laws and rules although they were representations untrue to the reality.

Religions

Living in nature and in social communities people observed that realities were not dependent only on them but also on causes beyond them. They imagined mental representations as superior entities under different appearances that make very important decisions for them. They practically acknowledged that they are part of bigger systems that have decision makers superior to them. They also found methods to positively influence them, more as self-suggestion, through offerings and through ritual bowings and through individual prayers that have become preoccupations. Subsequently, religions have perfected themselves thus becoming opportunities for knowledge through their contributions brought to the implementation of systems of superior values in human mentalities, through representations explained through words, of some justice and truth criteria.

Philosophy

Man began being preoccupied to represent for himself the world in its totality by imagining and formulating some laws of generalization, laws that could stand at the basis of the Universe, nature, life, society and thought. Observing the human capacity of mentally representing itself, itself in proportion with the surrounding world and of recognizing itself in the environment, man proposed to define conscience and to relate it to the material existence.

Medicine

Observing the very often sicknesses of the human body the need to remedy certain deteriorated functionalities of the body also appeared, through casuistic attempts and studies, using as remedies different herb mixtures. The visual observations of the human body interior being taboo for millenniums, the mental representation of the human body as structure and internal functionality has evolved according to the peak science of that moment. When mechanics was the peak of science the human body was imagined as a total of pumps and levers. After the proliferation of dissections the resemblance to the animal body seemed offensive. The study of anatomy has allowed the mental representation of the human body as a functional conglomerate made out of units and subunits, the organs being considered as subunits. To the material composition of the human body the psychic component was added, and under the influence of man's religion was considered a body-spirit duality.

Gravity

Although all the people saw that all bodies fall towards the ground, because this happened quite often it remained understood and unexplained for thousands of years. The apple having fallen in the vicinity of Newton the chance of explaining, as a universal law, the existence of a gravity force that acts on the bodies depending on their mass, presented itself. The mental explanation and the mathematics of this law allowed a mental representation of the world of celestial bodies as giant spheres in rotation, bound by the laws of universal gravity, as inertial systems.

Optics

The observation that glass has an influence on the propagation of light was a dare that generated the study of polished glass in different ways until it lead to lenses capable of correcting the eyesight or to light up fire or to allow the construction of optic apparatuses that facilitate the enhanced vision of distant bodies. The systematic study of optic laws has allowed the mental representation of the explanation of eyesight and the control of the conveyance

of light using optic agents geometrically constructive controlled which has generated new success in the mental representations through the access to visual images, normally impossible to the eye. One of the optical apparatus created, the microscope, has allowed the mental representation of an existing world but inaccessible to the eye: the microscopic world of cells, germs, of the microstructure of materials.

Microorganisms

Although the exclusively casuistic medicine has much perfected over time, the human bodies would get sick with certain diseases for which the cause was unknown. After the discovery of the microscope it could be seen that live organisms are made up of small dimension cells called microscopic. Medical studies of sick tissues have allowed the observation that there are some live organisms called germs that live, multiply and destroy certain organs. Having discovered the world of germs, posterior medicine managed to establish the real cause of many diseases and the mechanisms of spreading infectious diseases, based on the mental representations that are based on microscopic images of the germs and tissues of the damaged organs.

Immunization

The discovery of germs and the intense study of their multiplying and of the preventive adaptation of the human body for the fight against aggressive germs, through training in a simulated fight with subdued doses of germs inoculated before the possible decay, have allowed the immunization to diseases.

Electrical power

Starting from the premise that there are positive or negative electrical load in some electrically charged bodies, physicists have imagined the possibility of circulation of such electrical loads through circuits and have demonstrated this possibility right after the invention of the electro-chemical element as continuously supply source with loads. Using observations, reason, experiments, measurements and mathematical calculations the laws of electrical power and electromagnetism have been mentally established. The application in practice followed, insuring not only a very convenient electrical source for the quasi-totality of energy needs but also as supply sources for all systems used by man.

The atomic pattern

Although the concept of atom was formulated since the Antiquity, its mental representations as explicit images have become possible only towards

the end of the nineteenth century after a series of accumulations in knowledge as favourable conditions, the challenges of the discoveries appearing more often than not as mere happenings that established the release moment of the new knowledge through the images, calculations and previous concepts and of those induced. After a succession of proposed atom patterns it was accepted in knowledge the planetary pattern, as typical inertial pattern, whose mental image allowed big progress in the study of the field.

The periodical system of elements

Practically, it was man's biggest discovery in knowing the material world because it ensured a mental image explained purely systematically, representing the combination between structural and functional at the fundamentally atomic level. After the discovery of the periodical system, what was done in the field of chemistry and physics was conscious knowledge, as opposed to the previous knowledge which was more casuistic.

The airplane

Having reduced personal movement resources through the means available to one's own body, man observed the flight of birds, envies it and proposes to copy it. Only after many and big conquests of knowledge, after many enthusiastic experiments and lives sacrificed, the mental representation of a mean to fly that could be lifted from the ground, to travel long distances via air and to be able to take aboard people and materials for transport took shape. It was only after knowledge had allowed the achievement of some strong and light energy supply sources, as supply sources for the achievement of propulsion, and after fully controlling the laws of aerodynamics that the achievement of high quality airplanes that make travelling on long distances in a short period of time doable was possible. Now, seeing today's airplanes one can draw the conclusion that at the beginning of aviation it was the limited human knowledge that prevented men from flying with technical means.

The photo effect

After the knowledge and the achievement of some explicit mental images of the atomic configuration the problem arose if the light has effects on the structure of the atom. The accumulation in physics and mathematics knowledge has allowed the study and the elucidation of the double nature of the light photon, as wave and corpuscle, widely opening the door for some future progress, that were confirmed by big accomplishments that have changed the technological and communications world.

18. The electromagnetic waves. Some challenging experiments have opened the path of formation to some explicit representations that showed that in the circulation through conductors of some high frequency currents electromagnetic radiations brake that leave the conductor at the speed of light, such radiations being called electromagnetic waves. Controlling, through knowledge, the laws of producing, propagation and their reception, the distant telecommunications era became possible

The electronic tube

Having studied the behaviour of the electron in vacuum and in the electric field, based on the knowledge accumulated in physics the amplification phenomenon of signals in devices with vacuum, called electronic tubes, was discovered and they allowed the knowledge of a new field: radio technique, useful for the reception and transmission of electromagnetic waves.

The radio

After the advent of the electronic tubes, as the result of the accumulations in knowledge, the transposing of information comprised in the human voice on electromagnetic signal holders that was transmitted as radio waves was possible, and after the knowledge of wave reception and of electro-acoustic transducers as speakers, the popular radio appeared which, for a century, has served humanity with news, messages and music.

The television

Until the conveyance of images through electromagnetic waves not many years of accumulations in knowledge have passed because the progresses in the study of electronic tubes have allowed the achievement of the shooting camera and of the picture-reproducing tube that have allowed the taking of images from one place, their distant conveyance and their presentation in the human's home. This is how television appeared as news, entertainment and knowledge contribution source.

The neutron

Having discovered the neutron, as part of the atom, through the progress of knowledge and explicit mental representation through physical patterns and mathematical calculations, other progress in knowledge was possible that has allowed the generation and experimentation of some nuclear reactions under man created conditions, having opened the path towards chain nuclear reaction, at first as nuclear explosions with irreversible contributions to world peace and later by the appearance of the nuclear reactor as energy

source coming directly from the energy accumulations in the structure of the matter primary in the Big Bang. This proof of knowing the principles of nuclear power shows explicitly the existence of the two sides of the coin of knowledge: curse and blessing.

The rocket

Progressing knowledge through explicit representations and rigorous calculations, the human boldness was looking upwards towards the Universe. A means of fast movement and disposing of supply independent of air was needed. Through study and dramatic experiments it was perfected as means of movement and cosmic transport the rocket based on reactive motors, disposing of own fuel and oxidant supply. Thus, by knowing and perfecting the rocket the achievement of destructive weapons was also possible but also man's flight around the Earth and lunar landing as a first step in interplanetary travelling, theoretically foreseen by human knowledge.

The nuclear reactor

After the knowledge of the mechanisms of nuclear reactions, the nuclear reactor was mentally conceived and done as a structure that creates controllable conditions of producing such reactions in energetically complexes that produce electrical power at a very financially competitive price and technologically reliable but with a huge price to pay for neutralizing and storage of compounds resulted from the reaction, compounds that can deteriorate the natural environment.

The satellite

After the progress in human knowledge in the building of rockets as a means of transport from earth into space, the achievement and placement on the orbit of some artificial structures useful to man that will rotate on their own around the Earth or halt in rotation at a high altitude carrying out missions very useful in telecommunications, meteorology, Earth study, Space study, Sun study, was fast possible.

The transistor

The electronic tube was a progress in knowledge at the level of its time but it was a progress limited by the relatively big proportions and energy consumption. Semi-conductors being studied mental representations were possible that have allowed the designing of some original, miniature and with low consumption devices that could fulfil amplification, commutation and signal generation rolls. The typical semi-conductor done was the transistor that

allowed a miniaturization down to microscopic level, in complex constructions called integrated circuit chips.

The laser

One of man's most impressive accomplishments is the laser, as a pure product of knowledge, because in nature he did not see an example of a coherent light generator. Once theoretically predicted, pictured as representation, theoretically calculated and practically done in a pattern, it generated sensation and pride being a "wonder kid" of science. Its development, diversification and applications were very fast, improving almost all applied fields.

The microprocessor

The progress of technological knowledge in miniaturisation and of informatics have allowed the designing and achievement of some extremely complex structures on a single silicon chip, with the functionality of an entire arithmetical and logical unite, constituting a big constructive part of a computer and being called a microprocessor. Studies and high knowledge of commutation processes have allowed in a short period of time, working speeds and impressive memory capacities, in a reduced space. The microprocessor, as a product of knowledge has reached accessible prices to an increasing number of beneficiaries and entering the structures of many independent or complex devices and apparatuses of fabrication technologies. The biggest possible progress based on the microprocessor is the personal computer, the popular PC that insures for the user special possibilities in all fields, including in acquiring knowledge.

The internet

Knowledge in the fields of informatics and calculation techniques, as well as knowledge in telecommunications has generated the idea that was quickly put into practice, that of creating a world connection network between computers with information circulation possibilities in both ways, in relation to the beneficiary, disposing of huge memory capacity on servers, memories to which all those connected have quick access to. A very important roll of the Internet being the help it gives to the general, encyclopaedic type knowledge for all the beneficiaries and communication through words and especially through images and search engines.

Environmental protection

For millenniums knowledge has progressed considering that nature in general, the earth and the environment as superior entities, infinite,

inexhaustible in being assimilated in its values by the man. Together with the progress of knowledge in explicit images, accessible and convincing, in parallel with the observations and measurements that have manage to convince that the natural balance was being destroyed through many human activities stripped of concern, a new challenge and a new sense in which human knowledge should evolve appeared: towards the conception of all human actions so that they will not deteriorate the natural qualities of the environment and even to re-establish the portions previously deteriorated by man or even by nature itself.

4. Conclusions

The last five decades of history have witnessed major technological changes and innovations that have fueled global trade and the evolution of international firms but also that have raised important issues as the relevance of knowledge processes for sustaining firms' competitive advantage.

Over time knowledge has made impressive progress but the quality of life and the world itself have not become better in that same period of time, quasi-unanimous the feeling that the direction was reversed existed. The only conclusion that can be drawn is that something was left out or neglected. That neglected something is the knowledge of knowledge, the study of human mentalities, the preoccupation for improving the system of values with which the human mentalities operate. To this extent, at the beginning of the paper we insistently mentioned and we drew attention towards the study and functionality of the mental based on the system of values and through the cases in the content we exemplified that the big progresses were the consequences of the accumulations in the general knowledge, accumulation that were not small in numbers. And if they did not make a better world that means that big progresses in the knowledge and the perfection of human mentalities are still necessary, through intense study of the knowledge acquiring phenomenon and its perfection for, above all, it is at least implicit. Too little!

5. References

- Alavi, M.; Leidner, D.E. (2001) *Knowledge management and knowledge management systems: Conceptual foundations and research issues*, MIS Quarterly, 25 (1), p. 107-136.

- Alee, Verna (1997) *The Knowledge Evolution: Expanding Organizational Intelligence*. Available at: https://books.google.ro/books?hl=ro&lr=&id=Gjb9GtttMIwC&oi=fnd&pg=PR2&dq=Remarkable+Moments+in+the+Evolution+of+Knowledge+&ots=GaNRityB0E&sig=KGgi48nXcGxO7-H_j2_cEpJ_ItM&redir_esc=y#v=onepage&q&f=false.
- Armitage, D.; Marschke, A.; Plummer, R. (2008) *Adaptive co-management and the paradox of learning*, *Global Environmental Change*, 18, p. 86-98.
- Carruthers, P.; Chamberlain, A. (2000) *Evolution and the Human Mind: Modularity, Language and Meta-Cognition*, Cambridge: Cambridge University Press.
- Keen, M.; Brown, V.; Dybal, R. (2005) *Social Learning in Environmental Management*, Earthscan, London.
- Keen, M.; Mahanty, S. (2006) *Learning in sustainable natural resource management: challenges and opportunities in the Pacific*, *Society and Natural Resources*, 19, p. 497-513.
- Mezirow, J. (1996) *Contemporary paradigms of learning*, *Adult Education Quarterly*, 46, p. 158-173.
- Michailova, S.; Mustafa, Z. (2012) Subsidiary knowledge flow in multinational corporations: Research accomplishments, gaps, and opportunities, *Journal of World Business*, 47, p. 383-396.
- Sinclair, A.J.; Diduck, A.P. (2001) Public involvement in EA in Canada: a transformative learning perspective, *Environmental Impact Assessment Review*, 21, p. 113-136.
- Wijk, R.V.; Jansen, J.J.P.; Lyles, M.A. (2008) Inter- and intra-organizational knowledge transfer: A meta-analytic review and assessment of its antecedents and consequences, *Journal of Management Studies*, 45, p. 830-853.