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JOURNAL ON EFFICIENCY AND RESPONSIBILITY IN EDUCATION AND SCIENCE

Aims and Scope

The Journal on Efficiency and Responsibility in Education and Science aims to publish perspectives of authors dealing with issues of efficiency and/or responsibility in education and related scientific disciplines. The focus is on topics such as:

- theory and methodology of pedagogy and education;
- theory and methodology of science;
- human resources and human relations management;
- knowledge management and knowledge engineering;
- systems engineering and information engineering;
- quantitative methods.

The journal accepts quantitative, qualitative and experience-based full research papers, short communications or review studies. Applications and case studies introducing and describing impacts of new theoretical approaches in real conditions of practical case are also accepted.

All papers passed a double-blind peer review process.

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THE CONTEMPORARY SCHOOL AND KNOWLEDGE MANAGEMENT

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Abstract

The school of today faces circumstances that differ very much from the ones in which the current educators have been educated as students, especially in the countries that are new members of the European Union as EU-27. Therefore, in order to manage knowledge in their school of today, one must understand the socio-economic development trends and their impact over the school as a subsystem of the emerging innovative society in which the innovative business leaves little or no room for the routine-loving behaviour of previous decades, centuries, and millennia. This contribution summarizes a dialectical system of this development trends and the resulting newly required attributes of the contemporary schools and teachers, but it does so on the level of provocation for readers' creative and innovative thinking and action rather than on the level of any final answers. The Bologna Process seems to be an underused opportunity for innovation of higher education in Europe.

Key Words

Bologna process, education, innovative business, innovative society, knowledge management, requisite holism, socio-economic development, values – culture – ethics – norms circle.

The selected problem and viewpoint of consideration

By definition of their role in society, schools exist to provide knowledge for people to live on it in the context of their socio-economic conditions that keep changing today much more and much more rapidly than ever before. Hence, schools must – permanently – acquire (new!) knowledge, select their preferential part of the available knowledge, choose preferential methods of delivering it and of making/helping students acquire it, as the long-term basis of students' employability and viability. This process may be called knowledge management of a specific type, while the term knowledge management has many contents all way from very qualitative analysis of human behaviour and means (e.g. Houška and Berankova, 2006, and several other contributions in the same journal; Jurše, Potočan, 2006; Potočan, Jurše, 2006) to very technical considerations of computer work (e.g. contributions in Part 3: Knowledge Systems Engineering, Part 4: Data Mining and Text Mining, in Gu et al, editors, 2006). What is knowledge created and used for by knowledge management today? The topic of knowledge management was well delineated in OECD's study on knowledge-based society (Pavlin, 2005) one must study the impact of knowledge on the socio-economic development; traditional economic categories, such as labor and capital no longer explain social and economic phenomena well enough. Authors make a nice and clear distinction between knowledge and knowledge management in a knowledge-based society and economy, but the definition, that knowledge creation, retaining, refining and using are involved in knowledge management (Edwards, 2005, 9), does not necessarily imply using knowledge for the invention-innovation processes that are crucial in the contemporary times in which the innovative business and innovative society prevail. (For a brief elaboration on this topic see: Mulej, Ženko, 2004; Mulej et al, 2005, a, b; 2006; Mulej, 2006; Mulej, guest editor, 2006; here a next step of discussion is provided.) In these conditions, the content and way of working of the school must be innovated in order for the school to help society, in which and for which it works, to be contemporary rather than obsolete, hence to help population to have a good life and work life. The school aspect of the innovative society (in making) is what will be discussed here, therefore.

1 Four development-economics contexts making the dialectical system of conditions for the school of today to be contemporary

Consideration of the selected topic along with the law of requisite holism (Mulej, Kajzer, 1998; Mulej, 2007; etc.) is helpful (Figure 1). For it, four development-economics processes might be important, here: (1) the general market development reflecting the general socio-economic development, (2) the market development after the Second World War, (3) the development of the basis of societies' competitiveness, and (4) the development of the education subsystem of society. They exist in have influence in synergy, of course.

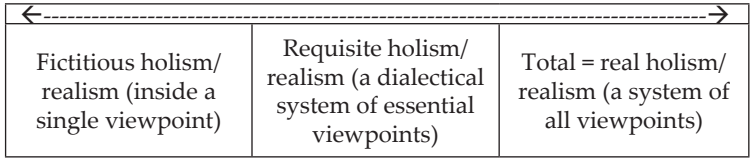

Figure 1: The selected level of holism and realism of consideration of the selected topic Between the fictitious, requisite, and total holism and realism

1.1 General market development reflecting the general socio-economic development

To make the long story short, see Figure 2 (new, after: Mulej, in Mulej et al, 2000):

Viewpoints Type of Market	Basic relation/s between production and consumption	The necessary skills of most people	Education
1. RANDOM MARKET	Producers' own consumption and occasional exchange of random surpluses	Minimal skills, mostly acquired by experience, growing as humankind grows in number and needs / requirements	Education is limited to power holding people; higher education provides general knowledge with little specialization
2. SELLERS' / PRODUCERS' PREVAILING POWER = PRODUCERS' MARKET	Growing production for poorly considered, known/ unknown, customers, who lack impact over suppliers	Specialization and narrow thinking grow along with industrialized production	Education is divided to three levels: primary for shop-floor workers, secondary for middle managers, tertiary (higher) for power-holding people; narrow specialization growing
3. BUYERS' / CUSTOMERS' PREVAILING POWER = BUYERS' MARKET	Growing impact of customers requiring satisfaction / total quality of products and services, and conditions of life	Specialization keeps growing, so does biased application of science, causing need for interdisciplinary cooperation	Education is equally divided; inter-disciplinary insight grows more in practical need than in curricula of any level of education; many more humans are included in higher education
4. STATE / GOVERNMENT SUPPORTED BUYERS' MARKET	Increasingly organized / legalized impact of customers demanding total quality of products, services and conditions of life	Growing awareness about the terrible impact of humankind's one-sided impact over e.g. nature and its dramatic consequences for humans' survival	Same as before, but world wide official documents and actions urge schools, governments and businesses as well as humans to be more holistic; so does a part of market

Figure 2: Development of market relations and its impact over education

Conclusion from Figure 2 asks the question: is the school of today requisitely holistic to be contemporary in terms of the last – 4th in Figure 2 – phase of the development of so far? If it was, most probably there would be no need for UNESCO to exist or for European Union to issue documents about the innovation-based society (EU, 1995; EU, 2000; EU, 2004; etc.) or for Europe to launch the Bologna Process (Zgaga, 2004; Jurše, Potočan, 2006; Potočan, Jurše, 2006), etc. Knowledge and knowledge management need adaptation to the current

and future reality urgently. But documents about the Bologna Process, which Zgaga has collected and commented so well, do not mention, at least not explicitly, innovation, systems thinking, and interdisciplinary co-operation as crucial contents of the modern curriculum, although EU requires them in documents, to which the Bologna Process is closely linked (see: Zgaga, 2004, 7, 48-49, 179-273). The document about employability (see: Zgaga, 2004, 334-336) mentions trans-disciplinary capacity (limited to master level only), which is coming close, perhaps, to interdisciplinary creative co-operation capability, but not requisitely holistically in terms of our practical experiences.

1.2 Market development after the Second World War

The process in Figure 2 was very much accelerated after WWII. In this period, but with limitation to the most advanced economies, the oldest two market types showed up, mostly, only in the period of the post-war reconstruction, and were replaced very quickly by the most modern market type (i.e. the phases 3 and 4 in Figure 2). See Figure 3 (Ećimović et al, 2002):

Decade	Market & Social Requirements	Enterprise's Ways To Meet Requirements	*Type of Enterprise*
1945-	Covering of post-war conditions of scarcity, rebuilding, etc.	Supply anything; supply does not yet exceed demand	Supplying Enterprise
1960-	Suitable price (as judged by customers)	Internal efficiency, i.e. cost management	Efficient Enterprise
1970-	Suitable price X[1] quality (as judged by customers)	Efficiency X technical & commercial quality management	Quality Enterprise
1980-	Suitable price X quality X range (as judged by customers)	Efficiency X technical & commercial quality X flexibility management	Flexible Enterprise
1990-	Suitable price X quality X range X uniqueness (as judged by customers)	Efficiency X technical & commercial quality X flexibility X innovativeness management	Innovative Enterprise
2000-	Suitable price X quality X range X uniqueness X contribution to SD (as judged by customers)	Efficiency X technical & commercial quality X flexibility X innovativeness X sustainable development	Sustainable Enterprise

Figure 3: From a supplying to a sustainable enterprise – and a new definition of the concrete contents of requisite holism

[1] X denotes interdependence. No attribute is avoidable any longer for a longer-term success. The original table (Bolwijn, Kumpe, 1990) did not contain X, but +. The sign + denotes that interdependencies and resulting synergies are not considered; elements are only summed up. Experience shows summation is an oversimplification. The original did not contain the decades of 1950 and 2000 either.

Conclusion from Figure 3 asks the question: is the school of today requisitely contemporary to meet the society's and economy's need for humans' capacity to behave as sustainable enterprises and other business systems? If it was, and if it had been so for long enough period of time so far, there would hardly be any need for the Club of Rome outcry that humankind is endangering itself by its mistreatment of its natural environment, followed (and thus made official for the entire humankind) by United Nation Rio Declaration of 1992 and many more documents urging humankind to diminish its consumption of energy etc. (for our summary see: Ećimović et al., 2002), including the ones published in May 2007 (e.g. Petek, 2007).

1.3 Development of the basis of societies' competitiveness

Several years ago, Porter published his model of development of the societies' basis of competitiveness in four phases (Porter, after Brglez, 1999), from which we have developed the model of five phases, including values etc. in Figure 4 (Mulej, Prosenak, 2007):

Development phase of economy	Economic basis of the given development phase	Values – culture – ethics – norms typical of the given development phase
1. Natural factors	Natural resources and cheap labor, hence poor life for millennia	Modesty, solidarity, collectivism, tradition preferred to innovation
2. Investment in modern technology	Foreign investment, mostly; poor competitiveness in global markets; neglecting of natural environment and health	Growing social differences based on property/ inheriting, local competition, individualism, ambition to have more and become rich (in tangible property)
3. Innovation based on own capabilities	Nations/regions live on own progress, attaining growing competitiveness and standard of living	Social differences based on innovation, higher standard of living, global competition, ethics of interdependence, ambition to create
4. Affluence	People are rich, happy owners, no longer needing hard work for new progress	Complacency, consumerism, no more ambition to have more and hence to create
5. Requisitely holistic creation and social responsibility	Material wealth suffices; effort for it to be renewed and for spiritual wealth and healthy natural and social environment	Ethics of interdependence and social responsibility, hence ambition to create; diminishing of social differences to the ones caused by creation, including innovation

Figure 4: From misery via one-sided investment and innovation to affluence and from there to (perhaps) requisitely holistic creation

Conclusions from Figure 4 ask the question: is the school of today requisitely contemporary to meet the society's need for innovation and other creation that is not one-sided, but requisitely holistic? If it was, documents cited above would not be necessary, and success of innovation projects would not be under five percent (Nussbaum, 2005); nor would the general success of the invention-innovation processes be under two percent (Likar, Fatur, 2007), neither would problems of humankind's natural environment be so terrible as they are. Criteria of efficiency would no longer be economic only, because they can explain less than 50% of success (Grayson, O'Dell, 1988; Levitt, Dubner, 2005) but more holistic, including e.g. happiness (Hornung, 2006) and other aspects of well-being (Diener, Seligman, 2004).[1] Life must make sense; hence owning things alone is not enough, once one can cover one's crucial material needs.

For good and bad practices see e.g.: (Afuah, 1998; Basadur, Gelade, 2006; Buijs, et al, 2007; Business Week. 2004; Chesbrough et al, 2006; Collins, 2001; Collins, Porras, 1997; Daghfous, 2007; Davila et al, 2006; Dyck et al, 1998; Fujs, Mulej, 1993; Gloor, 2006; Gu, Chroust, editors, 2005; Hippel, 2005; Hrast, 2007; Hrast, Mulej, Knez-Riedl, editors, 2006; Huston, Sakkab. 2006; IBM, 2006; Jaruzelski et al, 2006; Kuhelj Krajnović, Pibernik, 2006; Lee, Chang, 2007; Lee, Gandolfi, 2007; Lester, Piore, 2004; Leydesdorff, 2006; McGregor, 2006; Nakamori, ed. 2005; Potočan, Mulej, 2006; Rebernik, Mulej, 1992-2007; Rebernik et al, 2003-2006; Reich, 1984; Rogers, 1995; Rosenberg, Birdzell, 1986; Senge et al, 2004/2005; Stokes, Carr-Chellman, 2007; Schwartz, 2006; Tapscott et al, 2006; The Economist, 2006; 2006a; 2006b; 2006c; Wren, Greenwood, 1998; Ženko, 1999; Ženko et al, 2004; Ženko, Marn, 2006; Živko, 2005; Živko, 2006; etc.).

[1]Years ago I received from somebody the following statement by the philosopher Ralph Waldo Emerson: 'How do you measure success? To laugh often and much; to win the respect of intelligent people and the affection of children; to appreciate beauty; to find the best in others; to leave the world a little better, whether by a healthy child, a garden patch, a redeemed social condition, or a job well done; to know even one other life has breathed easier because you have lived – this is to have succeeded.

1.4 Development of the education subsystem of society

In addition to remarks about education in Figure 2 we could state, that, in history, the primary education has become normal as a tool of enabling shop-floor workers to take orders from bosses, once the industrial and urban life started to develop. Secondary education started to become normal, when the factory equipment started replacing humans and needed professional maintenance and service to work well. Higher education has existed for eight centuries, which means, that universities have a history of splendid isolation from the producing world (Kobal, 2003). Then, along with the development of manufacturing industries and resulting specialization, universities changed from 'communities of studying colleagues' to profession-based special schools, allowing for less and less room for free thinking (Pogačnik, 1994) and inter-disciplinary co-operation, which is now officially recognized as a failure to be corrected (Jurše, Potočan, 2006; Zgaga, 2004), e.g. with the Bologna Process. Still, documents about the Bologna Process do not mention introduction of more studying of the invention-innovation processes and systems thinking, which would be the way of correcting the failure of so far according to the EU Lisbon documents about the future of Europe saying that Europe must become the most innovative area of the world. (See: EU, 1996; EU, 2002). This mismatch of two crucial European policies may explain a part of reasons for the Lisbon Declaration to be found an unrealized dream (Competition, 2004; Vilfan, 2006). Authors of documents and politicians may have overseen that

its point is the innovation of culture rather than technology only, which has taken two generations or about 70 years in the transition from the pre-industrial to the modern life (Mulej, 1994). It can perhaps happen more quickly now, once people have already become used to the modern speed to some extent, but the current generation is the first one ever, anyway, to face this speed of change. Thus, the embedded experience calls this speed un-normal. This relates less to USA, which is a product of the most entrepreneurial Europeans who had left Europe in search of a new life, and more to Europe, in which the less entrepreneurial and more routine-loving people are making the culture in terms of the circle in Figure 5. (Potočan, Mulej, 2005; Potočan, Mulej, Kajzer, 2005; Potočan, Mulej, 2003; Potočan, Mulej, 2006).

Individual values (interdependent with knowledge)	↔	Culture = values shared by many, habits making them a rounded-off social group
↕	⫫	↕
Norms = prescribed values on right and wrong in a social group	↔	Ethics = prevailing values about right and wrong in a social group

Figure 5: Interdependence of values, culture, ethics, and norms

The circle in Figure 5 matters for knowledge management because of interdependence of knowledge and values (Mulej, in Mulej et al, 2000, and earlier, since 1974; for an English presentation see e.g.: Mulej, Ženko, 2004).

1.5 Conclusions from socio-economic development views at school of today

All four processes, which are summarized above, are having their peaks of so far in a more or less crucial synergy, today exactly and cause the pressures of the most competitive ones in the global market over the others:

- The demand is lagging behind supply very much (except for the most innovative authors, entrepreneurs, products and services!).
- Therefore companies that are the most developed as sustainable enterprises are best off among all competitors; they may be reaching beyond innovation due to the market pressure alone and kind of predict the phase 5 in Figure 4 to be a probable future.
- And they are so because they have innovated their management to develop and activate creativity and creative co-operation of their members best and most of all competitors.
- They succeeded to attain it because they have managers and co-workers with the most developed ethics of interdependence leading to their will and capacity of interdisciplinary creative co-operation, including across hierarchical level.
- They have combined technological, managerial, organizational, and technological innovation to innovate their business programs in time.
- And all these attributes in synergy lead to the best level of their requisite holism, causing the least failures in their business and personal lives.

Last, but not least, all these processes have their synergetic outcome in what Florida (2005) calls 'the rise of the creative class': it is no longer the working class that makes the biggest contribution and the biggest share of employment, because the creative class has grown from 5 to more than 30%, while the working class has fallen from 40% to less then 25%, and the service class makes the rest, but does not earn much either because it only creates preconditions for the creative class to work to the benefit of the entire society most of all. The outcomes of the rise of the creative class are best in areas where they have attained the highest 3T: tolerance (for difference in life style etc.), talents (attracted by tolerance from other areas), and technology (investment, because there are talents). Discussion at 27th PODIM in March 2007 in Maribor added a 4th T: time – for the laggards to catch up and innovate their cultures; this is in line with my law of two-generation cycles (Mulej, 1994) above.

There is one more process of crucial importance for the topic of this discussion: universities have become mass institutions rather than elite ones like in older times – see Figure 6 (Zgaga, 2004, 11-12):

Country	Students in 1975/76	Students in 2000/01	Index of growth of number of students	Percentage of students in generation, age of 19-21
Germany	1.334.000	2.084.000	1,56	
Finland	90.000	280.000	3,11	
Greece	117.000	478.000	4,09	
EU-15	5.647.000	12.820.000	2,27	
Slovenia 1981/82 Slovenia 2003/04				16,8% 44,8%

Figure 6: Some data about numbers of students

Due to the diminishing numbers of births the numbers in Figure 6 will become essentially smaller in the coming years, although the percentage may remain high or even grow. This matters because the number of schools competing for the same potential students has grown, which requires schools, especially the ones with lower investment in equipment, to face a severe and growing competition (Jurše, Potočan, 2006; Jurše, Tominc, 2007). Masses of students face specialization of jobs requiring schools to adapt their knowledge management processes to individual demands, which require these processes to reach far beyond the usual teaching or even reading the lectures with a passive presence and poor creative involvement of students.

There is another new component of competition between schools: Europe has less and less borders, and knowledge has less and less boundaries, both in terms of contents and accessibility, while the cultural, linguistic and similar differences between nations and regions in Europe should survive as important treasures (Zgaga, 2004).

2 Impacts of the rising innovative society and business over knowledge management in schools

The summarized processes cause the schools' task to match the innovative business and fit in the innovative society, as summarized below (Mulej, 2007a; enlarged after Mulej et al, 1987) much more than most areas of the new EU member states seem to consider:

Innovative business can be simply defined in the following ten sentences:

1. In principle, every cost is unnecessary. In reality it is so, if we work smarter, not harder, and produce innovations.
2. Today, every product and process becomes obsolete, sooner or later. That's why we must know their life cycles, do research, do development (connecting research results with the daily needs and practices), create other inventions and make from them innovations as a new, useful / beneficial basis of survival, on a continuous basis.
3. Survival and therefore both good and poor work is everybody's business. Nobody, neither the superiors nor the subordinates, are entitled to be irresponsible and to oppose or to disregard innovation in their own life reality.
4. Therefore let us continuously, all the time and everywhere, search for possible novelties! Only a small portion of them can become inventions. Some of them will be registered as suggestions. From some of them, by research and development, or connect and develop concept or other ways of 'open innovation' (Chesbrough, 2003), sometimes something both usable and new might be created, a potential innovation. Customers will accept only a fragment of them as useful / beneficial and worth paying for, hence making a benefit to both customers and suppliers, therefore deserving the name of innovation. They can be diffused, too, to support survival by business success.
5. The entire business policy and practice is innovation oriented, not just a fragment of it.
6. Results pay, not efforts. Hence, let us work like the clever ones, not like fools. Diligent stupid humans are dangerous: they do it wrong all the time; so do clever bandits.
7. These six sentences no longer apply to the producing part of the organizations only, but to all activities and all parts of life in all organizations.
8. The effort must be broadly disseminated and permanent, because the pressure from competitors is permanent.
9. For competitiveness the quality must be systemic, which is impossible without continuous innovation.
10. Systemic quality includes price, quality, flexibility, uniqueness, and care for natural environment, and all of them as a dialectical system (see Fig. 1 and 3 above).

The innovative society differs from the (foregoing, historically) routine-based society:

- It applies all achievements of development of the worldwide civilization.
- It accepts and applies its own and foreign inventions and innovations rather quickly.
- It applies foreign knowledge to upgrade its own knowledge in order to effectively develop and use all the technologies of production, organization, education, etc.
- On this basis, it attains both a high international competitiveness and quality of life.
- Its inventiveness and innovativeness, both as attributes and activities, reach the West European level, so do their

preconditions (at least!).

- The creative co/workers, scientific and other inventors and innovators are well appreciated because they are the most useful co/citizens and co/workers.
- The uncreative individuals are in trouble, especially the ones under-using their natural and learned capabilities.

The dialectical system of attributes of an innovative society includes, therefore:

1. A contemporary, creativity-based, and creativity-and-holism supporting, democracy (i.e.: bosses listen and make synergies) both in the entire society and all organizations from families on.
2. A contemporary, creativity enhancing market in which, as well as in the democracy, innovative persons and organizations prevail and reign.
3. A contemporary perception of ownership, which tells clearly the responsibility and includes creative and innovative ambitions rather than seeking rent (as an income based on owning without creating) only.
4. A contemporary perception of innovation, which says that innovation is every beneficial novelty accepted as such by customers and granting the suppliers a suitable profit / benefit, too.
5. A contemporary way of running the business, the innovative business, which continuously strives on innovation of any kind.
6. A contemporary perception of entrepreneurship, i.e. innovative entrepreneurship, which means that not every owner of an enterprise is an entrepreneur, but only the one who combines his or her business factors in an innovative way in order to produce innovation and live on it. Hence, private ownership is not enough for success, if owners are not entrepreneurial.
7. Education and other societal subsystems, which are not economy and business, but rather create human resources, circumstances and preconditions for them to flourish, and therefore also support innovation rather than routine growing to routine-loving.

Several crucial differences of the current situation and trends from the ones of young times of today's educators are arising from the above summarized situations and trends, such as:

- Current teachers, professors and managers, including government officials, were students in times when the innovative business and innovative society have hardly been a topic of research, and even less they were included in teaching, or a prevailing practice. Today innovative business and innovative society are a prevailing situation and trend to which the new generations are condemned with no choice due to the global market without isolation behind national or other borders. The alternative is even worse: living in terms of the first or second phase in Figure 4, rather than in phases 3, 4 or even 5 in Figure 4.
- Current quantities of available knowledge and sources of knowledge are by far too large for anybody to absorb all of them. Thus a narrow specialization of knowledge is unavoidable, but so is also the requisite holism of observation, perception, decision making, and action, requiring the requisite holism of knowledge. The latter requires interdisciplinary creative co-operation, because an individual trans-disciplinary knowledge with a requisite depth is impossible.

- Current knowledge grows so rapidly, that in many professions and scientific disciplines, it is hardly possible to leave school with knowledge that is not yet obsolete, although is has not been obsolete while studied. Thus, there is the a permanent dilemma what is worth studying and what is worth teaching:
    - (1) The applied knowledge to be used quickly after graduation, which allows little time for theoretical background and resulting adaptability to the new trends showing up all the time,
    - (2) The basic principles of the deep theoretical knowledge, which can hardly be used soon, but helps better in a longer term, if it provides a solid basis for creativity and adaptability of current students as the future professional, not the mere facts only.
- An additional dilemma includes the distribution of subsystems of knowledge to be covered in primary, secondary, and tertiary education, which build a pyramid, but should not include too much repetition, while providing a profession after the secondary school as well as after the tertiary one, because a half of graduates from secondary education do not enter the tertiary education and are in demand in the labor market or do net feel able to finish a tertiary education successfully, but rather as drop-outs.
- A further dilemma results from the finding and experience that entrepreneurship as an economic attribute, meaning the interest and capacity to live on and for innovation with an entrepreneurial spirit, is crucial for many more individuals today than ever before, when the innovative business and the innovative society have not prevailed as they do today (In Europe, 94% of all organizations employ less then ten or nobody, and less than one percent employs more than 250. On average, an enterprise employ 6, and the larger ones have units. This means that about 40% of all employed people, including owners, must have the entrepreneurial spirit or support entrepreneurship and hence innovation. (For details see: Mulej, 2007b)).
- In the current innovative society it has become clear that a technological innovation is important, but far from enough. One can even live better on a very good business style innovation dealing with a less innovative technology, than vice versa; experience is summarized in the literature cited above.
- It has also become clear, that eight decades ago Alan Mogensen had been right, when he required managers to view their co-workers as creative persons who offer much more, when managers do to not order them as persons deemed unable to think and create; managers should rather collaborate with them as a team of specialists different from each other and therefore complementary. (Mogensen, 1981; Mogensen, Rausa, 1989).
- Thus, for employability of students (of all 3 levels and all types of schools) a narrow profession is crucial and not requisitely holistic, neither is a superficial general knowledge so, nor a profession with no entrepreneurial spirit and capability of creative co-operation with other because they are different, not despite of their being different.
- The market to be served by school has no longer only the component of the government that used to establish and finance it in the name of the society at large, but there are many more and quite diverse market components including:

- Potential students from schools of one level below in the same or other countries;
- Students who have enrolled, but have the right to switch to other programs, schools or universities in the same or other countries;
- Employers with who students will try to get jobs after graduation, and may express their requirement – both conservative and innovative – now addressing the future, both in the same and other countries;
- The general society, no longer represented by government bodies only, but also by non-government organizations, both in the same and other countries.

- All these market components may express short-term or long-term interest and other values – cultures – ethics – norms (Figure 5) and related given and required knowledge.
- Knowledge of all of them may consist of mastering routine and of invention-innovation processes. Thus, their knowledge management processes in the form of teaching, education, practicing, workshops, discussion, application, virtual and real action, using books, internet and other sources of data, messages, and information, may include both vertical and lateral thinking and their combinations. (See: De Bono, 2003; De Bono, 2005; De Bono, 2006).
- Knowledge of students as future professionals may have to include all types of inventions' and innovations' contents (concerning business program composition, technology, organization, management, business methods, creativity and co-operation methods) with all types of consequences (incremental, semi radical, radical in either making or marketing or both of them), and with all types of duties (inside the job duty, outside it, partly outside it) and outcomes (new processes, new architectures/compositions of given or new or partly new components of products and/or processes), individually tailored to various degrees, etc.
- Etc.

All these and similar requirements of participants of the innovative business and innovative society put quite many new requirements on the teachers' capacities and values considering:

1. Contents to be included such as basics, facts, instructions for sources to be detected in libraries, journals, books, public press and other public sources, internet sources, etc.
2. Methods of transmission and of acquiring both knowledge and values related to the innovative rather than routine-loving business and society.
3. Ways of rather equal-footed co-operation of teachers in their work with students.
4. Ways of co-operation of teachers who work at the same time with same students, but on different topics, between which links can be established, but are not, if there is a poor co-operation and mutual information of teachers, and hence the potential synergies are missed, quite probably.

In the catching-up countries and areas, such as the ones of central and eastern Europe who have not belonged to Europe-15, but do belong to Europe-27, the above findings receive some additional weights such as:

- Catching-up requires additional speed, or it does not happen.

- Catching-up requires de-memorizing of quite some long-established habits, values, and insights, which have been rendered obsolete in the course of changes in the recent past.
- Catching-up, anyway, requires keeping one's identity.
- With all troubles, which accompany catching-up, or would show up anyway and tend to be ascribes to changes rather than to obstruction to changes, including innovative ones, one should not forget that the European Union has been and still is created as a peace project: this is the longest period of peace in Europe ever, and the first period in which public pools show that peace in Europe is taken for granted.

And last but not least, the resulting summarizing question reads: in which time frame and with how many students per teacher can dilemmas from this list be solved? There has, obviously, never in history of education been a shortening of time available for education. It is resulting now from the Bologna Process. Great Britain is said to provide the model (Zgaga, 2004), but what about her model of the student per professor ratio, etc.?

3 Some conclusions

Knowledge management in schools reaches beyond the traditional teaching as conveying of the established knowledge by lecturing, what ever technology is applied such as overhead projectors, power point, blackboard or paper work. It reaches also beyond workshop and discussion style, if the later is limited to the established knowledge with no or little new creativity of students. It reaches even beyond changing the role of students from passive addressees to active and creative participants of the education and learning processes, because it includes development of the students' and teachers' absorption capacity for the permanent influx of the new knowledge and their adaptation to the circumstances of the innovative business and innovative society. It tends to be much more complex than ever before and to demand teachers to de-memorize times of their splendid isolation in the academic life, which used to exist in times when science was worked on in monasteries (only). Schools are in market, actually in markets of several types that express several types of pressures, to which schools must respond creatively and with requisite holism, or perish. The Bologna Process seems to be an underused opportunity for innovation of higher education in Europe, because it tackles comparability much more than modernization matching the current socio-economic development of Europe as an innovative society, which Europe has decided to be, but with a poor success so far. Educators that have experiences education of yesterday which is history due to the current speed of changing must educate students of today to be professionals of tomorrow, which tends to be very different from the one of today and even more from the one of yesterday.

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K-MAPS OF HR SELECTION PROCEDURES AND THEIR POTENTIAL USE IN THE IDENTIFICATION OF TALENTED STUDENTS

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Abstract

In this paper the K-maps are understood as a graphical rendering of a procedural knowledge. The procedural knowledge in question concerns a possible use of selection procedures commonly used in personnel selection in the context of human resources management. Actually, the identification of talented students might be an important task in educational setting. If this task could be successfully carried out by use of a procedure developed in another field, the efforts necessary for implementing it might be alleviated to a considerable degree. On the other hand, this paper is about potential uses of K-maps in the first place.

Key Words

K-maps, selection procedure, talented students.

1 Introduction

In this paper the K-maps are understood as a graphical rendering of a procedural knowledge. The procedural knowledge in question concerns a possible use of selection procedures commonly used in personnel selection in the context of human resources management. Actually, the identification of talented students might be an important task in educational setting. If this task could be successfully carried out by use of a procedure developed in another field, the efforts necessary for implementing it might be alleviated to a considerable degree. On the other hand, this paper is about potential uses of K-maps in the first place. In the following text four K-maps are discussed in the successive order, as follows:

- the first K-map deals with a selection procedure based on knowledge of statistical associations of specific characteristics of a person (*predictors*) and performance of the same person (*criterion*) in specific task or tasks' combination, as e.g. in a paid job,
- the second K-map provides an illustration of selection procedure out-sourcing, when the selection of personnel is carried out by some external agency, like e.g. an executive search firm,
- the third K-map considers a different approach to finding a right person for a job or task, which is based rather on development and learning, as on selection,
- the fourth K-map differs from the three preceding it as it attempts to establish a decision procedure for finding out the best procedure to apply in a case of the identification of a talented student.

2 K-maps description

The K-maps introduced in the paper might be thought to be rather simple. However, they contain all the relevant information concerning the procedures in question.

K-map 1 – a selection procedure:

The method of development of a selection procedure is described in sufficient detail in Kolman (2004, p. 57ff) and Arnold (2005, p. 154ff). It starts with *job analysis*, by which it is determined what prerequisites the person will have to posses to be able to perform well on the job. The results of a job analysis will lead to a set of assumptions about possible characteristics of a person, which might be considered to predict the person's future performance on the job in question. These assumptions should be validated by means of *validation study*, in which the statistical association of predictors and a criterion is measured and tested. Predictors are measures of person's knowledge, skills, attitudes, motivation and other characteristics. A criterion is a measure of person's performance on the job. If at least some of the assumptions are proved to be valid, a selection procedure could be established.

Fig. 1: K-map 1 – selection *Step #*	*Procedure*	*Procedural knowledge*
1. ↓	Need analysis	Action to be undertaken
2. ↓	Job analysis	Job contends and process
3. ↓	Predictors determined	Assumptions on job prerequisites
4. ↓	Criterion determined	Measurable job output
5. ↓	Validation study	Results of assumptions testing
6. □	Selection method implementation	Selection method

K-map 2 – selection outsourcing:

The executive search firms and the like make their living by selecting personnel. Because of it some people believe that these agencies have got hold of some special knowledge, which enables them to be very good and precise in their predictions of future behavior of people. However, the only way how to make valid predictions of future behavior of people is the one described in K-map 1. Of course, an experienced advisor could always offer some educated guesses, but the value of these is questionable, at the best. Some information concerning this approach could be found in Yate (1990, pp. 56).

Fig. 2: K-map2 - outsourcing *Step#*	Procedure	Procedural knowledge
1. ↓	Need analysis	**Reasons to act**
2. ↓	Outsourcing	**Contract with an agency**
3. ↓	Accepting results	**Agency output**
4. □	**Implementation**	**Business experience**

K-map 3 – development:

In some cases it seems to be more appropriate to help to an employee to develop the skills and knowledge through time as just selecting her/him from a pool of possible candidates. This procedure is suitable in cases when the person is already employed by the company and her/his record of job results shows some promise of her/his future growth. This approach is suited when preparing a person to undertake a managerial or a professional position at the company and in some cases it was formalized in a specific method. One of these methods is called mentoring (see, e. g., Kolman, 2005, p. 19). The term "mentor" was derived from Homer's Iliad, where Mentor was the name of an older and wise friend of Odysseus. Odysseus consulted his intended acts with Mentor and took his advice seriously. In mentoring an older and higher standing manager acts in a similar way and the younger, lower standing, person develops by following the friendly advice of her/his boss.

The continuing process of mentoring is illustrated in Figure 4. In this diagram it could easily be seen that knowledge is exchanged, used, tested and that it results in producing some new knowledge. It would be more appropriate, of course, if the process is understood as a spiral, not as a circle. So, Figure 4 might be understood as just one turn of a spiral, which moves further on with every turn to achieve some specific goal in the end. Even so, Figure 4 is only a partial picture of the mentoring process. Mentoring is a continuing process of knowledge transfer, of teaching and learning involving two people. These two people are bound by a rather specific relationship, which is based on mutual trust, mutual interest in teaching/learning and goodwill on both sides. These wider aspects of mentoring process might be rendered by means of the following diagram (Fig. 3):

Trust, interest and goodwill → step-wise teaching/learning → implementing and testing knowledge → personal development and growth → development and establishment of new knowledge.

Figure 3: A wider view of the mentoring process

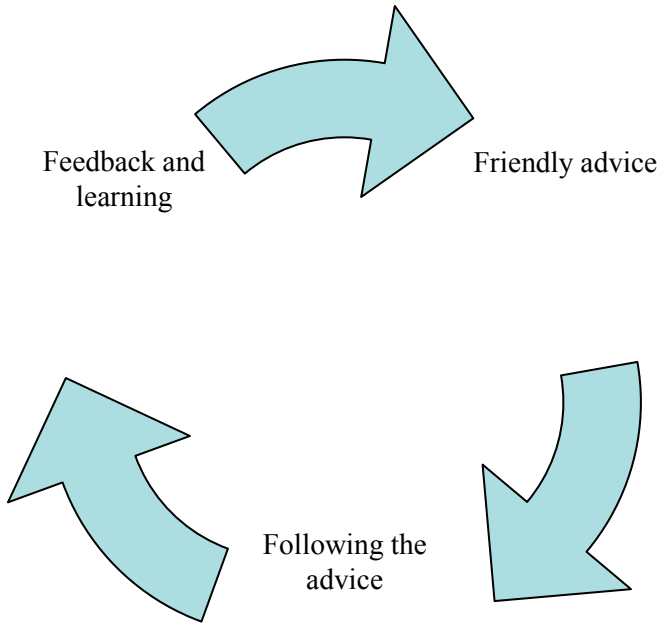

Figure 4: The continuing process of mentoring (one turn of a spiral of development)

K-map 4 – decision procedure

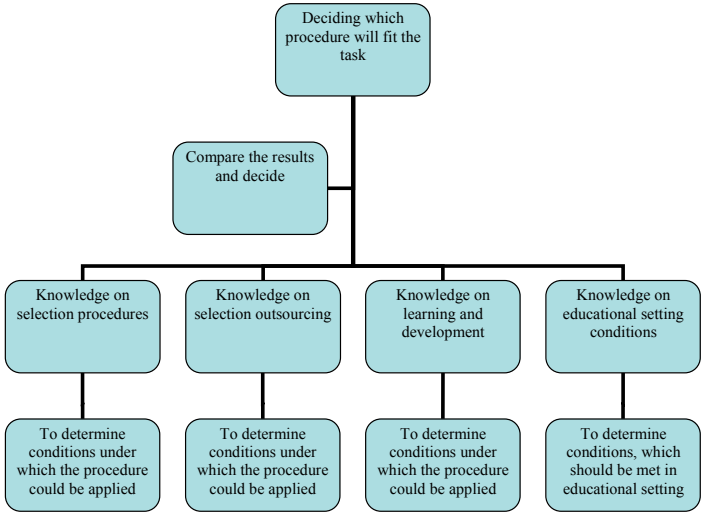

Figure 5: Basic structure of the decision procedure

So far, we have dealt in this paper with three different ways of how to find a right person for a specific job. The approaches described differ widely in a number of aspects. Our task at this point in our discussion of the subject in question is to find out on prerequisites of every one of these three approaches and to compare their potentials as candidates for the task of the talented students' identification. To do this we will have to gather specific knowledge on these three procedures and to use it to determine if and to what degree these three procedures might be used and applied in educational setting. To be able to decide what procedure could be used to talented students' identification we would have to make out about conditions and requirements of this task, as well. The knowledge gathered would enable to determine the utility and/or possible uses of the procedures discussed. The Figure 5 serves to illustrate the process.

Another way the procedure in the Figure 5 might be rendered is introduced in the Figure 6. In this figure we will use once more the step-by-step pattern of the first two figures.

Fig, 6: K-map4 – decision procedure *Step #*	Procedure	Procedural knowledge
1. ↓	**Gathering knowledge on selection procedure**	Where and how to find the desired knowledge
2. ↓	**Gathering knowledge on selection outsourcing**	Where and how to find the desired knowledge
3. ↓	**Gathering knowledge on development and learning**	Where and how to find the desired knowledge
4. ↓	**Gathering knowledge on educational setting conditions**	Where and how to find the desired knowledge
5. ↓	**Evaluating knowledge on selection procedure**	Aims and objectives; criteria for evaluation
6. ↓	**Evaluating knowledge on selection outsourcing**	Aims and objectives; criteria for evaluation
7. ↓	**Evaluating knowledge on development and learning**	Aims and objectives; criteria for evaluation
8. ↓	**Evaluating knowledge on educational setting**	Aims and objectives; criteria for evaluation
9. □	Deciding and implementing	How to reach a decision; how to implement it

3 Discussion and conclusions

In this section of the paper we will go subsequently through the step 5. to 9. of the Figure 6. It will be assumed that gathering the requisite knowledge is rather straightforward and does not need to be discussed in any length. As our task in this paper was rather to demonstrate the utility of K-mapping, as to reach any kind of final decision on talented students' identification we will limit the discussion to naming the known advantages and constraints of the first three procedures and based on it we will try to reach the conclusion based on the knowledge of the educational setting conditions.

K-map 1 – a selection procedure:

The selection procedure illustrated by K-map 1 represents the only scientifically based procedure of personnel selection. It is used world-wide and its usability and utility was repeatedly confirmed. However, there are costs and limitations to it. In the first place, the procedure costs time and money to develop. Because of it, it is advisable to use it only in cases where the costs of development could be covered, which means cases where huge numbers of people will be selected. The selection procedure is not universal – it should be developed anew for every specific job. Further limitations of the procedure utility are connected to *selection ratio* and to *probability of the event occurrence*. The first term is a ratio of selected persons to the number of candidates – in cases where number of candidates is roughly equal or less as the number of positions to be filled selection would not make sense. The second term concerns the probability with which the task could be successfully performed by an average person – if the job could be upheld by almost everybody; in such a case a selection would hardly make any sense, as well.

K-map 2 – selection outsourcing

As was mentioned earlier, the executive search firms and the like make their living by selecting personnel. Because of it some people believe that these agencies have got hold of some special knowledge, which enables them to be very good and precise in their predictions of future behavior of people. However, such a belief is not grounded in proved facts. The only way how to make valid predictions of future behavior of people is the one described in the previous case. Personnel agencies and executive search firms sometimes develop selection procedures of the type rendered by K-map 1. But, as they are business companies, they do that only in cases where they feel sure the costs of method development will be covered in not to far future. In all the other cases these companies deal in educated guesses of questionable value. There sure are alternative ways how to predict future behavior of people, similarly as there alternative ways of weather forecast. In both the cases the alternatives are unscientific and of no practical value.

Personnel agencies and firms are very strong in one other aspect of their functioning. This aspect is marketing. Quite often, it seems, they can sell their produce without its value and quality having been questioned.

K-map 3 - development

The developmental approach, as exemplified earlier in this text, resembles cultivation or tuition. It expects there are interest, motivation and good-will on both sides. This procedure is grounded in mutual trust and it continues for some time, developing new knowledge and expertise in the successive loops of advice, following the advice and feedback and evaluation.

K-map 4: decision procedure

By means of the K-map 4 we are now about to reach decision concerning the respective utilities of the three procedures preceding it in an educational setting. *Selection* might be considered as possible candidate, however, it is costly and limited by other constrains. Actually, it was tried several times (e.g. for identification of children talented for mathematics in the 1950th), but with questionable results. *Outsourcing* seems to be a fancy idea. In the best case the agency hired to accomplish the task would have to go through all the troubles of developing a selection procedure, as described above. Besides, the whole thing might be put in jeopardy by the business self-interest of the agency. The third procedure, *development*, seem best suited to educational purposes. Its structure resembles rather closely the educational process. Moreover it should be noted, that talent without motivation hardly could be found useful. As the K-map 3 takes motivational issues in the account it appears well suited to identifying talented students and developing their talents at the same time.

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CONTAINERS OF KNOWLEDGE AS A BASIS FOR KNOWLEDGE MAPS

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Abstract

The heart of most knowledge management (KM) strategies was and often is in technologies as data warehousing, dokument management, etc. The so called „second generation of KM" is based on a knowledge life cycle with both demand and supply side. Many discussions of KM are on theoretical and conceptual level and that ´s why many practicioners do not consider the KM as a significant contribution to competitive advantage. I tis necessary to make the knowledge more concrete, readable and user friendly. For knowledge collection and codification we use knowledge maps – schemas or models of how we undestand the problems and how we take actions. The knowledge maps can be expressed in texts, charts, pictures, etc. The character of knowledge map is closely connected with appropriate containers of knowledge. The containers perspektive is important in the implementation strategy of organizational learning.

Key Words

Containers of Knowledge, Mapping Knowledge, Knowledge Life Cycle, Knowledge Management.

1 Introduction

The maintenance of sustainable development faces today not only the challenges of the technical barriers as well as problem with nature and environment protection but there are also crucial problems connected with the necessity of nonviolent coexistence of different nations, cultures, religions. All enterprises are facing a strong global competition and the innovation process employed by the firm must be sustainable. The innovation process both in product sense and in process sense is based on using and creating knowledge. The knowledge management (KM) is a systematic approach to knowledge and experience from elsewhere.

In many cases the KM was not as successful as it was declared and that´s why many practicioners are rather suspicious. The main reason is by our opinior in over estimation of the supply side of the KM. The supplies of knowledge in the first generation of KM are managers and teacher who are presumed to possess the *wisdom* needed to determine *who* should have *what* knowledge, and *when*. The assumption is that the knowledge already exists (McElroy 2003).

According to this assumptions the KM workers try first of all to find, collect, organize and transfer the knowledge. The users (i.e. the demand side in the concept of second generation of KM) often are not ready or willing to take the active role in knowledge sharing and transfer.They think that they do not need the offered knowledge and that this way of learning activity is a vaste of time and money.

In idea of possibility of organizational knowledge creations has led to formulation of principles of the second generation of the KM.

One of key ideas of the second generation of KM are the containers of knowledge which are important for knowledge mapping. The knowledge maps as shared menthal model are of miscellaneous forms and contents. Because of strong text orientation of majority of the society other than text containers are often ignored.

2 History of Knowledge Management

The history of KM as a scientific discipline begins in the 1990´s and the numer of articles and book has grown rapidly. There are more theories on how the KM is developing, one group tends to focus on knowledge sparing, and the other on knowledge making. According to (Gorelick, Milton and April 2004) there are 4 phases of KM:

Phase 1: Information to Support Decision makers (prior to 1995)

The focus was on information flu to support decision makers. Typical applications:

- Executive information systems.
- Data warehousing.
- Process reengineering.

Phase 2: Tacit and Explicit Knowledge (since 1995)

It emphasize the conversion of tacit and explicit knowledge in order to translace the individua knowledge into public or collective knowledge.

Phase 3: The Use of Narrative in Organizations (since 2000)

The phase 3 and 4 is corresponding with the term second generation of the KM in (McElroy 2003).

One of the basic principles of Phase 3 and 4 is that the process of moving from knowing to saying and to writing (recording) involves some loss which might be massive. The narrative

management is managing the process of conversation as a tool of knowledge sharing process.

Very important is telling stories that describes experiences and events. The storytelling has been recognized as important management skill which uincreases insight and understanding.

Phase 4: An Integrated Knowledge Management Framework

Phase 1,2,3 can be see as a building blocks for an integrated model.

Definition:

KM is a framework for applying, structures and processes at the individual, group, team, and organizational levels so that the organization can learn from what it knows to create value for its customers and communities. The KM framework integrates people, processes, and technology to ensure performance and learning for sustainable growth.

The second generation of KM has according to (McElroy 2003) following main ideas:

- The Knowledge Life cycle.
- KM versus Knowledge Processing.
- Supply versus Demand Side KM.
- Nested Knowledge Domain.
- Containers of Knowledge.
- Organizational Learning.
- The Open Enterprise.
- Social Innovation Cupital.
- Self-Organization and Complexity Theory.
- Sustainable Innovation.

3 Knowledge Life Cycle

For enabling the knowledge to play role in innovation of organizations we have to take in mind both demand and supply side of the KM -see Picture 1. Using the knowledge life cycle (KLC) we characterize an organization´s current knowledge processing environment. Using KLC we do not assume that some knowledge already esists. The cycle begins with the production of knowledge. The new knowledge generation is based on natural, spontaneous interaction between people which leads to formulatin of a knowledge claim.The knowledge claim raise on the deman side of the knowledge cycle what means new knowledge is created on the demand side. In the second phase the knowledge is distributed and shared.

3.1 Containers of Knowledge

The containers are made up of agents (individuals and groups) and artifacts (documents, computersystems, etc.). The knowledge in artifact has been codified somehow, so they bring the explicit knowledge. The way of codification is not necessarily the text; not necesaroly linguistic, it might be also music or dance.

The knowledge container holds and reflect the knowledge claim procuced in KLC. In addition, they can be seen as an interface between knowledge processing outcomes and the business processing environment (McElroy 2003).

3.2 Mental Models and Knowledge Maps

Mental models are deeply ingrained assumptions, generalization, picture or images that influence how we undestand the world an show we take actions (Senge 2006). The mental model is an internal representation of the situation. It can be expressed also as a database or mathematical model.

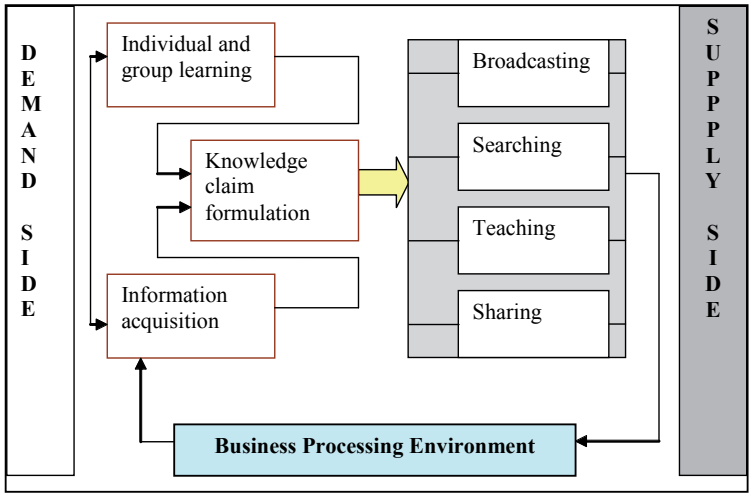

Figure 1: Demand Side and Supply Side of Knowledge Management (according to McElroy 2003)

The shared mental model contains shared vision and goal of a team. Building the shared mental model calls for thinking together a speaking to each other.

Shared menthal models are hypothetical cognitive structures that broaden the individual menthal model into a team context (Orasanu 1993).

The knowledge maps are mental models designed for knowledge collection structuring and sharing.

3.3 Organizational Learning Cycle

The organizational learning cycle (see Figure 2) has according to (2007 Our View on Knowledge Management) four main phases:

- **Mobilising knowledge before and during activities**

Knowledge will only add value when applied. Gathering, validating and structuring knowledge will have no value when the results of these activities are not used in a day-to-day practical context. A closed learning cycle requires all available internal and external knowledge to be mobilised at the start of a new project or any activity that requires knowledge.

- **Learning and applying knowledge in practice**

All people learn while acting. They reflect on the effects of their actions and might change their mental models and ways of working based upon the outcome of these reflections. This reflection might not always occur consciously and systematically. An organisational learning cycle however will benefit from practitioners who reflect consciously and systematically on their actions and the effects of their actions.

- **Capturing and validating knowledge**

To leverage individual learning an organisation or network should organise processes to integrate new knowledge in its existing 'body' of knowledge.

- **Structuring knowledge**

The product of the capturing and validation process requires rework, annotation, and explanation to make it suitable for the target group.

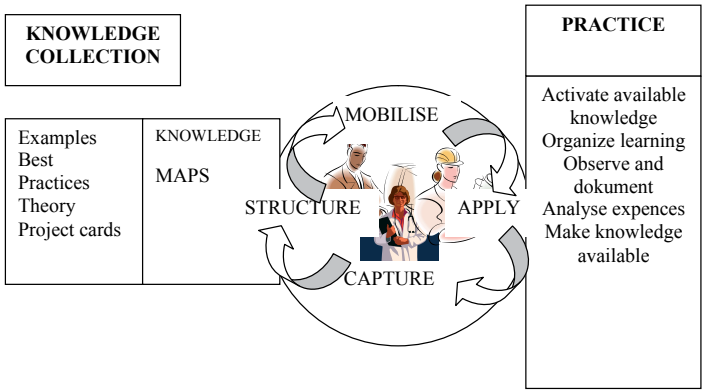

Figure 2: Organizational Learning Cycle (according to 2007 Our View on Knowledge Management**)**

The knowledge maps have their position in the organizational learning cycle in the phase of structuring knowledge. The maps are important in transferring the sense of the knowledge content to the users.

4 Conclusions

The concept of containers of knowledge is one of the key ideas of the second generation of KM which is based on a closed KLC. The attributes of the containers are important for construction of the knowledge maps. Different containers calls for different way of searching and collecting the knowledge. All these activities should be oriented towards the demand side of the KLC, to the knowledge claim. The knowledge maps support learning in the way of apprehension. Language, symbols,schemas, stories, models etc., are building blocks of the knowledge maps. The knowledge map should respect concrete problem situation, the user or users and the knowledge container on which it is implemented.

5 Acknowledgement

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KNOWLEDGE IN EDUCATION
A PROCESS VIEW

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Abstract

In this paper we review how changing paradigms of the Information and Communication (IC) technologies affect essential parameters of creating and disseminating information in the academic world. Using a historical perspective their impact on the university education system will be discussed. Both documents (e.g. electronic documents) and communication means (e.g. Internet) are investigated. The parameters are analyzed with respect to their effects on the timing of the various subprocesses of academic education (e.g. time to publication, time to teaching etc.). Consequences for quality attributes and teacher/student relationships are discussed in view of the academic education processes. We will show that many of the cherished traditions, habits and beliefs of yesterday are invalidated, especially by the modern IC-technologies.

Key Words

Educational Processes, Information and Communication Technologies, IC-technologies, academic education, time delays.

"... the times they are a-changing"

(Bob Dylan 1964)

1 The Knowledge Life Cycle

1.1 Knowledge and Education

Changes of the Information and Communication Technologies (IC-Technologies) from handwritten manuscripts archived in medieval monasteries to texts freely distributed with electronic speed via the Internet have considerable impact. They have (and still will) change our understanding and interpretation of the notion of knowledge, education and how it is to be provided and administered.

The paper is structured as follows: In the current chapter we will expand the notion of knowledge and its creation. Chapter 2 lists all interesting technologies, both with respect to creating documents and transmitting information. In chapter 3 we discuss the classical academic knowledge dissemination process and its individual subprocesses. For these subprocesses we will identify essential parameters, especially with respect to performance time. For each of these processes we note the changes in performance due to technological advances in information and communication technologies. Chapter 4 is devoted to discussing certain synergetic consequences of the parameter changes of the various subprocesses like teacher's lead time, verifiability, etc. In the last chapter 5 we discuss future global changes to some of the sometimes cherished traditions of academia.

1.2 The SECI Knowledge-Creation Model

A basic distinction exists between explicit and implicit knowledge (Nonaka and Takeuchi 1995) as indicated in fig. 1. Explicit knowledge is defined as „knowledge that has beenor can be articulated, codified, and stored in certain media. It can be readily transmitted to others" (2005 Wikipedia, → explicit knowledge). Today such knowledge can easily be processed by a computer, transmitted electronically, or stored in databases. External knowledge is contrasted to „tacit knowledge" which „is knowledge that people carry in their minds and is, therefore, difficult to access.

Effective transfer of tacit knowledge generally requires extensive personal contact and trust „ (2005 Wikipedia, → tacit knowledge), see also (Skok 1999). Fig. 1 shows how tacit knowledge is transformed into explicit knowledge via the process of externalization.

In this paper we will concentrate on the transfer (dissemination) of explicit knowledge, a major objective of university education.

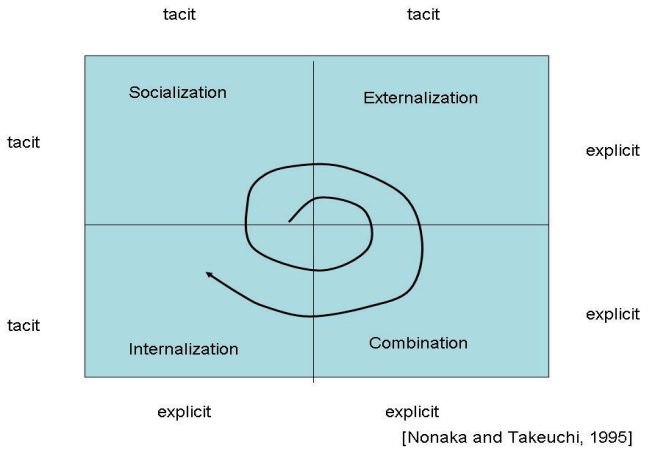

Figure 1: The SECI-Model of knowledge creation (Nonaka and Takeuchi 1995)

2 Technologies and their Properties

2.1 Education, Communication and Technology

One of education's main purposes is to create knowledge in the people to be educated (there are some other purposes like socialization etc., but this will not be discussed further). Even if there is no accepted definition of the notion of knowledge (cf. 2005 Wikipedia →knowledge) we know that a large part of knowledge acquisition is based on passing knowledge ultimately from one

person to another. As fig. 2 shows the Originator and the Recipient of some information (knowledge?) have to share a common communication channel and the information itself needs to be stored on some kind of medium. The figure also

indicates that it is necessary to distinguish between volatile and persistent media.

In the discussion of the academic education process persistent media play the key role. The receiving person adds the new knowledge via the process of combination to the existing one. This means that actually we accept that "Knowledge is based on Information", differently formulated "Knowledge is remembered ('stored'→ information" 2005 Wikipedia Deutsh, → translated from 'Wissen'). Information itself is understood as "meaningful data".

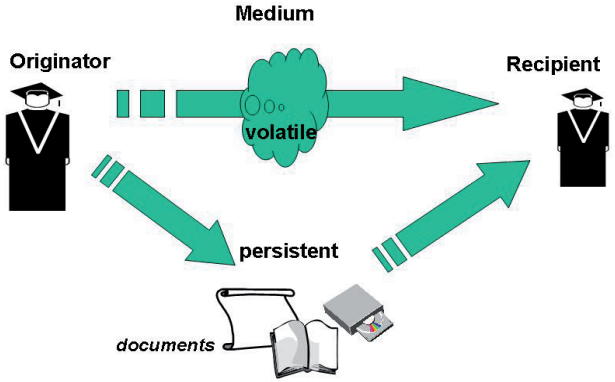

Figure 2: Basic Communication Processes

More precisely we should say that data are passed from one person to another which are interpreted as information and used to create knowledge in another person but otherwise we will ignore this fine point.

The desire and the ability to disseminate knowledge is one of the keys to scientific research (Schneider 1996). Scientific research implies not only the passing of scientific knowledge, it also aims at *"the acquisition of knowledge in a systematic, methodical process with intersubjectively reconstructible and purposeful research"* (Haux et al. 1998, p. 9).

By using knowledge from our predecessors we try - *as Newton formulated it* - to stand on the shoulders of giants, our predecessors.

Despite the fact that information itself is immaterial and clonable without any loss, it is necessary to bind it to an appropriate medium (see section 2.2). The information contained in this type of medium has to be communicated by an appropriate 'carrier' (see section 2.3). IC-technologies over time, but especially the last 50 years have dramatically changed both the available media and usually in parallel the communication technology (Kraut et al. 1994). Many of these changes often implyradical changes to knowledge dissemination and education.

2.2 Communication Media

The various documents usable as information media are listed in figure 3. Most of them are a product of the last 50 years, produced by IC-technologies. The figure shows relevant types of documents types together with their essential properties.

Dramatic changes in our times provide two outstanding media: electronically produced documents (e.g. desk top publishing, electronic office) and - a little bityounger - electronic documents on the World Wide Web.

Document typew paradigm	max info size	tool cost	effort producing instance	reprod. cost	
Handwritten text (fixed location)	persistence	medium	small	small	same as original
Handwritten text (mobile medium)	transportable information	medium	small	small	same as original
Handwritten books	aggregated information	large	small	very large	same as original
Type-set books	reproducibility	large	medium	large	small
Xerographic copy	cheap and fast reproducability	large	medium	very small	small
Electronic document / desk top publishing	variability of fonts, independence from printer	large	medium	small	very small
WWW document	self-representation, no restrictions	medium	very large	small	very short
Virtual reality	imagination, irreality	medium	very large	small	small
RFID-tags	active recognition, unobtrusive communication	small	small	very small	very small

Figure 3: Properties of Documents

Essential properties of these document types are:

new paradigm: What is the new paradigm introduced by this technology? A careful analysis would show that some of the later media often do not preserve properties of previous media, but since all document types essentially can be used in parallel this is no problem. The 'new paradigm' in many cases, however, was the 'unique selling point' for the introduction of that medium.

maximal information size : How much information (data) can be feasibly transported?

tool cost: What is the cost/effort of tools needed to produce the document? Typically producing color photo-slides needs an appropriate studio.

effort producing instance: What cost/effort does it take to

produce a single instance of the medium? Although producing a desk-publishing tool like LATEX (Goosens 2000) or WORD is a tremendous effort, writing an individual document is very easy.

reproduction cost: What is the cost of producing a similar copy of an existing document?

2.3 Communication Means (Carriers)

In this section we discuss the essential technological advances of communication (Kraut et al. 1994), (O´nils and Jantsch 1997), (Tarumi et al. 2000). The advances in technology go hand in hand with the advent of new information media (see section 2.2) which can serve to transport the actual information. Sometimes a clear distinction between medium and communication means is difficult. In fig. 4 we list essential communication means (see also (Chroust 1998) and (Chroust 2005)) together with the significant technological advance they have brought about.

The technologies are listed roughly in the order of their historical appearance. Only a few of them are of high relevance for the education process. We also list some of their essential properties which are of importance for the education processes (fig. 4).

These carriers come a long way from the initial start-up of oral communication: In the oral tradition (this has been included to stress the difference to today's communication means) the information was passed on synchronously from the Originator to the Recipient. No written records existed. No verification by regression was possible once the Originator was dead. Even if the Originator still lived it was often impossible to contact him/her. The lack of original written documentation is typical for most existing religions (cf. (Detering 1995), (Smith 1973)).

Carrier	new paradigm	proto-coll	aura of sender	max info size	delivery speed	fan-out	infrastr. prep. effort	instance product. effort
Speech	abstraction	push	small	medium	fast	1:n	null	null
messenger	spatial difference	push	small	medium	?	1.1	null	null
letter mail	organized service	push	small	medium	medium	1:1	large	very samll
Telephone	inter-activity	push	small	small	fast	1;1	large	null
Television	dynamic images	push	large	medium	fast	1:n	very large	large
Fax	graphics	push	small	medium	fast	1.1	large	small
e-mail	machine readable, fast dissemination	push	small	medium	very fast	1:n	very large	very small
Groupware, tele-conference	cooperation	push / pull	small	small	very fast	m:n	medium	small
Internet, WWW -publishing	self-presentation, no restrictions,	push / pull	very large	medium	very fast	m:n	very large	small / medium
Ubiquitous Computing	immediate access	pull	possibly large	medium	very fast	1:n	very large	small
Agent technology	delegation, asynchronous execution	push	small ?	medium	fast	1:1	large	large
smart objects (e.g. RFID)	fine-grained identifyability	pull	small	small	very fast	1:n	medium	small
subconscious, ESP techniques	access to subconscious	?	small	?	?	1:n?	?	?
intrusive techniques	neural manipulation	?	small	?	?	?	very large	?

Figure 4: Properties of Carriers

Of key importance to the changes in education are:

e-mail: The message allows for fast dissemination in asynchronous form. It is essential that the transmitted documents are electronic themselves and can be immediately and seamlessly processed further. The ability to attach further

arbitrary documents (including graphics, sound etc.) enhances the importance.

Groupware, teleconferencing: It allows a limited number of persons to have a virtual common meeting, irrespective of the geographic location of these persons. Computer support provides numerous helpful tools for brainstorming, voting, recording, minute writing etc. (Boehm, Gruenbacher and Briggs 2006), (Grünbacher and Chroust 1996), (Bächle 2006).

Internet, WWW -publishing: The World Wide Web allows 'individual self-promotion' by posting something 'to the web'. Anybody is able to put a 'publication' into the Internet, be it a scientist or an ignoramus. The effort to produce one instance is small to negligible. It is often already hidden in the effort producing the associated creative work.

Putting documents on the Web circumvents quality control, reducing total time-to-publication essentially to the part of the preparation time which is used to finalize text and figures and formatting it for web-usage. Since everybody has easy access to this 'published' material the acquisition time is also reduced to zero.

Agent technology: Agents have a activity of their own and can be programmed/instructed to perform tasks independently. They can roam the Internet for material etc. (Lieberman and Mauslby 1996), (Payr and Trappl 2004).

For each technology of the technologies listed above we show a few of their key properties in fig. 4:

new paradigm: What is the new paradigm introduced by this technology? A careful analysis would show that often later technologies do not preserve these properties, but since all carrier types essentially can be used in parallel this is no problem. The 'new paradigm' in many cases, however, was the 'unique selling point' for the introduction of that medium.

type of protocol: The information can be supplied somewhat in a push fashion, i.e. initiated by the Originator or can be supplied 'on-demand', i.e. in a pull fashion.

aura of sender: What size can a group have such that the producer can still communicate effectively?

max info size: What is the amount of data/information to be transmitted conveniently?

delivery speed: How fast is the transmission? The interesting IC technologies provide practically instant transmission

fan-out: How many recipients can be reached with one communication action?

infrastructure preparation effort: What is the cost of the infrastructure to enable people to use this carrier? Typically Internet, easy as it is to use, needs a tremendous effort for its upkeep.

instance production effort: What is the effort to produce a single communication act.

3 The Academic Education Environment

We want to point out that in this paper we concern ourselves almost exclusively with the academic education environment. Many of the facts and observations will carry over to other domains, but this would need an additional research effort.

3.1 Basic Processes in Academic Education

Basically academic institutions try to pass the knowledge from one generation to the next: a teaching process (fig 2).

In the simplified model of teaching (fig. 5) we use only four prototypical roles:

the Originator: This role creates some (new) knowledge which is valuable and is considered to become a part of the scientific knowledge base. This knowledge has to be disseminated. In fig. 6 we show the essential steps of a (classical) dissemination process. Once a book etc. is available on the market it is a candidate for being used in knowledge dissemination (and further on for teaching).

the Teacher: This role acquires (scientific) knowledge (it is usually also an Originator) in order to pass it on to the Student, by teaching. In fig. 5 we shown the various steps in the process: from the acquisition of the document containing the new knowledge, through understanding the material, to preparing material adequate for teaching and the actual teaching process.

the Student: This role is trying to learn the scientific knowledge available. He/she usually will follow some academic curriculum.

the Distributor: This is a subordinate, but essential role. It is in of distributing the documents containing the knowledge, nowadays it is usually a publisher, in Internet-times sometimes also an automated software programm.

The same person may participate in these processes in several roles: By law Austrian Universities have to follow 'research-based teaching', the academic staffperforming both Originator and Teacher roles.

In more detail we can distinguish seven different subprocesses (fig. 5).

dissemination: The Originator makes some knowledge available to others by publishing it in an appropriate form: it becomes explicit knowledge, fig. 6, section 3.2.

identification: In order to acquire additional information (knowledge) potential sources of information must be identified. If they are useful, the information in the respective documents would be acquired, fig. 7, section 3.3.

acquisition: The Teacher acquires this knowledge. This includes getting access to the medium where the information is stored. He/she combines it which other existing knowledge (cf. fig. 1) in order to gain understanding and consequently being able to teach it, fig. 8.

teaching: As the next step the knowledge is taught to the students, usually prepared in an appropriate way and often accompanied by (secondary) explicit knowledge, fig. 5, section 3.5.

regression: Especially the Student might want to access the original basis of the presented knowledge in order to check the validity and/or the interpretation by the Teacher. Additionally the Student might want to get some more details, more background or even a second opinion, fig. 5, section 3.6.

searching: In the course of preparation the Teacher might search for additional/supporting or undermining material. Likewise the Student might be interested in knowing more supportive material and would also engage in searching for more material, fig. 7, section 3.7.

browsing (serendipity): In the course of searching or regression the Teacher or the Student might run across other knowledge which is relevant for their work. Drawing a border between goal-oriented searching and undirected browsing is often difficult to draw especially since a user often switches from one type of work to another (searching something, finding something else of interest, searching on the new question etc.), fig. 7, section 3.7.

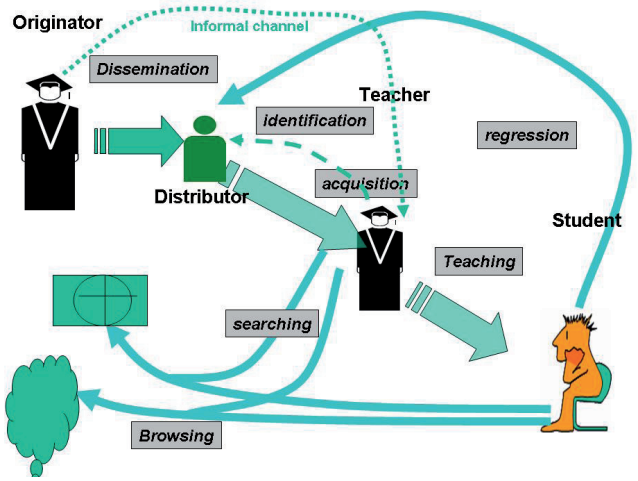

Figure 5: Basic tasks in the Education process

In the next sections we will describe the processes identified above in more detail and discuss the effects technology has on them. We explicitly distinguishdelays due to work and delays due to communicating with somebody else (communication delays, e.g. C_{PREP}, C_{EVAL}, C_{PROD}). We will show that especially the communication delays experience considerable reduction due to modern technology.

3.2 The Knowledge Dissemination Process

In the sequel we will only concern ourselves with communication via persistent media which is especially important in the dissemination of scientific knowledge.

Fig. 6 shows the key time delays in the dissemination process. The delays are:

Time for preparing the manuscript (T_{prep}): A certain time is needed (after/during the conceptual, mental work) to produce an appropriate manuscript. Usually some help from a specialist was needed for the preparation, be it a monk writing on parchment, be it a secretary writing the manuscript.

Transmission delay of submission (C_{prep}): This is the time needed to send thedraft (manuscript, typescript) to the evaluators (programme committee, editorial board, ...)

Time for Evaluation (T_{eval}): Knowledge submitted need not to be correct or valid. For scientific books, journals and proceedings of conferences a verification subprocess (performed by editorial boards, programme committees and reviewers) is standard, ensuring a certain quality of the published material. This activity is obviously the cause for considerabledelay, especially for books and journals where several iterations between reviewers and the author are not unusual.

Transmission delay of evaluation (C_{eval}): This is the time needed to send thefinal manuscript to the actual publisher or printer.

Time for Production (T_{prod}): It takes extra effort to produce a book/journal for accessability/distribution to a wider audience. Typesetting and proof reading take considerable time. The next step is actual printing the book and then binding the volumes. With the advent of desk-top publishing and the habit of requiring the submission of camera-ready copies this effort

has been drastically reduced. With the printing process the end of production is reached and the book/journal is ready for the general public to be accessed/acquired. The new knowledge becomes accessible to a (sufficiently large) public.

Transmission delay of produced document (C_{prod}): Time to send the material from the printer etc. to the final destination, be it an archive, a library or a distributor (book store, conference, journal mailing etc.).

Aggregation of above delays yields the externally relevant time delays:

Time to Acceptance (TT_{accept}): This is the time from the initial start of creating the document until it is deemed ready and accepted for publication.

Time to Publication (TT_{publ}): This is the time from the initial start of creating the document until it is available for the public. We ignore the overlap between conceptualization and actual writing, since this does not have much influence.

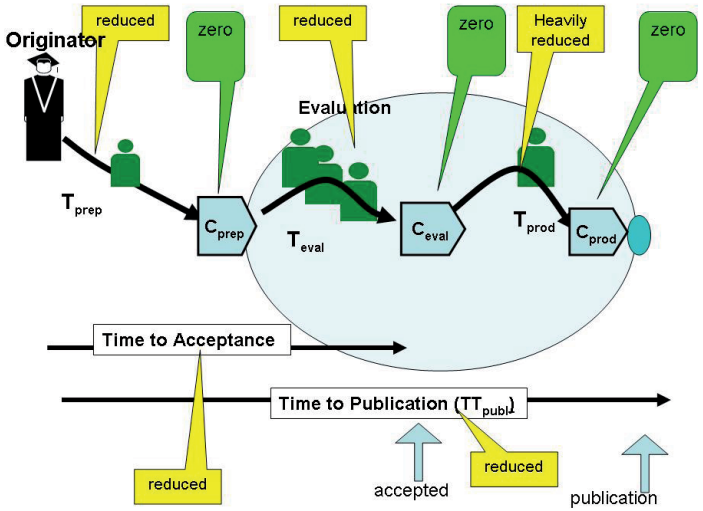

Figure 6: The Dissemination Process

In fig. 6 we left out potential feedbacks, iterations and rework, which is not really calculable and also does not considerably change the effect of technology, except to supply a multiplication factor.

Analyzing the individual delays as shown in fig. 6 we come to the following conclusions:

- Communication delays are reduced almost to zero.
- The time for preparing the manuscript is reduced due to the use of modern desk top publishing means, including drawing aids (e.g. Power Point, available clip art, etc.).
- The evaluation process is shortened due to the availability of Groupware support, virtual meeting support, and the

fact that documents under evaluation do not have to be physically copied.

- In the production of the final document (e.g. book) the seamlessness of electronic documents make a transfer step (or even a type setting step) unnecessary. Many production systems use the author's input directly to control the printing machines.

A typical example is the submission process to conferences. 20 years ago there were 3 to four month of elapsed between the deadline for submitting a paper and the final proceedings ready for print. Today this can be compresses to four weeks without any problem.

Semi-automatic conference systems (Van de Stadt 2002) offer several further advantages:

- The electronic submission allows for immediate comparison of the decision of the various reviewers and enables them to discuss their decisions and even to change them with electronic speed.
- Reviewers can see all documents (not just the ones the programme chair sends them) since (electronic) duplication and mailing creates practically no effort.
- The conference programm is automatically generated afterwards.
- Slight modification to accepted papers (e.g. reformatting) can be done by the authors (or sometimes even by the editors) on short notice according to the reviewers' suggestions.

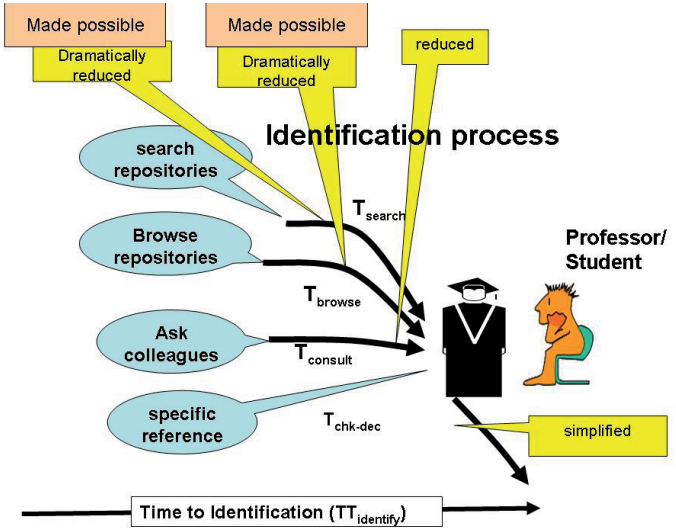

Figure 7: The Identification Process

The identification process tries to identify sources of additional knowledge to be accessed. Basically there are three sources:

- specific pointers to documents from other documents or colleagues,
- documents identified by systematic search,
- documents accidentally found via browsing (serendipity).

In most cases only references (pointers) to the documents are provided, the exact source and the actual acquisition are separate processes.

Time for searching (T_{search}): This is the time needed for a targetted search. This is dramatically reduced due to electronic speed. Additionally searching for certain documents or information would have been practically impossible without digitized documents.

Time for browsing (Tb_{rowse}): There are many ways for finding out about relevant knowledge. They reach from being notified, to consulting a colleague, to explicitly search, to accidentally find something by (undirected) browsing (serendipity). With globally available and accessible document bases (e.g. electronic digital libraries) search and browse meant day-long stays in various geographically distributed libraries, asking for copies and waiting for their production.

Time for consulting ($T_{consult}$): Asking colleagues is a matter of communication. Modern communication reduce this time investment and eliminate mailing delays.

Time for source-checking/deciding ($T_{chk-dec}$): Having found a promising document candidate it is necessary to check the validity/reputation/credentials of the document. Not every document offered to the public, even if it is printed, comes from a reliable source which ensures the document has passed some quality assurance process. Detecting (especially on the Internet) a promising looking document could still turn out not to be what was promised initially. Thus one has to be careful. For well-known publishers or conference organizer checking can easily be done by looking at the names and the credentials of the publisher/organiser. For other sources it might take longer or it can even be impossible (especially on the Internet (2002 Univ. of Michigan)). In the Internet is also necessary to make sure that the document is the original unmanipulated work of the author(s). This situation is similar to the software markets with so-called Software of Unknown Pedigree, "SOUP" (Hart 2003).

Time to identification ($TT_{identify}$): This comprises the total time until a piece of information, a document, is identified. Some of the activities are only made possible by digitalization, others are dramatically reduced in time and effort. Many of these activities can be performed in parallel. Analyzing the individual delays as shown in fig. 7 we come to the following conclusions:

- Without global search mechanisms it was necessary to visit several libraries to make searches.
- Comprehensive search functions (especially full text searches) are only possible by IC-technologies. They culminate (at the moment) in digital libraries. Agent technology (the first step into this direction is GOOGLE) will further improve the effectiveness.
- Browsing through hundreds of documents was a tremendous task without electronically stored and searchable documents.
- Consultation with colleagues is made easier with electronic media.
- Very often one not only receives an identifier of a document but the document itself, saving the ordering process.

3.4 The Acquisition Process

We consider the Acquisition Process (fig. 8) finished when the knowledge has been combined by the Teacher with his/her existing knowledge (cf. fig. 1). Therefore the process has two components:

- acquiring the documents containing the desired knowledge - and - if necessary - waiting for it,

- finally trying to comprehend the acquired information.

Essential delays are:

Time for Placing Order (T_{order}): Placing the order (or in medieval times arranging a visit) might involve considerable delay. Besides the potential formalities of the 'ordering' process there will be some communication delay. Paying for documents was also a problem before electronic banking etc.

Order Communication Delay (C_{order}): Communicating the request for the document will cause some delay. In the old days letters had to be written.

Time for Request Processing ($T_{order-prc}$): Once the request is received its processing will need some time until the request is granted (or not!). This processing could include checking the privileges of the requestor to see that document (e.g. when ordering from a consulting organization) and/or making the necessary financial arrangements of the order.

Delivery Delay ($C_{deliver}$): In medieval times acquisition of knowledge usually meant physically travelling to some often remote place (a monastery) to be allowed to read the manuscript/ book there. Very often these books were chained to their support for added security ('chain books'). Today scientists interested in printed books/journals have to order them and receive them by mail sent (causing some mail delay). In the case of Internet it might be possible to load the material down to one's own computer and have it for immediate local availability. For valuable rare books even nowadays it is necessary to request copies by some loan mechanism or even go to their safe-keeping place.

Time for Comprehension (T_{compr}): After having the document in one's hand it is often a considerable effort to read it, understand it, draw conclusions and finally be ready to prepare the material in a way suitable to be taught to students. Electronic documents offer there some help by being able to be formatted, searched etc. Also all the other electronic tools available for research come handy.

Time to acquisition (TT_{acquis}): Analyzing the individual delays as shown in fig.8 we come to the following conclusions:

- Due due electronic ordering, electronic payments etc. the actual ordering act is considerably reduced.
- The actual time for transmitting the order is eliminated.
- The processing of the order will usually be reduced to electronic means.
- If the requested document is electronic itself, then again the transmission time is put to zero.
- The actual comprehension process is supported by numerous electronic means and tools and thus eased.

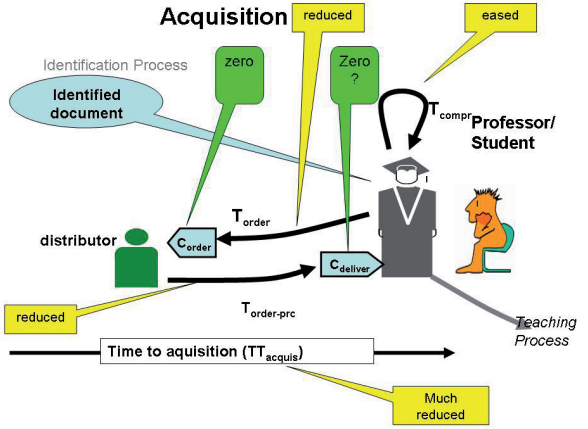

Figure 8: The Acquisition Process

3.5 The Teaching Process

This process starts with the decision of the Teacher to pass the newly acquired knowledge on to the students.

Time for Material Preparation (T_{mat}): There is still a large step between understanding a topic oneself and arranging it in a form amenable to be taught to students (cf. (Berg and Huber 1996), (Ossimitz 2000), (Carryer 2002), (Perritt 2000)).

Lecturing Delay (T_{lect}): Usually there is a certain delay between having the delivery readiness and actually delivering the lecture to students.

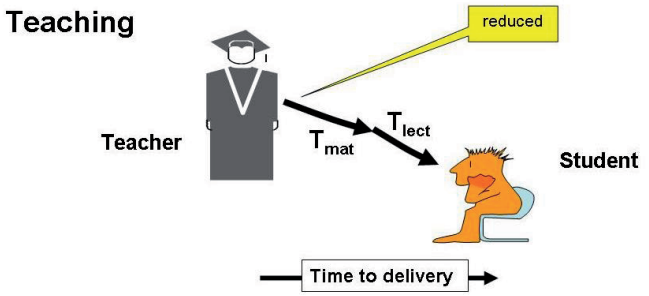

Figure 9: The Teaching Subprocess

Analyzing the individual delays as shown in fig. 8 we come to the following conclusions:

- The process of material production will be basically simplified by the new tools.
- There has appeared, however, an opposite trend in the students' expectations with respect to the formal quality of the presented information to the with the availability of modern presentation means. As fig. 10 shows the preparation effort to produce modern presentations means, using a notebook, a beamer and perhaps producing a multimedia show is rising.
- At the same time the flexibility during the lecture is reduced: during a presentation a power point presentation offers considerable less flexibility (e.g. for switching the sequence of pictures) than a overhead presentation or the writing on the blackboard.

3.6 The Regression Process

The motive for the use of the regressions process (both for Teacher and Student) is either to verify the delivered knowledge or to learn more about it by accessing the original document. The process of trying to locate the original document is essentially the Identification Process (section 3.3, fig. 7), assuming that a precise reference is available, otherwise a search process would be needed. Despite the fact that the Teacher might have identified a source, the document there might not be available, or not accessible, or prohibitively expensive to buy. In this case a search for a second source might be useful, e.g. nowadays on the Internet.

Medium	preparation time (P_{mat})	ease of presentation support	flexibility at lecture
Speech	null (only mental)	null	fully
Blackboard	small (only mental)	? hand-write everything !	fully
Diapositives	days	medium	null
Foils handwritten	hours, cumbersome	medium	medium
Foils (electronically produced)	hours	medium	small
Beamer/Notebook	**more hours**	**large**	**very small**
Multimedia	several days	medium	**null ?**
Internet, WWW-publishing	many days	large	null

Fiure 10: Delays in the Teaching Process

3.7 The Search and Browse Process

Although there are certain differences we will treat both searching and browsing together. A reason is that a user very often switches between the two modes. Both processes are already discussed under the heading of the Identification Process (section 3.3, see also fig. 7).

3.8 Informal Channels

We have to recognize that there are also some informal channel, especially for the Teacher: contacts with other colleagues, being on distribution lists of available knowledge etc. Modern technology (e.g. Web 2.0) will enhance this trend to "social software" (Bächle 2006). Examples are recommender systems (Balabanovic and Shoham 19997), (Bonhard et al. 2006), Electronic Performance Support Systems (Banerji 1995), groupware in all forms (Bonhard et al. 2006), (Gross 1997), (Selvin 2003). The classical knowledge dissemination process as described in Fig. 5 does not show an informal information flow between scientists. Informal communication at conferences, letters, and e-mail exchanges make a scientist well aware of the activities of the colleagues in his own field. Thus the appearance of a new document (e.g. a paper) by a well-known colleague working in the same field will not cause much of a surprise. Very often the Teacher might even have received a pre-publication copy or heard a presentation on the topic.

These effect of the informal channels have (amongst others) the followingeffects:

- faster notification of appearance of new knowledge,
- better chance to get feedback from colleagues,
- wider distribution of information, especially if a large aura (Gross 1997) of the Originator's e-mail enhances the information flow (cf. fig. 4),
- easier sharing of draft versions (cf. fig. 3) in order to hare information and the exchange opinions.

4 Technological impacts on the educational processes

There are several aspects in the technological support of the educational process which have been, sometimes dramatically, changed by technological improvements. We will discuss some of these aspects in the following sections.

4.1 Teacher's lead time

Dissemination of knowledge needs a certain temporal lead-time for the Teacher. This is the amount of time the teacher gains by acquiring the knowledge earlier than the Student. He/she has to acquire information, analyze, and comprehend ('digest') the material and finally prepare some teaching material, see fig. 9

and (Chroust 2005). Only then is the Teacher ready to lecture about this subject and to pass the derived knowledge to the Students.

4.2 Verification by the Student (regression)

The Student might himself/herself cross-check the statements a teacher made, i.e. verify the statements of the Teacher. Having been confronted with the subject only in the lecture (fig. 9), it takes some time for the student to follow up.

4.3 Surprising the Teacher

The Student might by chance (e.g. browsing) come across some knowledge and present it to the Teacher, perhaps in order to impress or embarrass the Teacher. The actual document (e.g. a paper or even a book) might be unknown to the Teacher. Usually we expect a Teacher to be aware of his/her field of expertise also via informal channels. How much surprise does the newly shown document hold for him?

The value of lead-time could easily become negative in the sense that the Student is 'faster' than the Teacher and thus is able to 'surprise' the Teacher. Some of the conditions for avoiding this situation are:

- The Student is unable to acquire the document at all.
- The acquired document is so difficult to read/interpret that the Student 'gives up'.
- The Teacher is highly familiar with the environment from where the document comes has a good estimate of the document's content due to some already received informal channel.

If one analyzes the history of dissemination of knowledge, taking into account historically older communication means and carries (oral tradition, handwritten unique books, printed books camera ready produced books, e-mail and world wide web) one can depict the lead-time of the Teacher in comparison to the Student approximately as shown in fig. 11.

4.4 Verifiability and follow-up

Verifiability is related to the time it takes for an outsider (e.g. the Student) to verify the statement of the teacher. The Time-to-Regression has been identified and characterized in section 3.6. As it is shown there IC-technologies allows a much faster regression to knowledge. Verifiability, however, assumes that the document is either persistent or at least that changes can be retraced. In the case of Internet, this is not true, such that withWorld-WideWeb the Verification Ability is reduced (fig. 11).

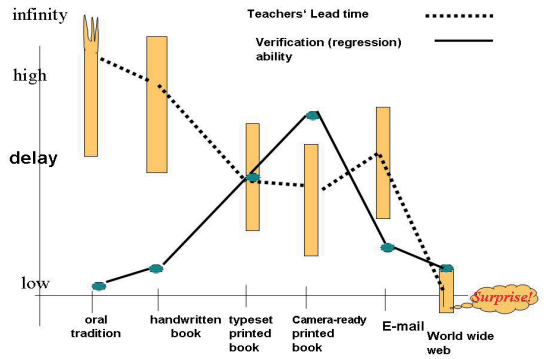

Fig. 11: Lead time and verifiability for various dissemination methods

5 Consequences of IC-technologies

The discussions in this paper allow several conclusions on some of the directions for the future.

dramatically reduced time to publication and to teaching: The reduction of these very important time spans has several reasons:

- Most obvious and also of high impact is the reduction of various transmission times to practically zero.
- The increased aura of the Originator allows more parallel work without (often expensive) physical copying.
- Many of the knowledge related processes, especially document processing, experience a certain speed-up due to more 'intelligent' tools.
- Search and browse processes are sped up by factors of magnitude.
- The ability to efficiently copy/duplicate documents also contributes to speeding up the processes, often (although not explicitly addressed here) the danger of plagiat (Kock 1999) and violation of copyrights.

Improved availability: Electronic libraries with electronic copies also of back issues considerably improve access to knowledge.

Improved verification potential: The global availability of electronic documents and the speedy access to them allows fast and efficient verification. The question of verification via regression could be handled by an electronic equivalent of a Library of Congress.

Lost Lead-time: With respect to academic teachers the problem of lost lead-time (students have documents in their hands faster than the Teachers (Chroust 2005)) requires more awareness of a Teacher and perhaps a more up-to-date awareness of developments in his/her field. One of the results could be that Teachers achieve a new understanding of their role : more mentors and moderators than classical teachers.

Unrestricted publication in the Internet:

- Submitters outside the established scientific community, not being bound into a network of peers, have a better chance to make their arguments, ideas public via the Internet.
- The flexibility and short-livedness of the Internet document base endanger the persistence of and thus the trust into the document archives in the Internet. This undermines the advantages gained by faster and better regression.
- The possibility of direct, unconstrained publishing endangers the quality and solidity of the educational processes and their documenting base, especially with respect to searching and browsing. The filtering mechanism which helped the Teacher to distinguish 'valid' from 'invalid' knowledge via publishers and selected peers is not applicable to the Internet.

6 Conclusion: Changes to academic education

The facts and trends indicated above force us to rethink some of the academic traditions established over centuries. Some changes are/will be:

from collector to hunter: The value of accumulating information will diminish in favour of a just-in-time hunt for the latest information on a given topic (Schneider 1996), abolishing 'shadow copies' in one's file cabinet.

from teacher to guide: Teachers have to guide and advise more and to lecture less. And they have to accept the sudden appearance of hitherto unknown information.

from believer in printed text to critical reader: The flexibility and the loss of some verifications mechanisms due to the unrestricted publishing capability of the Internet forces us to strengthen our criticality when acquiring documents especially from the Internet from stability to volatility :We will have to live with the fact that the information which we acquire from central sources will be unstable, volatile and often changed. Ways to ensure the permanence and authenticity of results once published have to be designed.

from territorial autonomy to global competition: Without globality a Teacher could establish his/her own terminological and conceptual system within his/her sphere of influence. Nowadays this is not possible anymore due to the permanent availability of documents on the Internet. Now the lack of a consistent terminology is felt very strongly and arises in many situations.

As one can see there are some dramatic changes to come to the academic world, many of them are already there but have not yet been fully understood or put into effect. There is still some work to do!

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