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THE EFFECTIVENESS OF ICT IN SCHOOLS:
CURRENT TRENDS AND FUTURE PROSPECTS

DISCUSSION PAPER

ICT and Educational Resource Policy

Walter F. Kugemann
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Looking back to more than thirty years of work in educational research, development and pilot implementation, I feel an unexperienced change of the frame for educational policies happening the last years. A very long period before education was a tool, an instrument to achieve other policies’ goals: increased national and regional competitiveness by a better educated/trained workforce; increased employability by a higher and more equal level of competences provided by educational institutions; education to promote entrepreneurship for broader groups, educational institutions as a core means to proliferate the cultural heritage of a nation to the next generation and by that to protect and even increase cultural identity; delivering literacy on all important cultural techniques to every citizen and so on and so on. Educational policies as a support tool for economic policies, labour market policies, structural and regional policies, cultural policies.

1.1 What changed the last years?

Let us take as an example European Union policies. While the Treaty of Rome excluded almost completely the field of education from the responsibility of the Union and therefore required pretty complicated auxiliary constructions to justify small fields of educational policies interventions by phrasings like “to support the European dimension” (see SOCRATES, ERASMUS), “foster European competitiveness in a globalising economy” (DELTA, LEONARDO), the Maastricht Treaty allocated the first time genuine European Union responsibilities in special fields of innovation (see ‘Open and Distance Learning’ in article 132) and finally the Amsterdam decisions, paved the way for a common European goal of ‘eLearning’, the first time defined as a first row element of policies within the overall frame of ‘eEurope’, on equal level like other policy goals e.g. ‘Social Inclusion’ and ‘Europe of Values’.

1.2 What changed by the new first line position for educational policies?

More than it seems on a first glance. While in the past educational policies were depending on the priorities given to the first line policy they had to serve: therefore education was out of the usual policies struggle on priorities and budget allocation - now educational policies became fully part of this struggle for priority and fights for budget share.

Secondly, no longer educational policy specialists decide on budget allocations for different subfields of the educational systems (e.g. emphasis on which type of schools, balance between budgets for traditional and newly founded universities, average size of classes, roles and budget allocation for public and private educational institutions etc.). Now “general policy makers” also decisions determine the policy space for education. From a rather outside view they allocate tasks, priorities and budgets to the educational systems, in direct competition with budgets e.g. for the labour market, economies support, social security and health care systems, defence and public security, structural and regional policies etc.

The intersection between educational policies and the role of ICT in education in future looks to be a forerunner of this shift from specialised to general policy making. Take the example of the first Clinton/Al Gore campaign, where the candidate for the presidency and specifically the candidate for vice-president promoted the programmatic goals for the educational systems (“Up to the year 2000 every classroom, every library, every hospital…” ) and not a shadow cabinet minister of education. The same happened e.g. in the UK in the Blair campaigns, when the designed and later elected Prime
Minister set the priorities on education. It also happened in the last French campaigns and in many other nations. Inside the European Union President Prodi as head of the commission itself highlighted the priority on eLearning for eEurope.

1.3 ‘Mature’ policy tools also for educational policy?

If this is true, general politicians increasingly have to take priority decisions by comparing and balancing policies like economy, labour market, family policies and so on and educational systems, they increasingly trend to apply comparable tools for those traditional first line policies to educational policies. What are these tools? Policy goals have to be defined by measurable outcomes (e.g. ‘unemployment rate less than x end of year y’; ‘economic growth will reach in the year x y %’; ’overall costs of the health system not more than y % of GDP’). Those definitions of goals include, those ‘measurable’ goals can be assessed afterwards and by that will indicate success or failure of a policy.

In principle this will allow to rate roughly a type of ‘policy cost-benefit-ratio’ by analysing, which amount of money was necessary to reach a comparable goal in economy, which in family policy, which for public health etc.

Consequences for the area covered by this report seem clear: if it is true educational policies are in the process of becoming equally important like other first line policies, politicians must be able to define also in that field goals with the same instruments of quantifiable results.

Those processes can be observed in a growing number of cases. A recent example using indicators for educational systems output is the Swedish policy, which had set the goal to increase the percentage of citizens with a university degree to 50 % of an age cohort. In general we can observe a relatively quick development from goals described in a rather qualitative way by selecting one of two controversial positions (e.g. supporting elites or equal opportunities for all) to quantitatively defined goals, which not only in the phase of policy definition (specifically in the phase of public policy assessment) precise assumptions on relation between resources necessary and/or provided for education and quantitative outcomes.
2 WHAT MEANS ‘ICT FOR EDUCATION’?

Not only out of a usual academic attitude, but also following that process of more candid definitions for policy elements, it seems necessary to give some thought to a more precise description of the three key elements of our theme: ‘ICT for education’; ‘educational resource’ and ‘educational policies’. To start with ‘ICT for education’:

2.1 Areas of definition

Analysing different sources and their (mostly implicit) assumptions, what means ICT for education, I would like to categorize: ‘Clear areas’, where almost all authors and papers share a common view what is included, even in detail; ‘blurred areas’, where on a very general level we seem to have something like a fuzzy consensus, but going into more detail strong differences become visible; ‘areas under explicit dispute’, which in some papers are included into educational ICT, excluded in others.

2.2 ‘Clear areas’

They are characterised by the mainstream ‘status quo’ of educational ICT we find in the public systems, especially in the school system: today’s PC’s, today’s notebooks (with reservations in some cases, see next paragraph), today’s operation systems (mostly Windows and Linux), today’s standard software (Office-bundle or equivalent), today’s Internet (or in practice sometimes only today’s WWW).

It is interesting these commonly agreed areas represent a widely spread, but from a technology point of view rather conservative settings (as a famous technicians saying quotes: “If it works, it is outdated”). It has to be discussed later, which limitations and problems may arise from the fact, indicators used for educational resource policies at the moment almost exclusively refer to this ‘smallest common denominator’ definition of ICT, which for sure will be partly outdated at the implementation time horizon, the respective policies addresses.

2.3 ‘Blurred areas’

These areas seem to me mostly populated by technological mature and mass production elements, which normally can be found more frequently in non-educational areas than in educational settings. This covers all the dissenses on the role of periphery (indispensable? necessary? desirable? nice to have? distracting the focus from education to other fields?). This area starts with the number and type of printers required (who needs e.g. colour printers, scanners of different types, burner - should schools really support software piracy - and mp3 download, beamer and other display devices and so on.

In many cases behind those discussions on the necessity/the inclusion or exclusion of specific pieces of ICT we find explicit (and even more frequently implicit) pedagogic assumptions. E.g. priority given to investment in beamers for every classroom is mostly based on a technology upgraded ‘chalk’n talk pedagogy’; high emphasis on scanners is based on a more constructivists view, where the individual learner by collecting material is assumed to support the building of own knowledge structures; printers are argued with more linear, knowledge accumulation concepts etc. From an international perspective
we would assume, priorities given to different types of ICT periphery in different countries would vary substantially following the well known national differences in mainstream pedagogical concepts.

These interdependencies seem somewhat less important for specialised areas of the educational system. The vocational education systems in general seem to adapt a policy to reconstruct the ICT environments actual in the occupational world inside the corresponding part of the educational system. For students in the constructing area for instance sketch-pads, three-dimensional input devices, large format scanners and plotters are mostly undisputed. General education trends to a sort of continuity from the old ‘paper and pencil paradigm’ to be assumed to stimulate cognition and fantasy into a similar ‘spartanic’ keyboard and screen only ‘philosophy’.

**Game consoles**

Despite of their high availability specifically at school age children theoretical discussions as well as practical use of game consoles in educational settings are astonishingly low. This seems to mirror a traditional dichotomy/contrast between education as something goal oriented, serious on one hand and leisure/entertainment as non-productive and therefore not really contributing to educational goals.

This contradiction frequently seen by educational professionalists also influences the evaluation of use for ICT equipment from the ‘clear areas’. As normal PCs by their increased multifunctionality in principle also offer a wide variety of options for entertainment and games, in not a few educational settings provision is taken to make those use impossible or to suppress it by special regulations (e.g. periodical search for ‘illegal’ game software on school PCs hard disks, websites with entertainment content blocked/filtered etc.).

Again the definition and discussion of game elements seems strongly influenced by pedagogical concepts, which emphasise e.g. learning by playing, game types of competition and small group cooperation, emphasis on skills like speed performance, strategic thinking, use of emotions in educational processes, while rather traditional pedagogic concept proponents like to exclude those types of use.

**‘Below notebooks’**

Interesting a group of ICT equipment with an obviously increasing market share only in few cases is discussed on a broader scale to be introduced in educational settings: the ‘below notebooks’ field with handhelds, palmtops, organizers and similar devices. While at the early development of those devices it could be argued with some proof functionalities had been too restricted to be of use in educational settings, this for sure is not longer true for most recent generation items, which offer the same level of functionalities an ordinary PC did some years ago.

They could be used e.g. for all types of outdoor observations, field research or field data collection, to take minutes, to organize learning including group activities etc. It would be interesting to investigate in depth the relation between the fact, those types of equipment are almost exclusively bought by the individual learner on her/his own expenses - and therefore vary to a high extent in their features and performance from student to student, not controllable by any educational authority. This seems to create the fear, the educational use of those (privately owned) devices could create a specific type of digital divide in educational settings, where students with a higher economic potential are privileged, those with a lower economic background handicapped, and no simple way seems in reach, how to balance this new divide in practical educational policy.

**‘Extended phones’**

Similar processes and interrelations between pedagogical models and the use of respective technical resources seem to apply for the relatively young, but quickly extending group of ‘extended phones’.
This means those mobile phones with information technology features, which reach from a middle level organiser to full functionalities of a PC, which are available since some years – only restricted by their smaller size of screen and their reduced keyboard facilities. As the ‘Nokia Communicator’ was one of the early items of that type, it seems interesting to have a look into the use of the ‘Communicator’ in educational settings. First: no mainstream use in a part of an educational system is known to me (even not in the Finnish school system), only a large number of pretty interesting and different experimental studies. Interesting also: almost of all of these studies concentrate on two fields: first occupational training/re-training/continuous education, specifically for target groups of learners with high mobility induced by their profession, secondly for university type post degree and continuing education, where field research and some elements of tele-cooperative teamwork near-to-research embedded learning settings is required.

To summarize: the ‘blurred areas’ described seem to be characterized mostly by a strong interdependence between specific pedagogic models and the inclusion/exclusion of specific types of those devices into the visions for tomorrow, research and pilot implementation programs and first ideas on mainstreaming in rather small and specialized/marginal fields of the educational systems (like bedside teaching in medical studies).

2.4 Areas under dispute

These areas are characterized by a normally high level of polarisation in the discussion. Out of quite different reasons (from technical quality and stability to pedagogical values/damages induced) the respective types of ICT equipment are seen in a central role for educational systems of tomorrow or denied.

Interactive digital TV

Maybe the most controversially discussed technology for educational use is really interactive digital television and its educational potential. Divergence in the argumentation seems to concentrate on two areas: The development perspective of really interactive digital television on one hand (with no or low additional costs for back channels/the users upstream flow of communication) compared to a view on digital television as only a slightly different technology to continue structures and the reception culture of well-known analog TV. Both include argumentations to the pedagogic potential or the limitations of a medium, which by the tradition of its use tends to be entertainment dominated, living-room based and therefore substantially different to formal education and learning as a type of ‘work’.

Depending on the interpretation of the existing educational system and its primary beneficiaries as well as the less favoured, this difference is either seen as a potential to reach new groups (‘learning distanced groups’, ‘school experience damaged parts of the population’) or as a danger to devaluate learning and to deviate the use of knowledge (e.g. the ‘who will become a millionaire’ use of general knowledge).

Examples for a mainstreamed use of interactive digital TV in educational settings are rather rare, because this needs a fairly advanced digital television infrastructure for a whole country. Therefore it seems quite logic, we find those few examples in areas with a well-advanced digital TV environment like in Italy and the UK: e.g. the RAISAT program in Italy in cooperation between the National Ministry of Education and the public broadcaster RAI, e.g. the Welsh educational digital interactive TV project in the UK. Those few examples have in common, most of the capacity of learning resources delivery is still uni-directional traditional TV accompanied by other media like the networked PC, print material. Only a part of those pilots use real integrated interactive TV services. The aim of those projects is mostly to lower access barriers for specific groups of learners (in both cases as well for learners in more dispersed regions as well as ‘distant to school’ groups).
Of course many other cases of educational digital television are reported, many of them with quite large audiences. But in almost all of these cases we find a almost complete unidirectional use of television. Following the obvious and striking vision to lower substantially entry barriers for educational systems for less favoured groups - specifically for ‘threshold economies’, countries with large distances and scattered audiences and those with a very quickly growing young population - plan intensively projects to implement interactive digital TV use in education (e.g. we find in the actual call for the Latin America-EU cooperation program @LIS a big number of respective project proposals for support programs, where interactive digital television is proposed as an educational resource with a high potential to serve scattered language minorities, populations in areas difficult to reach, economically and socially marginalized groups of the population in slums/favelas).

**Notebooks / portables**

While a certain limited percentage of portable computers in educational settings seems to be generally agreed, the exclusive or almost exclusive use of portable networked computers seems under high dispute. Different aims seem to be in the background, reaching from the vision, portable ICT equipment would generally shift the load of investment from public budgets to the private individual and respective policies like to supply all classrooms and lecture halls in universities with laptop sockets (like happened in some countries in South-East Asia) to ideas to ensure equal educational access and social inclusion by providing all students a notebook for free with identical features (like in some so called ‘demonstration projects’ of the German ‘Notebook University’ program and the announcement of German chancellor Schröder three years ago to supply each German school student up to year 2006 with a laptop - which had been dropped very soon because of a financial volume out of any reach for the Federal Government). Again these examples on the use of portables exemplify the strong relation between pedagogical and/or society concepts and the inclusion of a type of equipment ‘ICT for education’.

**‘Wearables’**

The concepts of ‘wearable’ ICT equipment can be found frequently within the long term perspective in most countries’ information societies development plans. Applied to the educational sector those visions seem to concentrate on two areas: early education, not only including primary schools, but also pre-school children (e.g. specifically addressed by the EU ESPRIT-long term basic research program ‘Innovative School Environments’) and for groups with special needs. Almost all of those ‘wearable’ devices under discussion for educational use are characterized by a close integration of I = information technology and C = communication features: wearable cameras should not only document the individual child’s daily life experience, but make it easy to share these experiences with others and to exchange on a more than verbal level by communicating these pictures in real time. In order to overcome spatial as well as time constraints most of these wearable devices planned combine storage capacity (and following time deferred playback) with online communication over distances of sound, written notices, drawings, still-pictures and sometimes even compressed videos.

The link between the visions on technology use and pedagogical visions seems especially obvious in this field of ‘wearables’. One element is constructivist’s individual and group learning even for very young children.

Another element is the ‘open classroom’ vision, means types of educational setting, which brings together much closer formal education and its institutions (‘the classroom’) and the educationally informal life environments of students (parents and relatives, leisure activities, aspects of citizenship, social and voluntary activities, NGO relations etc.)
‘Localized’ devices

As this group of equipment is under similarly quick development without a status absolutely clear to be predicted in several years, the distinction between ‘wearables’ and ‘localized’ devices will be not very sharp and most probably will come up with important areas of interface. Nevertheless different fields for educational use for those devices seem to emerge. Localized educational ICT normally trend to insert educational resources into a specific place outside an educational environment, which may support substantially (informal?) learning. But normally this is not predominantly made available for a formal learning purpose.

Typical examples: use of museums, galleries, collections, libraries as learning environments with the help of comments, complementing information, targeted communication with experts or peer learners over distance and hyperlink facilities for localized (and in most cases none mobile) objects (e.g. educational visits of a site from ‘Pompej excavations’ to a car manufacturers plants, from a historic itinerary through a special epoch in Kyoto to ecological food production).

At the very moment pilot implementations of those ‘external educational resource centres’ seem to be centred around and owned by one cluster of objects to be used in a formal or informal educational setting. Generally usable (means in different environments) localized devices are still a vision, because the huge challenge to standardize the necessary protocols and interfaces to make those devices really applicable throughout all types of those objects and clusters, results in a lot of development work still substantially ahead of us.

Another field, where research, pilot implementation and a regulatory framework have still to be developed are questions of responsibility, ownership and control over those learning opportunities. Will public budgets for those educational ICT devices go to the existing educational institutions like schools, universities, vocational training institutes or would they be under the responsibility of the respective clusters like historic sites, museums and collections, companies or industrial associations, regional authorities or (third possibility) would – like with the mobile phone model – the investment in those universal devices due to its ‘dual use’ also for e.g. tourism and leisure be expected to come from the individual, while only specific uses are subsidized e.g. by free telecommunication costs, when connecting to a museum, not if only trying to identify the next suitable ‘in-disco’.

Embedded systems

Technology development shows a strong trend to more and more devices in our every day’s environment equipped with more and more powerful ICT functionalities. Examples are the navigation systems of a modern car, the MP3 portable player, a fully digitalized able to communicate dish-washer or freezer of tomorrow, the house climatisation, smart homes of tomorrow for specific groups of inhabitants and many more.

Very soon those embedded ICT systems will offer to us technical features, which are equivalent to a networked PC some four or five years ago. There is no reason, why those embedded systems should not offer a potential for educational functionalities similar to those used in schools or universities by a PC in the mid-nineties.

The fascinating aspects of the educational use of those systems is on one hand the predictable big number of those different systems at our disposal in the near future (at least in the industrialized countries) as well as the substantially increased potential to integrate respective and targeted learning components into environments, which are characterized by those systems (e.g. a car navigation system, which after continuous analysis of a driver’s behaviour can offer personalized driving improvement training; a fridge which on demand supports me with consultancy on healthier cooking and eating behaviour, also considering seasonal availabilities and habits of different family members).
**Extended / cooperative settings**

The ICT devices addressed here group around different concepts of virtual reality environment for learning purposes. Those may allow us to explore environments, which otherwise are not accessible to us, because they are too small or too big (from e.g. walking through a cell touching and turning around a DNA to walking through the universe to sensumotorically experience distances in our solar system) and the dimension of the too slow and too fast processes to be experienced (from e.g. following the signal flow within a microprocessor to experiencing the continental drift).

Third dimension is to create virtually co-presence and co-operation between persons, which are physical at quite different places. This would include e.g. a students group cooperatively manipulating with data gloves molecular structures in a virtual environment to achieve special characteristics, while the group members are geographically far away. It can include a virtual conductor’s course linking a conductor’s ‘guru’ in America with a conductor students’ class in Northern Europe (as already practised by the Jan Sibelius Academy of Music in Helsinki). Characteristics of those virtual/cooperative ICT settings are their potential to overcome traditional didactic barriers by creating learning environments, which out of different reasons could not exist before.

The obviously huge variety of those educational ICT and the quite different qualitative and quantitative interlinks between those types of equipment, expected pedagogical outcomes and underlying concepts and values complicate things obviously. So we need some common structural approaches to facilitate argumentations and the dialogue on the usefulness and functionalities of those extended/cooperative resources today and in future.

2.5 **The ‘available technology paradigm’**

Especially from North America and from the UK we learned the last decade the pragmatic benefits of the ‘available technology’ approach for educational ICT. This also marks a paradigm shift away from the purely technology potential visions (as characterized by the visionary artificial intelligence discussion of the late eighties) to a more pragmatic educational reality and learning demand centred view. Considering the lessons we have learned since then I would like to specify this ‘available technology paradigm’ a bit more into different aspects: a technological one, an economic one, a social/societal one, a literacy one and at least a cultural one.

**Technological**

Technologically available means the respective devices and systems are not only existing in principle, but are also reliably to commission and to operate in a given environment. This usually includes local consultancy competences for specifying, selecting, buying and configurating equipment, service and maintenance capacities at acceptable response times, and so on.

Those requirements on the first glance seem to be trivial and easy available on a global scale. But in practice this is not true in many cases for educational ICT. E.g. school administrators, head teachers and teachers normally lack competences for all decisions necessary buying even state-of-the-art equipment in a way it works reliable. Network operators, postmasters, server responsibles in most educational settings worldwide are available e.g. on university level, not in schools and in a vocational training centre. Usually the local investment necessary to ensure those local technical services, is underestimated and not sufficiently budgeted. The latest, the famous Gartner study pointed out, maintenance, trouble shooting and operational support of office PC systems is more costly than the initial investment in hard- and software.

While similar specified studies for cost structures in different educational institutions still lack, we can take for granted, that the situation will be at least similar (maybe even worse) in environments like schools or vocational training institutions. E.g. in most countries in school some technophile teachers are motivated to take over those technical tasks instead of teaching. By their relative amateur status of
technical competences combined with normally higher salaries, than 'pure technicians', come up with support services compared to the companies’ world, which are substantially more expensive and less effective, means less economic.

Economic

‘Available technology’ from a economic point of view means the costs for the respective educational ICT (initial investment and operational) are affordable for those, who usually within that environment cover those types of costs. Who is that, differs quite substantially from one national educational heritage to another. In highly centralized countries (like e.g. France) ‘available’ therefore means available national funds to equip all schools and all universities over the whole country. In decentralized systems like in the US or Germany it means the respective public body (e.g. one state, one city, one county, one school board) has budgets available, which put the respective technology in reach.

Where traditions of public-private-partnerships and private sponsoring for educational institutions exist, the economic potential of the respective community of sponsors determines the ‘economic availability’. Where students and their parents are by tradition expected to contribute substantially to the costs of education, their economic potential is the limiting or promoting factor.

Again systematic studies are lacking. But there seems to be a certain evidence of an important relation between the level of decentralisation of educational investment decisions and the amount of educational ICT resources available in a country ora specific sector.

The many existing OECD studies allow no methodological rigid analysis, but if we can compare the ranking even by insufficient indicators on existing educational ICT with the described level of decentralisation of financial contributions to the educational system, we find a rather impressive interrelation.

This effect seems to be even augmented, if elements of competition between different decentralised financers come into the game. As case studies this can be identified e.g. for the competition between one state in Germany and another, one Spanish region with another, but also on competitions between rural schools and schools in agglomerations as in Denmark, competition between different language areas like in Belgium or Canada, competition between neighbourhoods as in the USA or partly in the UK.

A general finding seems the absolute dominating role of private investment over to public money. Again systematic and globally comparative studies are missing, because of all the problems with basic data, which will be described later. Nevertheless there is some sudden evidence. In Germany exists a survey for the year 1998 (see MESO) comparing the overall amount of public investment in computers in schools in this year and the investment estimated for parents and school students in ICT equipment. As a result roughly nine times as much money was invested by students and their parents compared to public investment. For teachers this ratio was even more extreme with their investment in the magnitude of thirty times as big as the public one for ICT equipment for this group (which can easily be explained by the relatively high level of payment of German teachers combined with comfortable tax deduction possibilities for investment into work related tools, which do not exist similarly for students and parents). Analysis of investment in the university sector showed a substantially higher percentage of public investment, but in absolute figures again a higher over all investment by the university students compared to public money. Maybe his can also be explained by rather comfortable ways for university students or their parents to reduce taxes by those investments compared with the school students. Here the ratio was about 1 : 4.5.

Even if these findings are not completely representative for other countries we nevertheless can assume, the by far biggest part of investment decisions for educational ICT is taken by the end user. It is quite feasible, educational resource policies which create value added for private investment (e.g. by
tax reduction) might in average be substantially more cost effective than direct investment in purchasing equipment). This seems true for the field we called ‘clear areas’. The private investment dominance is even higher in the ‘blurred areas’ and in most ‘areas under dispute’. As an extreme example is the investment into mobile phones, which is made almost 100% private.

**Social/Societal**

The ‘social availability’ of a technology may correlate with some economic factors, but has its own independent characteristics. Factors like gender, age, educational level and area of residence are well-known differentiating factors. The best known example is the still quite unequal penetration of internet use. Here we find quite different profiles for young men with a high educational level in agglomerations compared to older women with a low educational level in remote regions.

With respect to the just reported fact, private investment decisions dominate absolutely the overall investment in educational ICT, those strong differences in the ‘social/societal availability’ may cause problems to educational policies, especially the more those policies highlight the goal to provide access for all. Educational policy has two different strategic approaches to avoid that effect: a) either to exclude the use of privately invested ICT equipment from formal education or b) to set up a big and costly grant program, where groups are benefitting gradually equivalent to the extent, economic and social factors limit equal access/equal chances for them in the respective educational sector.

Those sophisticated grant programs - therefore pretty complicated to decide and to administer - up to now mostly are set up on very small scales and experimentally. Most experiences exist with rental programs on university level for notebooks. At the moment no really solid assessment studies for those programs exist, namely because the size and therefore the number of beneficiaries in the different projects had turned out to be very low at the end of the day. There is small indication those grants usually are not as targeted as wished. The frequently reported impression is, a reasonable part of those grants is used by students, which are able to provide formal evidence of their limitations, but would not really need those grants while others, which out of social reasons are less favoured, seem also to be disadvantaged in their competences to access grants and to fulfill the whole application procedure.

**Literacy**

Since more than ten years studies in the business environment as well as from the private area confirm continuously, a reasonable percentage of existing ICT equipment is not used at all and the majority is used far below its technology potential. We can take for granted, the same is true for the use of educational ICT. Specifically in countries with a relatively good level of educational ICT penetrations in schools increasingly a under-use or no-use of parts of this equipment is reported. Reason might be manifold. Groups of buyers initially are motivated by the technical fascination of some features of equipment, but discover in every day’s practice an obvious lack of real need. This seems to coincide with the critical transition from the necessary first phase of educational ICT use, when the handling of a machine and the exploration of the technical features is dominating to a second phase of maturity, when educational ICT is safely mastered and has to turn to the function of a tool supporting learning processes.

Under the phrase “From learn to use to use to learn” the Dutch educational authorities at the moment try to promote actively - and by that to improve substantially - the transition from the first to the second phase. Because there is more and more evidence of teachers and students to stop before this threshold and never enter the real potential of educational ICT to improve and innovate pedagogical and learning processes itself.

As described, wrong expectations, not realistically assumed demand and other motivational factors influence this no- and under-use. In addition – and maybe as the most important factor – a substantial
lack of ICT literacy is contributing to that under-use of existing infrastructures as well as to a lack of motivation, to invest in new and additional equipment.

To be more correct, instead of one literacy we have to think in terms of a bundle of literacies, which not only covers aspects like familiarity with standard software competences to use standard features of a browser, but also competences like finding problem solving strategies for lower level technical problems, strategies to find in a self-guided way on quickly to access a piece of new software, basic competences in selecting and buying equipment, basic search strategies, strategies to optimise procedures by exploiting the potential of the accessible ICT and - not to forget - the experience, how to effectively manage self-learning with the help of ICT resources.

Specifically for the importance of the last element we find an increasing number of empirical evidence. University students using virtual university offers across different countries come overproportionally from groups, which in the same or a different institutional frame have already experienced another form of eLearning. In addition those students with prior eLearning experience report to benefit more from that type of learning compared to students with their first respective experience.

Therefore the availability of technologies based on the respective competences and literacies of the user is a specifically important element, because of that described ‘servo-effect’. For a longer period those who are privileged early in their educational career to learn to handle traditional teaching as well as eLearning (‘dual learning literacy’) will be privileged in the following learning career compared to those, which did not acquire eLearning competences. This seems to be an important mechanism of the ‘educational digital divide’, to which educational resource policies will be increasingly confronted in the future.

Cultural

Also cultural factors affect the subjective availability of technology. Most studies existing come from environment, where people from different easy-to-identify cultural groups use the same educational institutions (e.g. the native population with different ethnic minorities, migrants, refugees). Again studies about the differences in internet use are the most sophisticated on that theme. They give us insight in those mechanisms, where e.g. on the basis of strong cultural differences internet use in the USA is still quite different for white, afro-, Hispano- and East-Asian-Americans. We see quite similar findings when comparing different origin refugee communities e.g. in Germany, France or the UK.

An interesting type of large scale ‘field experiment’ just started with the beginning of the integration process of the ‘candidate countries’ into the European Union. Striking is here the example of Estonia, where by characteristics of their cultural heritage and their historic relations to Finland this country by its educational culture obviously promotes successfully a very quick uptake of ICT use in general and in the educational system, in particular compared e.g. to candidate countries with a much lower emphasis on educational innovation embedded in a culture like in Slovakia. This seems to be mirrored in differences found in country analyses of comparative studies e.g. on ICT use by university students (SPOT+ project, in progress, first results available soon). Especially for educational resource policies in areas with important multi-cultural elements these obvious differences in ‘cultural availability’ need much deeper consideration, especially if the political goal of equal educational access for all is taken serious.

2.6 ‘Available technology’ and time horizons

One characteristic of the concept of ‘available technology’ is a strong dependency on developments, which specifically in technological aspects trend to change in time cycles, we do not know from other policy areas. The technical life cycle e.g. of today’s standard PCs is near to three years. Prices for comparable performance are often cut by one third or more over one year. In consequence what is
‘available technology’ in one or two years time - which are normal periods for policies from definition and consensus processes to its implementation - changes substantially.

Therefore at least the technological and economical aspect of ‘available technology’ have characteristics of ‘moving targets’ for policy decisions. It is interesting to compare those time horizons and life cycles between the different areas. If for instance in the social domain we observe how the percentage of internet female users develop compared to the originally dominating male, we can observe major changes within time spans over four to five years.

An interesting example we find in some highly industrialized regions is the impact of targeted policies to support internet user for the group of senior female citizens (a pretty important group for society, because of the very significant demographic dominance of women in the older age groups and the societal as well as economic importance of the percentage of them, able to master their life independently compared to those, who need resource-demanding special ambulant or hospitalised care). Examples from parts of the US and Canada, from Scandinavia, the Netherlands, Germany and some other countries demonstrate, a period of around five years may change dramatically the social distribution of internet use. In most cases when supported properly by a respective targeted policy senior women use of the communication features (especially e-mail) even trends to exceed soon and sustainable the respective use in the comparable male population.

Again systematic studies with a sound methodology are mostly lacking. But there is first evidence, the duration of life cycles of societies attitudes towards ICT in general and educational ICT in particular is also valid for other groups in society. Interesting seems the comparison to time horizons and ‘life cycles’ of literacy development in specific segments of a society. Inclusive strategies to promote for instance educational ICT literacy in all important aspects needs a series of consecutive steps: from awareness raising over curriculum development and access to those respective target groups, periods of train-the-trainers to the competence building process itself.

Again not based on sound and comparable studies, but with sufficient case study evidence from different environments we may hypothesise, a literacy building life cycle is longer than life cycles of the underlying social motivation processes.

Only as a side remark: this hypothesised different time horizons for technology and literacy life cycles seem to contribute substantially to an actual economic problem of ICT: The demand is no longer strictly following the availability defined by technology developments or even by prices, but is slowed down by the (slower) speed of respective literacy and competence growths. This would explain partly the substantially slowed down buying and investment behaviour of citizens in the traditional PC sector the last years.

The situation concerning the cultural dimension seems less clear. More qualitative evidence makes two different types of processes plausible: Some cultural groups in societies trend to resist to a remarkable extend innovation processes dominated by ICT mainstream use. This might explain the slowing down growths rates e.g. of internet use penetration in highly developed countries, when this penetration goes remarkably over the 50% line.

On the other hand we know examples of cultural compartments within areas or nations, which adapt to ICT use with a very high speed, even under not completely favourable conditions as we see for example in the development in many parts of China, some regions and sub-cultural settings in Latin-America and in Eastern Europe. Maybe we could hypothesise, specific cultures may have a much bigger predisposition of adapting to technology innovation than others, which seem more resisting. Probably very general values with a long historical tradition may form those different backgrounds. But unfortunately up to now clear indicators for the development speed in different cultural compartments of different societies are missing. Therefore the necessary research to identify more in detail those different speeds of development and to identify the culturally based background aspects of those differences are still and important task to be addressed.
2.7 'Available technology' and indicators

Regarding the whole span of educational ICT described above we quickly find a rather poor supply of actual and comparable indicators which differentiate sufficiently the exact situation of availability of respective technology devices within the different compartments of society. Availability of continuous data over longer timelines in order to detect and to compare developments within the respective compartments of societies is poor.

Just to name core problem areas: Mostly no commonly agreed and sustainable definitions for specific educational ICT devices are used. Even in the broad and ‘traditional’ areas, consensus and standardisation of terms and definitions is lacking. Even what is regarded as an ‘educational use PC’ varies substantially; not only between nations but also between different areas of the educational systems (what appears in statistics as a ‘PC in school’ is mostly differently defined to what is identified as a ‘PC in university environments’).

In addition – and obviously based on the quick technology life cycles here – the definition, what is for instance an ‘educational multimedia PC’ changes from year to year of data collection, so that it is the absolute exception, when indicators collected in one country in spring of a year might be comparable to the data in same country collected in autumn the following year. At the same time they may differ substantially from the definition, under within a neighbour country collects its dates some months later. So we may not only be wrong, if we compare the development across countries at one given year of reference. We are also mostly unable to compare developments between countries, because definitions are lacking necessary for homogenisation processes.

For economic data like e.g. the inflation rate we are aware, which enormous efforts are necessary in methodology and permanent consensus building to keep data comparable within a country, between countries and in their changes over time. The task to generate indicators of comparable quality for educational ICT may require comparable efforts, where at the moment obviously the institutions, the methodology and the sustainable resources to organize and carry out that work are lacking.

2.8 Educational ICT indicators life cycles

Another complication has to be discussed: how indicators on educational ICT trend to change their meaning and significance over their life cycle. Take the example of an indicator ‘percentage of schools connected to the internet’. In initial phases of development this might be an indicator summarizing in a very valid way a multiplicity of complex and difficult innovation processes on local level, when it is very complicated to organise pioneering internet access for a school community. The educational innovation potential of a country which may reach in such a initial phase 3% of schools connected compared to another country, which only reached 0.3%, may be pretty indicative.

Utilising exactly the same indicator some years later when many countries report a 100% connectivity of their schools eliminates the validity of such an indicator almost completely, because it does not mean, different countries both reporting 100% coverage are equally progressed and may have a comparable level of use of communication functionalities in their educational system. The indicator ‘schools connected’ can range in its meaning from ‘school administration has a computer exchange messages with the ministry’ to ‘almost every student in the majority of subjects at least once a week is learning with the help of online functionalities’.

Therefore, we can identify limited life spans of most technology resource indicators, which in addition within their limited life span trend to change their meaning. Before getting frustrated about that amount of complications originating from the rather simple initial question of ‘what means educational ICT’, let us analyse the next component of our scheme:
3 WHAT MEANS ‘EDUCATIONAL RESOURCE’?

In order to analyse this field we need a minimal and most general educational model. A rather broadly agreed categorisation identifies ‘information and presentation resources’; ‘communication and cooperation resources’ and ‘learning process management resources’.

3.1 Information and presentation resources

New information is generated at quite different places in society. This ranges from creative processes in culture over the scientific processes to generate new knowledge to innovative practice in application areas like the workplace or even leisure time or voluntary activities of citizens.

Broadly we can distinguish those informations, which are stored in all types of media (and therefore available, accumulated over time) and those linked to persons (and which therefore only can be accessed by accessing the respective person).

In former days the media available to store the ‘knowledge heritage’ of a society was rather restricted. Proliferation of information was almost inclusively linked to print techniques (from writing to drawings, maps, pictures, notes etc.). Information stored in other media, objects and artefacts could be duplicated only with many difficulties and high costs. To organise access to those ‘unicates’ for educational purposes mostly meant to reduce them into a print format. From an educational perspective the key-characteristics of the transition from print age to the digital age is the aspect to generate easily and cheaply ‘multimedia copies’ of an increasing variety of representations.

From ‘schoolbooks’ to ‘dual use media objects’.

Important from an educational resource perspective: the ‘print reduction’ of the information heritage of a society promoted a development, where print products were mostly developed specifically for educational system use compared with other use in society.

To teach e.g. school students core elements of the literature of a nation, schoolbooks had to be compiled and printed containing a special selection of pieces of the respective literature for school use. This schoolbook production was completely different to the book production sold to citizens. That type of distinction between ‘schoolbooks’ and ‘non-schoolbooks’ trends to disappear more and more under the influence of the digital revolution. The practical example: the European transnational cultural and entertainment television channel ‘ARTE’ over the last years developed a specific strategy for ‘dual use’ of its television productions. Since some years specifically the news programs are accompanied by an internet service for teachers and schools, which deliver pedagogic use metadata for normal news material like explanations, indicators of language difficulties, support for pedagogic embedding and use etc. In that way the separation between an entertainment TV chain and educational television is overcome by a concept of multi-purpose availability.

From ‘educational characteristics’ to ‘educational use’

While ‘educational resource’ was characterized in the past by the aim to use it in an educational environment when planned and produced, the definition of an ‘educational resource’ now cannot longer stay with reference to characteristics to that resource, but only referring to its use. At the
moment any information resource is really used for educational purposes, it becomes functionally an “educational resource”. It may exaggerate only a bit, if we state we are in a quick development, where almost every information resource of a society becomes a potential ‘educational resource’. If this interpretation is true, the scope of ‘educational resources’ may vary depending on particular characteristics of an educational environment, specifically its capacity to support the integration of originally not as pedagogical intended resources by an individual learner or a group of learners.

It seems useful to develop a classification of educational environments following a dimension of ‘rather closeness’ in terms of the educational resources allocated by definition to that environment on one hand up to the other extreme of complete openness, when an educational environment shifts into the role of a highly supportive and assisting general ‘search engine’ for learners.

From ‘closed’ to ‘open’ knowledge policies

To which extent policies dealing with ‘educational resources’ is a specified ‘closed’ area or only one aspect of more general ‘society’s knowledge resource policies’ is defined by general targets for policies and the consensual concepts of a society, how to deal with its knowledge heritage. It is interesting to discuss to which extent we follow even within nations and societies a process, which we can observe specifically in big companies: the integration of different compartments and functionalities of an enterprise into a multi-functional knowledge management system. From that point of view the educational systems of a society are no longer a separate entity from other systems of the society, but may be one contributor and user amongst others of a society’s knowledge management. It seems a likely hypothesis, the educational systems will be by far the most important contributors and users of a society’s knowledge management system. But even accepting this dominant role, the development described needs a new definition of roles and relations between the educational institutions on one hand and other cultural actors (from theatres to libraries, from museums to archaeological sites, from local history sources to popular customs, also including the whole range of mass media from daily newspapers to television). It would be interesting to discuss, to which extent we are at the beginning of a convergence process from separated fields resource policies like education, culture and mass media to a more integrated ‘knowledge policy’.

Policy in that case would only follow a development, we can observe in the internet, where information can be searched following content denominators rather than specific groups of use. As an example: to learn about ‘art deco furniture’ searching in the Internet, one may combine information coming from museums and collections, from encyclopaedia, from scientific research papers and from side informations arising from art auctions on the net and even including the design furniture area of ‘ebay’.

From ‘only teachers’ to ‘also teachers’

A similar shift from ,educational use as a purpose’ to ,educational use as a function’ we described for media stored information and knowledge can be observed for person stored knowledge in a society. In a traditional education system one professional group of persons formed the exclusive knowledge source for students: the teachers/trainers. Since long we observe specifically in vocational continuing education (with emphasis on big companies in-house activities) a trend to complement full time professional trainers by part time or occasional trainers, where by training converts from a profession in a temporary role. While traditional educational environments like schools, universities or vocational training institutions still keep the dominance of a dedicated teacher/trainer as the interface between personalized knowledge and the student, the shift to learning support as a bundle of roles becomes more obvious in the Internet. A typical newsgroup illustrates: people may put the question to a unlimited and mostly anonymous community of persons, those who feel able to give an answer may take temporarily the role of a teaching person and in the next moment may appear in the same virtual community as a learner with a specific question to the others. In those virtual learning communities the shift to a functional definition of an ,educational resource person’ becomes obvious. Of course the
exclusive professional roles will not disappear: the tutor may stay identifiable as a tutor, but not necessarily she/he has to stay a full time tutor. That role could be defined for one particular virtual community while the same person could be a domain expert in another community and a learner in a third one. In this way everybody in a society, who owns some specific and demanded knowledge, becomes a potential educational resource.

3.2 Communication and cooperation resources

The above said on information and knowledge resources implies, the whole media based as well as person bound knowledge heritage of a society becomes a potential educational resource. Its impact for education is limited to the extend, this existing knowledge can be made available when required. This concept of ‘availability’ can in that way also be defined as a type of ‘connectivity’. All information, all knowledge of a society which will be entered into a network accessible format will immediately reach a much higher level of educational availability. In that sense one basic aim of educational resource policies has to be, how to make most effectively the different compartments of a societies knowledge ‘network available’.

Stays the next step from accessibility in principle to the real use in a communication between a real individual learner and a source, which is useful for this learners learning and competence building goals. In that way we progress from the potential to real use.

A distinction between processes of educational communication and educational co-operation seems useful, as the first one mostly describes the interchange processes between one individual and her/his aims and an educational resource (be it media bound or personal bound), while cooperation means the active interchange of more than two actors oriented towards common goals. For cooperation it seems not immediately necessary to predefine the relation of the number of actors on the resource and on the learning side. This makes specifically sense, if there is evidence that in many cases participants in a cooperative process may change their role frequently between an knowledge demander and a knowledge supplier. For educational communication and educational cooperation we can as already described distinguish between the potential resources (means all, which in principal fulfils the requirement) and getting and staying in interactive contact and before the real use.

It would be interesting to discuss this relation between a society’s potential of educational resources on one hand and the real use of these resources as a type of indicator of ‘educational productivity’ of a society.

Another interesting aspect would be to develop concepts, on how to define and measure the relation between the overall amount of learning, of educational resources accessible and the use of educational resources. In this way defining something like export and import of knowledge between societies and cultures and studying conditions as well as effects of balances and dysbalances between countries and regions.

3.3 Educational management environments

As we can derive easily from the argumentation above, by the use of digital networks a society’s knowledge base, which potentially is accessible for educational purposes turns quickly to become of an enormous size. The productivity of the educational system therefore depends centrally on the quality of links between these potential resources and their actual use. Learner support and educational environment management systems will play therefore an increasingly important role, because they centrally will influence the different levels of intensity, to which the accessible educational resources can be exploited in average within a society.

Those management and support systems itself become increasingly a resource for educational policy: How to create them in a target and effective way? How to convert elements of the traditional educational system into effective elements of those support and management components? Which
types of change are necessary? And how strategically to support best and quickest those transition processes. Take the example of the existing conglomerate of roles and competences, which forms the existing professional profile of teachers. The necessity of a basic change of their professional profile is commonly agreed. But what to do exactly to support this change process effectively? All agree, the teacher of tomorrow has to fill predominantly the role of a moderator, a facilitator, an individual learning path supporter. But from which existing competences to derive those new ones? Where teacher training and retraining has to create new competences completely from scratch? And where we have ‘only’ to redirect and/or to reinforce competences which already exist may be in another embedding or with lower priority to be properly applied in a new educational management environment?

The persons supporting and improving the learning management processes are only one part of that type of resources. Another big area of obviously growing importance are so called ‘educational meta-data’, which describe potential educational resources in a way, it facilitates substantially the targeted search for specific knowledge and for specific rooms communicate/corporate on the base of that knowledge.

Meta-data promotion policies - from educational repositories to standardisation - therefore is a field for educational resource policy of increasing importance. This is mirrored in a quick development of money and programmes made available in many different states for that purpose, observable very explicit in the European Union when following the discussion and definition process of the just starting 6th Framework programme.

To sum up: The meaning of ‘educational resource’ is characterized by an obvious and still up-speeding process of a conversion from ‘dedicated educational resources’ to ‘functional educational resources’, which not only broaden the potential for educational systems and learning in general - including concepts of lifelong learning - but at the same time of course complicate the definition of educational policies.
For educational policy assessment observatories the last years a certain standard has established dividing the field into: ‘Policies supporting the supply side’; ‘policies supporting the demand’; ‘policies supporting infrastructures and the general availability of resource access’.

4.1 Supporting supply

Starting problem of educational ICT policies over the last decades always had been a lack of maturity of markets and therefore market mechanisms. Perspectives, visions and isolated pilot implementations contrasted reasonably to the progress in mainstreaming those findings into the educational systems as a whole, because key requirements for a self sustaining and even self growing market lacked.

These deficits were mostly of a ‘chicken-and-egg’ nature. Supply of appropriate technology access, content and support systems was not sufficient to reach critical mass or not sufficiently visible to do so. Therefore the demand rested a potential, it could not articulate in real demand in choice situations. Demand did not articulate sufficiently in user decisions to invest in educational ICT, because the supply did not seem appropriate, broad enough to allow comparisons and to develop momentum for forward pushing competition. This caused a lack of investment potential into the supply, which limited the development of the demand and so on.

Faced to this situation, most educational ICT policies started by concentrating on seed money to trigger own dynamics on the supply side. Grants were and are given to develop content, to develop models of innovative learning offers, to pilot test e-learning solutions and to disseminate these results or to raise awareness as a pre-phase of a self development process of demand.

Within those supply supporting policies we can further distinguish strategic approaches and operational ones. ‘Strategic’ means to create by policy decisions favourable conditions, which make it relatively more attractive for potential market actors to set priorities in this area compared to others. Those strategic policy measures are for instance public platforms, to raise awareness for pioneering suppliers like organising events, congresses, awards, supporting public relation, launching national programmes with broad public attention. This type of decisions creating more favourable conditions are contrasted to measures of direct operational subsidies for specific work like the famous French multimedia content programmes of the late eightieth and early ninetieth, the British Open Learning programmes, and as a very late example the big German ‘New Media in Education’-programme, which utilised additional money coming from the UMTS licences to boost the supply development with an overall amount of about 300 million €.

While all types of actors will potentially benefit from strategic measures to strengthen supply and therefore feel supported, by the case of operational support those policies after a first round of initial success are in danger to damage sustainable development, because they discourage systematically private investment. Content, which is developed using public money is normally ask to be supplied to the educational systems for free. Those zero-cost supply (or even supply with subventioned, unrealistic low costs for the end customer) spoil the market, because actors investing own money due to the low revenue level of such a subsidised markets will not have any chance to get a return on investment.

In many cases in that way a emerging market became unintended state money dependent and therefore could not develop its potential for autonomous growth necessary to become mainstream.
Again this is not proven by very systematic and methodologically rigorous studies, but rather by the evidence of observatories and case studies. As an example the European observatory project ‘L-change’ supported by DG INFSO on the basis of a global survey could identify profitable markets in e-learning the last years almost exclusively in vocational continuing education, specifically for larger companies’ in house-training (which at the same time seems to be the area, where public money for the development of supply is rather rare), while almost all investors addressing the publicly financed parts of the educational system (like schools) lost substantial amounts of money, specifically due to too low market prices.

4.2 Supporting demand

Public policies to support supply naturally should be complemented in a balanced way by support policies for the demand side. Nevertheless this simple principle seems not to be applied in the majority of cases. Where a explicit demand support policy could be identified, the observable impact was pretty positive.

Also here we may distinguish strategic oriented policies and operational oriented ones. Strategic ones may improve the situation for the end user, for instance by creating favourable conditions to deduce such costs from taxes, by setting up regulations which allow the allocation of existing budgets for learning resources also to ICT-based ones and similar. Those strategic demand supporting policies are not so frequently found. Nevertheless there exist examples of reasonable importance. One example may be the policy shift, which was a made in the German labour market support policy field between the year 1997 and 1998, when the general labour market qualification funds in Germany (at that time in a magnitude of more than 8 billion € a year) the first time were opened also to ICT-based learning, which up to that time was not allowed to be publicly funded. The funding regime of German labour market policy is based on the financial support to the individual learner, which in an imagined mature market could make a choice itself. This does not work completely in that way in practice, but in principle this is a clear policy to subvention the demand side. The strategic element of that shift from the so called ‘AFG’ (Arbeitsförderungsgesetz) up to the end of ’97 to the so called ‘SGB III’ (Sozialgesetzbuch III) from ‘98 on was an equal treatment of traditional forms of teaching and training with innovative ones.

The effects, which could be observed up to now are interesting. The existing big actors of traditional presence training and re-training were expected to immediately start to invest also in parallel offers of e-learning in their fields of competence. This intended and expected effect did not happen. This seems to be based on the following: the traditional sources of revenue continued to exist. Without any change of their business policy the respective actors could continue not taking new risks by new ways of operation, which they were not at all familiar (for instance entering an investment logic, where up to now they only organised on-demand service provision, entering benefits as well as risks of economy-of-scale effects, entering unknown areas like taking risky development decisions, organising larger scale project work etc.).

Examples of operational policies to support the demand are a bit more frequent, like for instance the famous programme of the UK government, which some years ago allocated specific budgets to schools to purchase educational software on CD-ROMs, with the only condition, those software titles were listed in a quality control list of the Ministry.

4.3 Supporting infrastructures

At the beginning of targeted educational ICT policies most policy makers saw the initial block of the ‘chicken-and-egg’ spiral in the absence of specific infrastructures like the total absence of computers in most schools or non-existing (or only at non affordable costs existing) private networks to set up internet connectivity.
**Hardware**

These two different lines characterise important types of policy actions: On one hand programmes to supply educational institutions with sufficient numbers of computers (whatever sufficient numbers mean). First programmes of that type were launched in the US mainly on the initiative of important hardware suppliers of these days (the respective ‘electronic schoolhouse’ programmes of IBM and comparable ones of Apple), where the concept of freely accessible computer pools for learners was developed and tested. Afterwards different types of policy implementation developed, most of them including models of public-private-partnership to quickly supply big numbers of educational institutions with respective hard-(and soft-)ware.

These policies the first time culminated in the Al Gore programmatic goal “Up to the year 2000 every classroom ….”. It would be interesting to analyse, why in almost all cases known those programmes to support the computing infrastructures (for schools, universities, vocational training institutions) build on the principle of sponsorship and public-private-partnerships are all using the same elements in different proportions: Hardware providers, software providers, regional and local volunteers with special emphasis to local economy, parents, students, own contributions of learners and public money out of specific short term programmes almost completely outside the regular budgets for the respective educational institutions. In contrast regular long term public budgets to sustainably finance initial investment as well as maintenance, operational costs and periodic updating investment for new equipment are practically not found for those purposes.

**Networking**

It seems interesting the infrastructure support policy for communication technologies = the network side developed structurally in a different way. Practically all nations of importance developed early and with high priority plans to build up educational networks, usually with the academic research networks as the core element. In the majority of cases schools and other educational institutions had been allowed/encouraged to co-use these originally research networks. Different to the hard- and software supply those networks were almost completely financed by public money without substantial contributions from sponsors.

**Technical supporters**

As a third important element of supporting resources competences for persons to build up and maintaining those infrastructures can be identified. A special case is the interesting development in schools. For the school sector almost all countries started with the assumption, the existing professional teachers must be qualified to take over all work necessary to set up and maintain the technical infrastructures (from training programmes for specialised ‘system administrators’ out of the teaching staff over regional support and consultancy centres for teachers to benefits for those ‘ICT-teachers’ like a reduction of their teaching load etc.).

It took a number of years of implementation of those policies to discover independently in many countries the rather negative side effects and the counterproductive outcomes of those policies. As a core finding, professional teachers need reasonable investment to generate competences sufficient to take over tasks of system-administrators and other technical functions, which are outside the normal professional scope of a teacher.

Based on time constraints of teachers and limitations of the resources available for this additional training, the resulting qualification of those types of specialised teachers always remains on a more or less advanced ‘amateur-status’, always less actual, less profound and therefore less professional compared to from-scratch technology resource specialist like network specialists, computer network configurators etc.
On the other hand at least in most of the more developed countries the salaries and overall costs of teachers are higher than those of technicians able to cover the respective technical support work. In consequence the respective policies to generate the support personal out of the existing teaching staff turned out to be in almost all cases more expensive than comparable solutions to outsource those services to competences available on the market, combined with a substantial lower level of professionalisation and effectiveness in most of the cases.

While these findings came increasingly clearer in quite different educational settings, quick policy reactions can less frequently be found. An early example of an adequate reaction are the American programmes to recruit ICT professionals from outside to volunteer with these services in schools (like the retired telecom professionals schemes in parts of the US in cooperation between public school bodies and the trade unions).

One unintended side effect needs to be mentioned again: In most cases there seems to exist a potential of teachers, which are more attracted and motivated by dealing with technology compared with their in principle genuine task to teach real students. Across cultures especially specific type of male teachers in subjects like mathematics, physics or computer science trend to those ‘escapism’ strategies to shift from boring work with nasty students to a technology feature fascinated ‘do-it-yourself’ attitude to set up and the continuously improve networks, where by in not a few cases the students as users and pedagogical resource functions of the school networks as the ultimate goal of all technology get out of the view.

Systematic research is missing, what are the costs of those infrastructure support policies compared to the benefits and which can tentatively prove the presumable negative balance of efforts and effects. Sound finding here would be very helpful to allow policy makers to re-adjust their policy quicker than in the past in fields where negative developments become obvious.

4.4 Educational policy levels

Speaking about ‘educational policy’ is to short, when we do not go in detail on the different levels, on while those political decisions are taken: from the allocated pre-running processes of priority definitions and consensus building to the following rounds of implementation and assessment. Educational systems are characterized specifically by a deep hierarchy of those levels.

It starts with a global level which increasingly be comes important as a source of orientation and of more or less systematic comparisons or ‘embryonic benchmarking’ comparing to other countries. We also find increasing importance for a ‘continental level’ like the European Union policy on Europe exemplifies. The national level still is the most important for countries with a strictly centralistic educational system (like France). Regional levels seems to grow in importance worldwide, where we frequently observe a downward shift of responsibilities from central national authorities to regional ones (e.g. to the French regions, in the UK with the growing importance of regional authorities in Scotland, Wales and Northern Irelands and specifically in countries like the US, Canada or Germany, where the states deduce important elements of their identity from their responsibilities for the educational systems). Cities and communities as a educational policy level also gaining importance because of their closer links to the different groups (e.g. relation between schools and local industry) and of the more evident and more direct participation of citizens in all educational policy processes.

Across all of these geographic levels, we identify a level of sectoral policies, which naturally can be foremost found in vocational training and continuing education (e.g. initiatives and policies in the automotive industry, for the chemical and pharmaceutical industry, for financial services etc.). At least we have to consider policies on the level of important pre-scriber groups like single companies, chambers of commerce or their national associations, parents organisations (some of them we probably could identify as the ‘NGOs’ of educational policies). As a last level we can see single schools and school boards as an educational policy level as far as they have real policy decision
power, but if so, with quickly increasing importance (e.g. when they use educational ICT policies to profile in regional/local competition).

As described we can see a shift of the relative importance of those levels. But in total we are confronted with a development - on the first glance paradox - most of these levels grow in the importance. What is the explanation behind? We can observe obvious developments from mono-level, pure top-down policy decision processes (the classical National Ministry of Education) to more combined and level interacting solutions. Some actual examples they may be not directly intended, but impressive in their dynamics. Take the enormously strong interaction between the global level addressed by the OECD-PISA study and the immediate impact on regional state educational policies in Germany with the pre-dominant element of using the global references as a platform for neighbourhood competition. Another example is the increasing cooperation between European Union educational programmes and regional partnerships. The increasing dialogue between bottom up prescriber groups like parents organisations and community or country level policy decisions are another example.
INDICATORS AS THE ‘GLUE’

5.1 Why indicators are needed for which purpose?

To link the areas of ‘educational ICT’, ‘educational resources’ and ‘educational policies’, a set of tools is needed. One element are common definitions, which make sure we understand precisely which learning resources can be complemented, improved or functionally replaced by respective educationally used ICT. Similarly we need those commonly agreed definitions to identify policy measures, which in a targeted way influence the development of educational resources, the processes and the effects, the respective policy addresses.

Beyond such a common set of agreed and clearly distinguishable definitions we need operationalisations, how to identify, whether respective pre-conditions exists or not (and preferably to which extend) as well as whether or not (and preferable to which extend) policy interventions reach the goals addressed.

What is described there are the very basics of each methodology of metrology: define/standardise terminologies; make sure those definitions are free of overlap and complete in there overall coverage of the field; define procedures, how to measure and finally how to label the results of those measurement procedures.

What mean these pretty abstract and general measurement methodology terms described applied to the field of educational systems indicators? Indicators in the educational domain of course use concepts and wordings, which are already existing in order to be understandable and to be able to make use of the known interdependencies between the areas described by indicators and as well to make use of the existing discussion on hypotheses of interdependencies and causalities between them. The problem is: most of these existing implicit understandings/definitions of the terms which are underlying indicators are rather individual and/or group specific and may differ to a not known and not obvious degree between various actors. Take as example the term ‘networked PC’. It is easy for the individual to use this term and to integrate it into a recommendation, because the individual may have a clear personal interpretation what is a ‘networked PC’ and what is not.

The problem is: even known communication partners may have interpretations, which differ to an unknown extend. The problem gets more severe, if with the help of published indicators widely in use – in extreme globally – we do not know and therefore have no idea about the span of the interpretations of the term ‘networked PC’ for one of the potential readers/users. Following the example we can be sure published figures on ‘students per PC in schools’ will be composed in one country on the basis of an specific understanding of ‘what is a PC’ plus ‘what is a student’ and ‘what is a school’!

We are sure there are big differences, but we are not sure to predict the nature and the amount of those differences. Sometimes we even find the paradox situation that quasi naive assumptions may be misleading up to the extend those assumptions are exactly the contrary of the reality. Take the assumption, the higher industrialized richer and ICT progressed country may be the more advanced in the definition of what is a PC in schools compared with countries with a lower economic background and a substantially lower ICT development level. There is some evidence exactly the contrary is right. A very well developed country with respect to computer use in schools like the UK might include into the figures pretty old and low level PCs (even including reasonable amounts of 386 and 486). In contrast countries which a much younger development and substantially lower economic basis like the
EU candidate countries of say Hungary or Estonia due to their more recent high priority for PC supply for their schools will own and report for the statistics almost exclusively computers with a clock speed of 0.5 GHz and above, because those PCs had been bought in the last years and donations of outdated PC from industry to schools (which is a substantial source of a educational ICT resources in the high developed ICT countries) is almost missing here, because the quick and recent development in these countries makes almost no outdated PCs available for donations to schools.

This example may help to clarify: professional support, consultancy and assessment of educational resource policy needs a lot of systematic work on indicators to ‘glue together’ the key elements described. If we look at the world of educational indicators we see on one hand a limited number of naive ‘trivial’ indicators like ‘students per computer’, which are used on the basis of a pretty individual understanding (and therefore with all the described difficulties of being not comparable) and on the other hand rather sophisticated and well defined indicators, which usually are introduced and used by one well reputed, important institution in one big study with a subsequent lack of generalization (i.e. those indicators are not continuously used and not comparable with other similar indicators outside the institution) and are – in many cases with a rather high amount of resources – collected once within one punctual project. Even such a globally active, experienced and highly reputed organisation like OECD operates like that, e.g. partly by the well known PISA study, where longer term sustainability is still under discussion. OECD and PISA mark a positive extreme, because first the geographic coverage of the homogeneous data capturing following standardized definition and procedures is extremely high, secondly because PISA stands within a continuous tradition of similar types of measuring procedures (nevertheless earlier generations like the pre-running TIMMS studies are not completely comparable with the last PISA.

This description of the actual situation points out two deficit areas: Consensus processes to standardize over most or all of the important actors the definitions of the respective indicators and the procedures of data capturing. Second the identification of institutions, which are able and can be committed to carry out those indicators’ data capturing on a regular periodical basis (e.g. yearly) over a longer time perspective. A consequence of the second is: as no single institution will be able to cover all indicators necessary for educational ICT resource policies in that way, a network of many existing institutions has to be created and sustainable maintained, whose commitments are complementary, so they sum of those commitments (and the necessary long term resources behind) will cover completely the whole field.

This statement may sound trivial, but the consequences are important. We have no alternative to set up rather quickly structures, which in a targeted and professional way do, what up to now normally is not done: to develop a methodology, how to identify relevant, meaningful and valid indicators in a consensual way, linking methodological needs with cooperative processes, come up – again based on a sound and clear methodology – with ways to identify a sufficient number of indicators, which allows to support all necessary processes in the triangle between ‘educational ICT’, ‘educational resources’ and ‘educational policies’, which at the same time are maximal economic, means restricted to the minimum of interventions in amount and number.

The European Union became specifically aware of that urgent need in the framework of the development of the so called ‘eLearning action plan’, which is supposed to structure the important policy field of eLearning, as it was defined at the Lisbon summit as a core element of the overall goal of ‘eEurope’.

As an offspring DG Education & Culture of the European Commission in 2001 created a round table on eLearning indicators, where all relevant institutions with a transnational missions on EU-level (but also important institutions with a coverage beyond, e.g. OECD itself) participate. This round table agreed, an operational project would be needed to come up with a consensual minimal set of well defined indicators and to build upon that basis a cooperative network of existing actors to set up a sustainable European e-Learning observatory infrastructure. This project under the acronym DELOS (Development of a European e-Learning Observatory System) started from 10/2001. The following paragraph refers to a high extend to intermediate results and the work done under DELOS up to now.
5.2 Use of indicators in a policy life cycle model

One element of work was to agree and structure, when and how indicators are used in the respective policy processes. Three main phases had been identified:

**Policy definition phases**

This means the whole process from highlighting and actualising a educational theme needing policy decisions in a society (be it derived from other policy initiatives like the US ‘information highway’ policy of the early 90s, the qualification and education visions initiated by the two Blair election campaigns) or deficit triggered (like the historic ‘sputnik shock’ in 1957 in the US or the recent ‘PISA shock’ in Germany).

This triggering phase, where educational deficits, needs, goals and measures to achieve those goals are normally mixed in a complex discussion of many and different types of actors, is followed by the first professional round of programmatically defining a coherent policy or a set of contrasting policies. The latest in that stage indicators come into the game, because they seem indispensable to build up coherent discussions and to define the linked policy interventions in a way, the necessary financial and/or regulatory resources can be estimated.

Both, the definition of goals and resources form as a next step ‘policy formulation’, which is the basis for priority decisions. The more important a field of policy becomes in the public perception, the more it is expected - specifically by the public - to quantify its goals and also to include the yardsticks and milestones, against which success of failure of the proposed policy measures can be assessed.

These characteristics are quite familiar for fields like economy policies (e.g. targets for next years grows of GDP), labour market policy (reducing unemployment within x years to y %), health care policy (e.g. limit the costs of hospital treatment to...), family policy (allow x percent of women with small children to find part time employment) and so on. It can be interpreted as a sign of increasing maturity of educational policy - which was stated at the beginning - we see an increasing need to define also educational policy in an comparable way. Such a development defines an additional requirement for indicators. They have to be designed and defined in a way, they are understandable in principle and are accepted as being of important by the citizens. This requires reasonable work on dissemination and awareness raising within the society as a whole.

As policy makers predominantly decide on expenses, but argue with outputs, they have also to be supplied with reliable data on relations between different educational expenses indicators on one hand and educational output indicators on the other.

**Supporting policy implementation**

To have a educational policy not only defined by the amount of money allocated to a specific measure, but also by easy to understand and clearly defined indicators is necessary for an effective and targeted implementation process. By its nature educational policy implementations engage a high number of persons and institutions through many levels and functions. To make all of them act in a coherent way needs logically a similarly coherent understanding of goals and the respective tools to achieve them. The more people contribute to the implementation by tailoring general goals to the specific needs of a specific institutional or local environment and the more we expect an adequate, creative and engaged interpretation of that type of tailoring, the more we are depending on a quite clear basic understanding of the respective concepts. Operationalised and therefore measurable indicators that way play a central role to support a coherent, quick and effective implementation process.
Assessing policy

The clear definition of an educational policy outcome indicators and the indicators for the required interventions allows a rather undisputed, not to complicated way to assess the relation between policy goals and policy achievements. In addition only those 'standardised’ indicators make it possible to assess different policies in different areas as far as they address comparable goals in a comparative way: when based on sufficiently quantitative indicators even in comparable quantitative way. This opens an additional dimension for processes of ‘continuous improvement’ in policy performance.

Finally, when we can make sure the set of indicators stays constant from the phase of policy definition and consensus over the implementation to the assessment, it is possible to close the loop and to make successful processes of improvement achievable in a more systematic way.

5.3 Types of indicators

Being rather simple and commonly agreed is not automatically an argument against a structure. Therefore a simple typology of indicators is used for the following: ‘input indicators’, ‘process indicators’ and ‘output indicators’.

Input indicators

An overall group of all indicators, which describe the resource input into an educational system, be it in terms of direct educational resources, be it in terms of the financial budgets necessary to generate those resources and to maintain them, be it as measures of other framework conditions for educational processes (from statistical characteristics of a population to training needs and learners attitudes).

Process indicators

Dealing with functional measurements of processes or important agents of those processes, which are assumed to characterized the relation between the input and the output (e.g. like the amount of average use of networked communication facilities by students as an assumed requirement e.g. for improving ICT skills, making cooperation more effective, promotion of key qualifications like ‘communicative skills’ or to raise the level of ‘higher level knowledge’ in a field, by increasing small group processes to speed up the understanding of complex relations).

This exemplifies the problems as well as the potential of that type of indicators. Most educational processes are not sufficiently characterized by only one of those indicators. Most times more than one are needed to get a complete view. Secondly only in rare cases we find one to one relations between one of those process indicators and one specific output indicator, because normally specific processes influence several areas of pedagogical outputs – and of course in a reverse way one pedagogical output is influenced by more than one pedagogical processes and their indicators related.

Output indicators

While the definition of pedagogical outcomes targeted seems to be not too difficult, as long as those definitions stay rather general (and therefore leave sufficient room for personal interpretation) like e.g. become a competent citizen, is literate, is able to think in an abstract way, things complicate if we start to define those outcomes in terms of clearly characterised and exactly measurable indicators. Then we need to decide, whether this particular outcome is what we meant by the rather broad goal identified at the beginning. And as a rule mostly we are only able to measure a small example of the whole area of competences/values or skills targeted. So we have also to make sure, the sample defined by that indicator and its measuring process have sufficient representativeness for the whole range of the respective outcome targeted.
5.4 Fields of indicators

Of course there are many ways to defined fields for indicators. But if we want indicators to be useful as a tool for communication, we also need to identify those areas in a consensual way. The named EU project DELOS tries to come up with a solution and for that purpose collected a so called ‘long list of indicators’, which is the result of a survey of a number of widely renewed and influential institutions worldwide and their educational indicators published. This ‘long list’ will be a dynamic collection process. The actual intermediate draft status is attached to that article as a (still confidential) annex. In order to make this enormous number of 400 indicators usable, those indicators identified where clustered into a limited number of categories. These clusters, also based on desk research on existing systems of classification at the moment and again as a draft, looks as follows:

- Contextual Factors of Education
- Education Finances
- Access to & Participation in Education
- Characteristics of Learning Environments
- ICT Penetration & Use in Education
- Learning and Knowledge Outcomes/Achievements
- Labour Market & Social Outcomes of Education
- Other Indicators

At the moment we are in the middle of a not simple process to define and pilot test the methodology how derive to from this ‘long list’ a ‘short list’ by a clear and reproducible process. It would be absolutely premature to report on that methodology, which at the very moment is under discussion and internal trials. But it seems some characteristics will be used anyway: Indicators have to be each characterized by a rather long list of meta-information in order to set up the ‘short list’ (or several ‘short lists’ for different purposes), which in itself shows a pattern, where different characteristics, fields of coverage etc. of the indicators included are sufficiently balanced. Parts of that process of allocating attributes to each of the indicators will be derived on a strict methodology how to derive those allocations from research. Other parts have to be based on ratings and the respective averages of a group of experts.

Secondly: it became clear, we have to distinguish different ‘levels’ of indicators. In DELOS we introduce a system of a restricted number of so called ‘pillar indicators’, which are characterized by a complete or highly representative coverage of data capturing (geographical, sectoral), by a high level of ‘granularity’ (e.g. with which geographic resolution data can be accumulated for geographic regions) and with a sustainable, longer term periodicity (e.g. in a comparable and unchanged way every year). To complement those important, limited and costly ‘pillar indicators’ we need a much bigger number of so called ‘research indicator’, which may be used only at one location, in one or some selected geographic areas and with only one or a few levels of granularity. Those research indicators are used in targeted studies with the specific aim to explore more in detail the relations between input indicators, process indicators and output indicators.

Both, the set of ‘pillar indicators’ as well the big group of ‘research indicators’ are not fixed, but have to allow a dynamic maintenance and further development (again with the help of the meta data attributed to each of them and to keep the whole system flexible for inevitable changes of the educational systems and the embedding societies as a whole.)
It would go to far to explain here in detail the mechanisms for those continuous updating processes, but just to describe the principle: It is necessary to agree on a general methodology, which fixes, how the value/effectiveness/appropriateness of an indicator has to be monitored over time, how and by consensus of which institutions/persons criteria have to be defined, when to remove an indicator from one of the lists and to replace/complement it by another indicator of which characteristics. It is also obvious, a clear transition process is necessary for ‘research indicators’, which on the basis of changed conditions and or their proven relevance/effectiveness will become candidates to be included into the ‘pillar indicators’ list.

5.5 Granularity

Indicators availability (means which type and which extend of data are available) is characterized by its granularity. This means: what are the underlying areas, for which separate data sets are (or should be) available. The levels which can be roughly distinguished are

- national
- regional
- local
- institutional
- sectoral or types of educational institutions
- cross tabled according to characteristics of the individual (e.g. gender, age, level of educational participation etc.)

Without going into details of that concept of granularity three important areas directly influencing the use of indicators for educational policy should be described:

5.6 Correspondence to policy levels

It becomes obvious, policy definition and decision levels – according to the area of responsibility – can be classified exactly with in the same categories. We described the granularity, of indicators. Most of the today’s available educational indicators are covering only one (or a limited number of) granularity levels. This might be sufficient, if the policy decision processes include only one or very few levels of responsibility and exactly those, which are available in the granularity of the indicators data (e.g. only national level or only national and regional). As we can observe as part of the innovation processes of our educational systems systematic shift down of responsibilities (e.g. to from national Ministry of Education level to strictly local school boards like in Denmark), the requirements for granularity of indicators increase subsequently. To adopt the level of granularity synchronously with the shift of areas of responsibility, therefore remains a systematic and permanent task for policy preparation and policy support actions. Embedded into that we see the tendency to shift educational policy decisions from uni-level ones (only the National Ministry of Education defines and decides ...) to cooperative multi-level ones (on Federal Ministry tries consensually with state/regional authorities and considering the articulation of local responsables ...). This process requires a corresponding process of increasing completeness of granularity levels for at least pillar the indicators data capturing and presentation strategy.
5.7 Correspondence to policy time horizons

From the above mentioned policy life cycle process we can deduce adequately related policy time horizons defined by the period between one policy decision process and the next subsequent decision cycle. In many cases these life cycles are synchronized with the election periods of policy makers, which means several years. In many areas indicators data collection periodicity as described does not exist (i.e. those indicators are only collected once in a comparable and unchanged way) or are collected over shorter time intervals (e.g. only two or three years of regular collection with substantial changes of the definition or the data collection methods after that period.) In that case nicely designed and above described loops from policy definition to policy assessment and to the next round of definition are interrupted by the none adequate continuity of an indicator (which we can describe as its time granularity).

5.8 Correspondence to levels of hypothesis

Similar to the described problems between the level of granularity available and the policy process this can be also applied on the correspondence with the level of hypotheses. If for instance it is assumed a specific ICT resource in primary schools might be of specific importance for those classes, which show specific pedagogic difficulties due to a high percentage of none native (e.g. migrant) children, but the indicator of ‘students per computer’ is only available in the granularities ‘primary school’, ‘secondary school’, ‘rural areas’, ‘urban agglomeration areas’, such a granularity of the indicator will not allow any empirical answer on specific interdependencies due to the mismatch between data granularity and the level of hypotheses. It seems, this mismatch is very frequently found and one of the key factors limiting in practice the value of indicators for the policy decision process. It is therefore understandable, many policy makers do not trend to explore in detail the availability and the usefulness of exact indicators in a field under discussion, but based on a frequent experience, indicators which would really support the decision process are mostly not available, fall back to existing preoccupations and implicit ‘feelings’ of needs and causalities between interventions and results.

5.9 Time lines

The methodology of data capturing for educational indicators is mostly delicate, it is not simple to avoid problems and inconsistencies. These many sources of errors can be ‘adjusted’ only insufficiently or with unacceptable efforts. Properly defined base lines are hardly or not at all achievable. Where perfect methods are available, their costs are in not a few cases not justified by the respective benefits, so that there is no alternative to sub optimal strategies. All these difficulties limit specifically the comparative value of a indicators measurement at one given time horizon.

The way out is clear: to collect the respective data with a sufficient periodicity, ensuring in all aspects of measurement not only methodological, but also time consistence. That means, in a global approach to collect periodically data on say’ ICT skills of students’ the respective tests can not be carried out in one group of countries or regions in spring of a year, in another group in summer and in a few in winter, because that inaccuracy of the measured time windows might be by far too big compared with the time distance between observation periods of say one year.

This makes data collection with a constant and sufficiently precise time organisation a pretty demanding organisational task. But if we succeed, the available measures on relative changes over a comparable time period open up access to rather precise and comparable data, normally substantially above the level we will get from punctual measures. This effect is well known from other areas of indicator measurement and assessment with a longer tradition. If we want e.g. to compare public debts across several countries (as this is at the moment actual within the European Union), we all are aware due to different definitions what is included into the public debts of a nation or not, the absolute values reported may be compared with some reservation. If on the basis of secure data time lines available we
are able to identify the yearly percentage of change, this will deliver a much more precise and comparable picture. When measuring economic development we are all aware of that process and we accept the rather substantial need of resources to supply us with those data. That process is still at the very beginning in the educational domain including the awareness on the resources necessary here in the future.

Another area to be considered is the stability of indicators, indicator definitions and indicator relevance over time. Specifically in technically so quickly evolving areas like ICT it is clear, it will be pretty problematic to keep the same definition, for a decade, what is a multimedia PC suitable for schools. If we keep the definition constant, the respective indicators trend to become useless. If we change the definition permanently the whole value added of the time line gets lost. From other areas of statistics we are familiar with exactly the same type of problem and we know the solution. Lets take the example of indexes of cost of living. Here the statisticians since long are aware, the assumptions of what is needed for living and the societies acceptance is constantly changing. Therefore a complicated system of baskets of different needs had been developed with a system of constant adaptation and at the same time defining reference measures to adjust the indicators to the respective absolute changes.

Everybody who is a bit familiar with these processes knows, this is a delicate process, which needs not only methodological rigorosity, but also a lot of consensual estimates and decision processes. Therefore the process is costly. To argue due to the amount of these costs those methods are not in the reach of the educational community would be, I guess, too short. If we feel the effectiveness of the educational system is of similar importance for a society as the economic system is, we have to accept that we will have to allocate substantially more resources to measures of policy support like the permanent operation of sophisticated indicator watch and observation systems.
Is it acceptable to describe - as done here - educational policy processes as an agglomeration of many different deficits, inconsistencies and fields of insufficient clarity and precision? The justification for that seems the evidence on a quite variable degree of success of educational policies we could observe let’s say the last decade in the field of education as a whole and especially in the field of ICT and education. Really impressive evidence of success and useful innovation stands beneath similarly evident examples of wrong estimates, the support of visions which turned out to be illusions and a waste of money and enthusiasm in processes which failed or didn’t succeed at all to reach the results targeted.

Such a spread of effectiveness of policies can only be explained either by enormous differences in the professionalism of the respective policy makers (from genial and professionally perfect to disastrously ignorant) or a high contribution to variance by mere chance or by a combination of a substantial spread of policy professionalism and unpredictable at random influences. The third possibility seems to correspond with the following characterisation of usual policy cycle processes as ‘action and surprise’. This means: education policy goals are defined rather on the basis of implicit and general definitions of goals (from the completely general goal ‘to improve the school system’ to rather broad ones like ‘prepare students better for the knowledge society’, ‘motivate to take citizenship responsibilities, to increase individual initiative” etc).

This is combined with rather general and simplified measures to intervene at one component of infrastructure (e.g. ‘Up to the year X, each classroom should be supplied with at least one network computer’). In not a few cases goals and interventions and the respective indicators are chosen on their potential, they can effectively be visualized and communicated to the citizens (e.g. ‘President X opens a computer network in a school, which is broadcasted nationwide one evening on TV).

When general politicians of high importance (like Prime Ministers, National Ministers of Education, Presidents of a countries industrialists association together with the heads of the trade unions) take on decision and visualized symbolically over the mass media, they all are in a need to shift their attention the next day and over a longer period to other fields of policy outside education. Therefore neither their person nor that original action for the ‘grand public’ is more continuously linked with effects of that action. After a certain while peaks of effects (positive or negative) of that initial action will become obvious and in not rare cases the initial policy makers are surprises about these effects. They tend to be surprised, because in the absence of a clear expectation on the degree of an intended effect they cannot develop differentiated expectations, so they live with a ‘coexistence of different expectations’ (‘I expect this action will be a success, but I am mentally prepared to accept and to look early for explanations if it will fail’). Subsequently policy makers are surprised in the case of a clear success as well as in the case of a clear failure.

In cases of a clear success policy makers try simply to repeat the successful interventions, but in the quickly changing environment of educational ICT and innovation of the educational systems find out quickly, to repeat the same intervention unchanged one or two years after is not possible or not feasible or both. And they feel success is emotionally nice, but not helpful to improve the next round of policy decision.

In case of failure it is not sufficiently clear, where the reason was allocated: in the insufficiently quality of the policy decision or in not considered or meanwhile happened changes of the framework conditions, for which the educational policy maker cannot be made responsible, because they either
were not detectable at the time of the decision or the intermediate processes, which led to that change where out of the area of influence of that policy maker.

In the very frequent cases of a partly success, partly failure the analysis of the causalities is even more complicated to impossible. In all three cases this initial type of policy ‘action and surprise’ trends to start a new learning process for each round of a policy cycle. With such as lack of transferability described the process from one cycle to the next gets the characteristics of Sysiphos (the stone rolled up to the top of the hill with incredible efforts after reaching its goal immediately rumbles down to be rolled up again from the same starting point).

As a consequence of all the difficulties and problems described ways for improvement had been outlined. All these single hints and proposals fit into one strategy: to overcome the accumulation of those repeating cycles and to initiate to a real professional development by the help of two types of continuity and connections. Between the subsequent cycles that means, the results of a policy and its assessment have to use exactly those concepts, target definitions and indicators, which are usable for the subsequent policy rounds, definition and decision phases. The second type of link is the coherence between the phases of policy decision, implementation and assessment. A clear functional relation between the input, the processes triggered by these inputs and the outputs measured can be only made when these outputs measured in one cycle can be projected onto the intervention inputs for the next cycle. To ensure these two continuities needs a lot of different measures, which had been described.
VALUES AND HYPOTHESES

7.1 More is better? or why we need to build consensus on values.

Dealing with indicators on educational ICT, educational resources and educational outcomes, the implicit and naive assumption when we quantify is normally “more is better”. If one country, one region, one sector shows ‘seven students’ per computer and another one only ‘five students’, almost automatically we assume five is better and the respective areas or sectors must benefit from that difference. Even if we assume such a linear link between an input indicator and an output indicator is justified, the basic question rests unanswered: better for what? And we detect, outcomes of educational processes have no value as long as not linking them with areas outside the school system or another segment of the educational sector. Sometimes it seems to help for a certain period to refer to functional improvements of the educational process itself by results from a process before.

Again the OECD PISA study may act partly as an example. Its concept of linguistic literacy is based on the pretty reasonable assumption of the tool functionality of that type of skills for many other parts of an educational process (‘as long as you are not able to properly understand a written instruction you would have problems with all subsequent educational processes, where to understand the instruction is a key element’). Of course the validity addressed by the respective PISA indicator goes substantially beyond the educational system into almost all areas of live, but this is not considerer in this example.

The usual statement ‘We don’t learn for school, but for live’ is only partly helpful, because it only shifts the question. We now have to take a decision, for which aspect of live it is of value. Therefore it helps if we are able to list those areas of live which usually are developing rather independently.

7.2 Concepts on policy support and subsequently indicators

For working reasons those areas can be listed as:

- Economy

with sub areas like the relations between educational performance and vocational performance/economic success/income, work satisfaction, labour market success) with e.g. relations between educational indicators and employability or entrepreneurship.

- Knowledge

linking average indicators of educational outcomes (e.g. percentage of students with an academic degree from one age cohort, related to the number of patents of a country; absolute number or percentage of noble price winners etc.).

- Access to education and educational outcomes

as e.g. expressed in a percentage of working class parents of upper secondary students or percentages of participation in the educational system depending on living in a remote region.

- Inclusion/Cohesion
e.g. educational chances for handicapped, national language performance levels for migrants.

- Citizenship

for instance relation of educational levels and educational outcomes and active participation in citizens activities from election participation to volunteer activities.

- Change

e.g. linking educational outcomes and mobility, change of occupational qualification profile over the lifespan, lifelong learning participation.

Such a frame of value and goal areas and related indicators will allow us to define more specified and therefore better measurable outcomes of educational processes. It avoids a frequent difficulty of blurred and implicit understanding of what is ‘good’ or ‘desirable’ and the subsequent confusion, when specific measures on interdependencies disgustingly may not show the expected effects, because the area derived and its indicators doesn’t really correspond with the implicit idea of ‘success’, on which initial policy decisions may have been based.

As described for the policy process also here it is pretty important to use the same set of areas and related indicators from the definition phase to the assessment and further on to the next rounds of decision process.

7.3 Hypothesising causalities

Most policy decisions in education are based on (implicit) assumptions, which usually include different types of hypotheses on the relation between input (sometimes processes) and output. Most frequently we find the less feasible in empiric reality:

**The monocausal linear approach**

This assumption hopes, there is a linear relation between one and only one input variable and one and only one output variable (‘more computers in schools result in better ICT skills’). This assumption, when theoretically described may look strange for almost everybody. But this contrasts with its very frequent appearance especially in the field of educational ICT resources and its effects in practical policy definition.

**The threshold approach**

The first further development beyond assumptions on linearity are those on specific critical thresholds (‘we need at least one networked computer per classroom to practise and train digital communication and search across all subjects’). If those threshold hypotheses are made about the relation between specific infrastructures or enabling factors and a pedagogical process, this might be pretty evident, specifically if the respective technological or organisational resource or enabling factor plays a crucial ‘go’ or ‘no-go’ role for the subsequent processes. The threshold hypothesis becomes more problematic, if it hypothesises a direct link between an input indicator and an output indicator (‘when we achieve at least one computer per classroom, students with develop better communication skills’). Such an assumption might be problematic, because it may contain implicitly a threshold relation between an input and a process. But for the next relation between this process and the output unconsciously a monocausal linear hypothesis slips in.
The ‘Boolean approach’

More complicated, but at the same time more appropriate for many areas is an approach to link clusters of conditions with one process or one output (if there is at least one computer per classroom and the teacher is familiar with the communication functionalities of the computer, at least on ECDL level, then more students will have the opportunity to train and by that to improve their telecommunicative skills in school). This ‘Boolean approach’ is near to the mechanisms of processes and rather easy to be empirically verified or falsified. It is interesting - and would need some further discussion - why despite of that methodological attractiveness and obvious benefits in praxis we find only very few sound studies using those types of hypotheses. One explanation to be further exploited in the discussion could be, that normally quantitative indicators where they are easy to collect as in the case of ICT equipment cannel thinking into quantitative methods (‘lets quickly calculate the correlation’) and so may suppress the more intellectually demanding analytic thinking in causalities and requirements of processes.

Those’ Boolean hypothesis’ can not only be applied to the relation between multiple inputs/conditions and processes, but also between multiple processes and one respective educational outcome.

The ‘strategic element approach’

A rather pragmatic and intervention orientated approach on hypothesis is what I would like to call the strategic element approach. This assumes a rather complex process with many influential input factors and a multiplicity of processes, which contribute to one outcome (and most probably beyond that to a certain degree to a variety of other outcomes). It secondly assumes many of these input factors exist already to a reasonable extend or can be functionally substituted by other inputs or will themselves in a retrograde mode be influenced by specific processes when they show up. A specific intervention (lets say the introduction of new elements of educational ICT) is seen with a specific strategic value, because it might influence in parallel or subsequently other processes and/or inputs and will bring them by that over the critical threshold (e.g. the policy intervention of the Hungarian Ministry of Education in the mid 90ies to supply the whole of the population over the compulsory school system with quick access to the internet with no additional costs and therefore create on a broad scale network-positive attitudes, which will have a strategic value for many processes including those crucial for the educational system itself). This approach is pretty interesting, because in principal it tries to maximize the effect of interventions by identifying critical elements, which seem to be missing and therefore by removing this block the value producing potential of other existing resources and favourable conditions is set free. Therefore this hypothesis could also be labelled as ‘critical element’ or ‘critical path analysis hypotheses’.

The ‘process trigger approach’

Here the underlying hypothesis is: specific processes can be triggered by one intervention, either directly by the intervention or with the help of an intermediate process. The typical example is the assumption, convincing teachers by an appropriate training and upgrading of their respective skills to benefit from ICT use in education will innovate schools as a whole. This input (e.g. indicated by the percentage of teachers with a successful training of a certain intensity like the Danish Educational Driving License) will change the motivation of teachers to combine actively and creatively own existing pedagogical and subject competences with new value added applications of ICT. Such a process of substantially changed teacher attitudes and subsequent behaviour is assumed to influence the whole range of processes in a school which are under teachers control, from a shift from presentation orientated teaching to learner centred search of resources to initiatives of local sponsoring for hard- and software.

This approach at the same time is promising as well as demanding. We need a pretty good understanding of processes in educational environments including their subtle interdependencies and
(as can be derived from the teacher trainings example easily) their strong interdependencies with national or even local educational cultures and complex process chains with multi elements in complex school settings. On the bases of these complications it is not astonishing we up to now only find descriptive case studies and qualitative good practice analysis, which give evidence on those complex interrelations rather than empirical analyses of a traditional type. It is an interesting question, to which extend it would be considerable, to shift here the traditional result paradigm and try to use different approaches like for instance meta analysis tools for a sufficient number of case studies/good practice analyses, which will be collected and described by a more coherent and standardized methodology than case studies are done today.

If the respective scientific community could create and put into place such a more coherent methodology in qualitative research, this for sure would open new perspectives in methodologically sound meta research and surveys promising structural insights, which would allow to concentrate interventions in a better-to-control way on ‘servo-elements’ of educational system processes, which may set free value added processes to a degree substantially above what we know today.

For summing up this paragraph on values and hypotheses I would like to mirror that in the light of a prototypical and widely referred empirical study, that clearly demonstrates the danger, when not considering what was analysed here. ANGRIST & LAVY seem to be prototypical for studies, which did not analyse in a differentiated way what outcomes of the educational system are at stake and combine that with the in almost all cases too flat ‘monocausal linear approach’ described. From that perspective it seems clear that when we try to correlate one or a few indicators of ICT equipment with one or a few not really precised indicators of “school success”, the result can hardly be something else than a correlation not significantly different to zero, because I regard only one input factor, which requires many other non controlled factors to initiate to a certain degree a range of necessary and helpful processes, which might be specific for only very few targeted outcomes, but not really specific for very general ones. To caricaturise: what if we investigate the hypothesis “Will more computers in schools make students better persons?” The result is predictable and the reason for that failure is easy to imagine also. If out of methodological and analytical weaknesses no effect of educational ICT can be found by this method, does this justify the conclusion, educational ICT is of no value? I find it necessary to state clearly and frequently, we should not accept such flat unseriously generalized, methodological post-behaviouristic approaches.
8 WHAT ARE ‘EDUCATIONAL NEEDS’?

If we accept the frequent use of a term in general discussions and in the more popular presentations of policy is an acceptable reason in itself to use those terms also in the scientific discussion, it is useful to give some thoughts to the concept of ‘educational needs’. First we should distinguish: ‘who needs what’. From that we can derive two groups of ‘educational needs’.

8.1 ‘Educational process needs'

First the needs for a continuation of the subsequent educational process itself. It seems not too complicated to describe and analyse those ‘educational process needs’, especially those which are added or substantially changed by the influence of a mainstream educational ICT use. First we should not underestimate ‘circular functional need’: when we wish to massively use ICT in education, this triggers an obvious need for all participants of the educational system to develop as quickly as possible a sufficient level of skills to use ICT. Even if this on the first glance seems pretty simplistic, it is not in practical terms, because it seems not easy to identify exactly, which are the functional qualifications a student needs to successfully use later on educational ICT. Out of the experiences of the last decade - which astonishingly intensive cared about that area - we have strong evidence, what is not necessary means what are no strict needs. The assumption, to use productively a computer in a learning setting needs definitively to be able to understand the programming logic and techniques of that computer by writing own codes has proven to be an error. The big programmes of the 70ies and early 80ies to start with courses on e.g. LOGO in schools failed first in Scandinavia. Nevertheless the worldwide global educational community seemed unable to learn quick enough from this obvious failure, because similar approaches had been repeated up to the mid 90ies and even today we find some ignorant programmes which try to introduce compulsory computer programming elements in the school curricula (e.g. the Bavarian ‘Informatics for Schools’ curriculum draft of 2000).

Out of similar broad scale field experience we know: keeping students too long in specialized computer cabinets with the main aim to learn how to use a computer in general (maybe also instructed by a teacher, who is mostly motivated to keep a computer network running and to upgrade it with new features) trends to develop specialized computer skills, which later show no functional value for ‘how to use a computer to learn’. Small side evidence of those blind alleys can be seen in the university environment, where very powerful networked computers together with frontends and storage capacity and peripherals plus advanced instruction on multimedia features led to an incredibly intensive use of university resources to download MP3 and DVD files to fill with them terabytes of advanced storage capacity to an overall amount, which exceeds the data volume of all educational software of a respective university by a factor of several thousand and on top of it trading (legally or illegally) globally with those data instead of making any use of the computer network for studying purposes.

Based on that experience we could try to hypothesize: the functional needs for computer skills in schools are normally overestimated. A strategy seems recommendable, to start with no special initial skill training – or only with a pretty basic one – instead to start immediately with learning applications and upgrade general computer skills possibly missing ‘on demand’ only when limiting deficits show up.
8.2. ‘General educational needs’

In the general pedagogical discussion a lot of ‘key skills’ had been addressed, which are said to be functional and necessary to enter ‘higher level’ means more complex tasks in school (and other educational processes). We should also be aware that schools and teachers habit to explain ‘first you have to …, only when you have mastered, you should go to …’ hierarchises learning processes in an unnatural and demotivating way, because students in many cases experience themselves, those strict interdependencies do not hold the confrontation with reality. A statement seems not unreasonable traditional school presentation of content trend to overhierarchise the process. If we take that statement serious, we should be aware on one hand of course educational ICT has a specific potential to improve acquisition processes of basic skills. But it is doubtful, to which extend the use of that obvious potential will help outside the educational process and it is even doubtful, whether undesired side effects (like frustration, feeling of too big amount of prescription, damaging negative emotions) over all come up with a negative saldo of effects. As an example: spelling for sure can be trained with increased effectiveness by the use of a computer. The question is: how indispensable is the outside school value, if we follow the technical availability and reinforce spell training by a computer.

Similar dangers can be observed in some practical experiences using the computer in language learning. The obvious drill and practice potential of even technically simple and not networked computers combined with attractive and entertaining features computer software may provide specifically for younger students misled in not a few cases to an emphasis on mechanic vocabulary training, which seemed to be overcome by modern communication orientated language didactics by long.

Overall summarising not very systematically the failures of practice of the last decade, it seems worthwhile considering an educational ICT use strategy to start with ignoring ‘functional educational needs’ and waiting, where the real deficits will show up. Afterwards we should be prepared to offer effective ‘remediary measures’, but normally not for all, but only in a tailored way for those students, who show the need and secondly only to the amount minimally required.

8.3 ‘Educational needs’ as outcomes

First it seems useful to consider to define educational needs as a result of an educational process. Not in terms of the requirements of the educational process or its delivered certifications. That means: to measure the impact of educational ICT by the improvement of existing school grades trends to become a logic cycle. Only if we can be sure, we know which school grades contribute to which requirements of the different sectors of the society, we have good reasons to use school grades as intermediate variables.

Many studies since many decades show significant but limited and over time and countries varying correlations between different school grades and external indicators on employability, professional success, life satisfaction and so on, using these results to generate structural hypotheses, we should try to come to a consensus what we would like to understand by a ‘successful educational process’ and related ‘real life indicators’, because the less intermediate indicators and error collecting processes in between are (like the delivery of school grades), the clearer we can expect to detect underlying interdependencies which will allow us to improve decision processes.

The list of policy areas listed in the paragraph on ‘Values and Hypotheses’ (7.2) seems to be a useful checklist. Some short examples: if we feel educational ICT should increase substantially employability of our students, why not to define clearly with the help of available indicators for different aspects of employability, which aspects we address and then link directly. Or to design with the help of intermediate process indicators possible interventions with which are likely to lead to that profile of employability. If we see a special focus on social inclusion with emphasis on groups of different ethnic origin, why not to do the same: first shape by the selection of respective indicators, what
concept we address by social inclusion equal access and subsequently investigate the potential of different intervention alternatives to reach that goal.

At that point it seems necessary to limit a bit this maybe too optimistic view. When we compare the different policy areas (from economy over labour market to social inclusion/cohesion or citizenship or promotion of change) it becomes quickly obvious areas like economic benefits or employability are covered by indicators with a density enormously above fields like social inclusion or citizenship. It is possible to derive a dependency between the availability and familiarity of indicators in a field and the use of those indicators. To oversimplify: it can be predicted, that targeted policies towards educational ICT use for social inclusion stay rare as long as no simple to understand and feasible indicators on social inclusion are available. Therefore it seems useful to start early with an exercise to represent the overall societal goals of education by a comparable set of indicators across all different target areas. By ‘comparable’ it is meant not only a comparable number, but also a comparable level of face validity, of public awareness and on how clear and understandable the definitions of respective indicators are. Obviously at the moment we start with a heavy unbalanced set of those indicators, which needs quick and intensive efforts to become more balanced.
9 WHAT MEANS ‘THE LEARNERS VIEW’ FOR ICT IN EDUCATION?

It seems useful to divide ‘the learners view’ into two aspects, which of course are not completely separated, but show mostly different characteristics: The ‘learners view seeing itself as a ‘learner’, means from inside the learning process and the school/university, training body as an institution, and secondly the ‘learners view’ as a member of a society today and tomorrow.

9.1 Process orientation

The overall aim from a learners perspective concerning the learning process is the hope, to get more control over that learning process and therefore to improve it, because ‘I know better than others what are my needs, my wishes, my learning framework’ and with a substantial increase in learning autonomy I expect from educational ICT we it will raise that level of autonomy. Empirical evidence for that assumption comes from the manifold observations, learners in newly framed learning environments with substantial ICT elements almost in all cases show quickly an intensive testing behaviour of autonomy limitations. Learners, which only use part of their potential autonomy are rather rare to be found. If we compare that with the speed and intensity, learners explore and exploit other features of ICT characterized learning environments (like e.g. the shift from traditional linear learning to relational, hyperlink relating learning passes), which mostly are only cautiously explored, we see all aspects of autonomy seem to be much more important over those features from a learners viewpoint. This global benefit of increased autonomy is seen in practical terms in different aspects:

Relevance of learning content

Mostly the first aspect of increased autonomy and power to decide is the learners wish and hope, by that to identify learning content, which it matches better to personal interests and wishes and by that in general becomes more relevant for the individual, therefore making learning motivation more natural and easier.

Improved learning process

By choosing elements of own interest in ICT learning environment characterised by a bigger potential for autonomous learning, learners expect a more challenging process, because difficulties of a self chosen learning pass can be much closer adapted to the individuals level of aspiration and the individuals learning potential, so that the feeling frequently felt in traditional classroom environments of long periods of either an under-use of the potential (and subsequent boredness or a level of requirements above a persons potential (and subsequent frustration) characterize long periods of a learning process.

Empirical evidence for that assumption comes from findings, students in most ICT characterized learning environments work more continuously without the typically found periodicity between distancing and engagement periods in classroom teaching. This is supported by the general observation, students trend to invest in more autonomous learning environments reasonable more of their time compared to conventional learning settings, because they usually report ‘time was felt to pass quicker’ (reduced boredness and/or the learning process itself was more interesting and motivating (lower level of frustration). It is necessary and interesting to mention, learners in a situation
of increased autonomy are not primarily interested to make learning easier or to reduce learning time and efforts, but want and approach a higher level of challenge.

This process can be observed for individuals. But it can quite similarly be observed (maybe even reinforced) for groups of learners, which as a group experience a higher level of autonomy, because self organized processes of group consensus and the setting of goals is not experienced as individually limiting, but by the activation of all well known effects of groupwork (stabilization of motivational processes, motivating forces of collaboration and competition, reduction of fear and emotional backing etc.) trends to increase the feeling, those group autonomous learning processes are as a process specifically challenging, rewarding and therefore motivating. This might be of specific significance for cultures, where part of the educational heritage is a strong group orientation, which is feared to be damaged by an assumed isolating effect of educational ICT (the ‘lonely computer learner’).

Decreased blame / controllable competition

Responsibility during a learning process for myself or within a small group of peers, makes it less problematic for the individual to give and receive feedback without any aspect of a type of ‘official’ blame by an authority like the teacher and by that influencing the structure and the positioning within a class from the outside. Failures and blind alleys are much more seen as natural parts of a learning process and not as emotionally stressing outside control processes. Empirical evidence out of studies and cases of good practice comes from the fact, if ICT based learning environments offer possibilities for more exploratory ‘trial-and-error types’ of learning, learners use those potentials very quickly, so we can assume behind that rather general adoption of those areas of new freedom must be a sort of an implicit deficit in ordinary teacher-centred learning.

The question is widely discussed, to which extend schools are allowed / should use and even promote competitive behaviour or should rather concentrate on solidarity and the experience of equality in educational settings. All experiences with ICT characterized new learning settings, which offer substantial increase of learner autonomy trend to show us, this intellectual assumed dichotomy between the support of competition versus the support of solidarity in classroom environment in practice does not show up as those exclusive alternatives. If learners’ autonomy is experienced as autonomy of the small self organizing learning group, which the learner has handed over by free decision to that group, she/he is a constituting part of competition within that group is rather experienced as a ‘controllable competition’ and therefore much less stressy compared to situations, where the orientation towards competition and its rules are imposed from ‘above’.

The evidence for that process, which leads to ‘enjoyed competition’ comes most striking from the observation of computer games, where users in many cases actively look for competition, but under the condition to select themselves their reference group.

This aspect seems to be highly interesting, because ICT based learning by its more candid and comparable processes offer substantially more opportunities for frequent and small scale competitive processes, which we know from psychological research have the potential to keep motivation on a constantly high level much easier compared to competitive feedback over longer distances like it is offered e.g. in traditional grades inside school classes.

The evidence described about autonomous small group learning, which seems not to reduce the learning autonomy felt by the individual learner and at the same time seems to add some additional benefits, puts a new light on the discussion on optimal ratios between ICT equipment and the number of students. The assumption based on the already referred naive ‘more is better’ hypothesis quite naturally will come up with the final aim to supply each student with all equipment. But logically this is only true for complete individually autonouised learning, as we find it for instance over longer period at home or if technology is advanced in a way, small groups are able to collaborate in a nearly natural way over digital networks. This is not yet the available technology reality in most areas of the educational systems. We have to consider one-to-one ratios of learners and equipment are only
optimal for a limited period of overall learning time, characterized by individually autonomous phases, while important time slots will optimally be technically equipped, when the respective self organizing small groups (with two, three, in some cases up to four or five members) have one piece of equipment at their disposal. Based on that argumentation it becomes obvious, that the educational benefits of a low ‘student-to-equipment-ratio’ can only be interpreted with reference to the learning environment paradigm used in the respective period (another argument, why overall correlations between student-computer-ratios and ‘quality of schools’ must fail).

Feel of control

Analysing the reports of learners (for instance from retrospective interviews on the most enjoyed aspects of eLearning), as we find them in good practice studies, almost always statements on the felt autonomy and control over all processes concerning learning phasing and learning time, learning place, if available also learning style and selection/definition of content, rank constantly high. This seems specifically important, when we try to assess the positive potential from a learners’ point of view FOR different educational software. The more freedom and control this software by its underlying pedagogical concepts will allow, the more it will be preferred by the learners. One interesting aspect either limited/excluded by a chosen technology or opened up by it is the closeness/openness of content, e.g. when comparing a CBT type software with closed content compared to learning settings, which open to the individual learner a guided/supported/moderated pass into the ‘open internet’ as part of the learning environment.

Group belonging

Evidence for that important aspect from a learners perspective again comes from quantitative learner reports in good practice case studies, which are available mostly for livelong learning processes, but can be generalized also to the school environments. Learner at the same time have a strong wish to feel belonging to a group of commonly shared aims, goals, difficulties and values. In contrast to some widely discussed assumptions networked ICT environments neither trend to isolate the individual ‘lonely learner’ nor do they create a desire to learn in complete independence on her/his own. In contrast, networked environments even on the bases of flat technologies like e-mail or electronic fora obviously prove a high potential to communicate all the mentioned factors, which glue together a group and create a strong group feeling, from communication on shared values to increased sensibility on individual differences. Well managed and supported electronic fora seem to create a higher acceptance of private and personal information introduced by communication into the learning process compared to traditional institutional learning settings, where there we find an ‘official separation’ between ‘learning’ allocated to the classroom/lecture hall and private communication restricted to coffee breaks and other ‘non productive’ activities outside.

There is a strong and rather homogeneous evidence from all good practice case studies, if this accepted balance between ‘content oriented’ learning and communication on private activities (and therefore values, experiences and interests) is demonstrated, will create a strong background for group belonging. Evidence is coming from the alumni activities of traditional open universities, where links to the former learning communities are set up, which in intensity and duration are quite comparable to those created by traditional studies, but mostly on the bases of much shorter common learning experiences.
9.2 Learning relevance

ICT literacy

With increasing age learners in school even more in the academic environment and further more increased in lifelong learning settings have also a view as a citizen, means as a user of learning results outside the educational institutions. This perspective of the learners view obviously is oriented to a strong extend towards the own ICT literacy acquired during formal education, because this literacy is unanimously seen as a key factor, where to position itself in the working environment of tomorrow (and increasingly also in the other areas of society, from organizing the own family over volunteering activities up to leisure time quality).

There is a close link of that aspect of ICT literacy for the future to the above mentioned feel of control. Frightening aspects, frightening perspectives accompanied to the increasing importance of ICT is always centred around implicit, emotional fears to loose control. The feeling to master and control technology in somewhat protected learning environments contributes centrally to a type of optimism to not loose control in a technology environment. Linked to experienced own autonomous learning this is the way to achieve and maintain this control in the future, and in that way contributes substantially to an improvement of livelong learning attitudes.

Improved orientation

When the use of the networking capacities of educational ICT opens up access to more authentic ‘outside world information’ within the learning process, learners at the same time are confronted with a substantially increased need for orientation on future demands on own skills and competences, as they feel in parallel much better oriented on those requirements. On that base it can be predicted, learners coming from rather outside oriented, open ICT learning environments would manage the transition from educational phases to work (or other forms of applying acquired competences) quicker and more successful compared to learners from rather closed traditional learning environments. There are no really well funded studies on that hypothesis available. Therefore it would be highly interesting to compare e.g. average time spans candidates from rather closed academic teaching environments need for worklife integration compared to those coming from rather open, ICT characterized learning settings.

Co-existing of learning and living

Due to much more frequent ‘virtual excursions’ from the educational environment into aspects of reality and application of learning outcomes the respective learners in networked environments have the chance to develop a more experience based and realistic few on the co-existing and mutual support between learning and living. When for instance school students learning a second language have the possibility of frequent communication with native speaker peers of that language including private interests, this creates an area, where it can be experienced, ‘enjoyable lifelong learning is possible’. Again methodological strict surveys on that question, to which extend those ICT communication characterized learning environments promote lifelong learning attitudes are missing, but on the evidence of case studies are promising to be carried out.
10. HARD- AND SOFTWARE POLICIES

10.1 Hardware policies

It seems useful to distinguish ‘learners frontend hardware’ on one hand and ‘infrastructure/back office hardware’ on the other side:

Learners frontend hardware

As already described, in all cases observed individuals investment decisions on learner frontend ICT hardware dominate by far over public investment in the same segment. Many policy assessment studies (e.g. MESO, L-Change, POLE) give evidence, on the long term run investment for learner frontend hardware, which is exclusively or predominantly used for autonomous individual learning is bought, maintained and actualised by the learner itself. Policies seem to be promising, which ‘only’ try to facilitate/subsidise the purchase of those hardware by the individual (e.g. tax reduction, special subsidised loan programmes, direct subventions for small restricted groups, which prove to be able under no circumstances to invest with own money).

Following such a policy, learner frontend hardware public investment should concentrate on learner frontends usable at the same time by groups of learners. It seems useful to remind, own hardware (means decided by myself, financed by myself, maintained by myself in case of problems and replaced own costs when increased requirements go over the limits of the existing hardware) leads in all these aspects to a much higher level of personal responsibility, commitment and care compared to the use of learner frontend hardware, which is bought/supplied by others.

Infrastructure-hardware policies

Such a described policy to focus on supporting/facilitating individual investment gives room for public investment to be concentrated on infrastructure hardware like servers, network components, centrally accessible storage capacity and all types of background hardware to increase over all performance, data security or 24/7 availability of services.

10.2 Software policies

Public money to buy educational software on the commercial market

In the paragraph on ‘educational policies’ the distinctions between supporting supply, supporting demand and supporting infrastructures had been already explained in detail. Here is just room to repeat. Programmes to completely or partly subsidise the buying of educational software on an existing commercial market is a clear example of a policy supporting the demand. Many examples show, this trends to be a rather successful policy, because it creates pretty favourable conditions for the development of the supply with the help of market mechanisms. Entrepreneurs in that field get much saaver and better ground to calculate investments. This will stimulate their motivation as well as their creativity in all fields, from how to bring together resources, which outside actors to include,
which alliances to form up to creative thinking, where to identify and to include existing competences in a society for the purpose better develop educational software.

This policy needs to consider carefully the criteria, under which the supply is subsidised/supported. For that purpose commonly agreed standards are needed, which are the useful concepts for educational multimedia. It seems almost impossible to reach that consensus quickly enough in a society on a pure theoretical/general bases. The pragmatic solution seem to be types of ‘accreditation bodies’, which follow the known mechanisms of accreditation bodies in the academic world and transfer those solutions to other areas of the educational system dealing with accreditation of educational software.

**Public investment to develop educational software**

As already described subsidising the supply in the case of success will lead to educational software, which is expected by the educational community to be given away for free, because the investment was made with public money. Such a policy seems simple and comfortable, especially it periods, where a commercial market of substantial self-sustaining size for educational software in a respective field is not yet existing. In those cases such a pure public investment seems to a certain extend justified. Nevertheless it is necessary to be aware of the already mentioned danger, such a initial public investment and the subsequent expectations of getting software for the (institutional) customers for free will block any development of a motivation to invest by entrepreneurs because those free-of-charge reference products will not allow to get out revenue from that field, in general.

**Open source concepts**

The world of research lives from an old tradition to allow everybody in the scientific community to use any results for free. This tradition is based on two assumptions:

First assumption: It is agreed investment into a certain research area is necessary for the interest of a society. But it is absolutely not clear at the moment of that investment which actors/parts of the society will be the beneficiaries of those results or whether their will be beneficiaries at all, because research decisions by its nature are unable to guarantee exactly their result. Therefore there is no way to allocate that investment to a specific individual or group in society with the consequence, public money is necessary. Logically the use of those results is not allowed to be restricted by an individuals intellectual property rights.

Second logic is the mutual interchange of results within the scientific community, especially necessary for the progressing nature of research, where every researcher builds her/his work on results from others as well as her/his results will form the bases for the next generation of research. This principle of a mutual use and interchange / contribution to results, which in principle are owned by the whole scientific community, is a constituting requirement for the long term sustainability of those processes.

Based on that it becomes clear, a flat ‘freeware’ philosophy most probably will not work on the long term in an educational environment, because in that model one type of institutions (e.g. the universities and their research capacities) develop with public money and give away for free (with all the negative consequences described above), another type of actors (e.g. the schools) only will utilize for free, in a ‘parasitic’ way without giving anything back.

The situation is completely different in a balanced cooperation as it is expressed by the ‘open source’ model, which at the same time offers free use of results, but on the other hand is linked to an obligation to contribute itself to the further development of that product and to feedback all own contribution into the common repository. There is evidence, those ‘open source’ concepts work well and effectively in the near-to-research university environment and for those environments it seems to be a wise policy, which only by supporting developments and setting rules can create a lot of effects. Whether such a policy can be ‘transplanted’ into a school environment without problems, where this culture of a user also as a contributor and further developer is not so deeply funded as in the research.
area, rests questionable. Specifically the different school nets worldwide demonstrate, that it is necessary as well as possible to set up a type of 'communities of good practice' and further development amongst teachers in a specific field, where those 'open source' concepts can create a self-growing repository of didactic software, modules and objects, especially of the type of training tasks, single demonstrations, schematisations, elements of simulations etc. It could be rather interesting for policy makers to study in detail, under which conditions those 'communities of practice' succeed with a productive 'open source' system and under which conditions this is not happening.
Understanding by ‘just in time ICT’ those ICT solutions, which enable synchronous multimedia communication / cooperation, we see a not simple area of as well useful as of not promising solutions when used as educational resources. The two key characteristics of those synchronous technologies are on one hand as they only offer one area benefiting from ICT: the independence from distances. The independence in time, which is offered by non-synchronous digital communication is normally not exploited.

As a second restricting element those time synchronous ICT solutions normally are more demanding for the networks they use: Need of guaranteed minimal band with, stability, small windows to accept time delays (see the problems of speech echoes), increased requirements on the reliability of all technical components, because two or more systems must work without problems at the same time.

Which special benefits balance these obvious and strong limitations? In principle there is only one benefit: the interaction of two or more individuals is to a certain extend more natural, because the periods of interactive dialogues are similar - in the best case identical - to real life situations (e.g. a conversation over telephone shows identical patterns of time interaction between the two partners as a normal dialogue). It has to be mentioned, this similarity to normal communication not automatically is a characteristic, a learning process is benefiting from. In such a near-to-reality communication environment the usual reaction time trends to determine, when I will reply to a question or a demand, not the time a learner needs cognitively to process all information and to come up with a senseful result. To oversimplify: in those synchronous communication and cooperation systems the phases of speaking dominate not the phases of thinking.

To draw the conclusions: The use of restricting and normally expensive synchronous services for educational purposes, is only justified when for the respective purpose specific benefits from a quicker interaction will exceed the impact of the restrictions. It depends completely on the respective learning setting and the underlying pedagogical concepts and functionalities, when this is the case and when not. It is obvious, all learning processes with a result, where timing is of crucial importance are suitable applications.

In some cases they are the only educational ICT solutions of use. A striking example are the already quoted virtual learning offers by the Finnish Jan Sibelius academy for music, which very successfully set up high level workshops for instance on conducting an orchestra with a leading conductor in the US and the students in Helsinki. This and other available good practice cases could offer valuable information, for which purposes and under which conditions the use of those time synchronous solutions promises identifiable additional value and where investment in those techniques will not come up with an increased effectivity (in not a few cases even decreases the effects).

A general expectation seems justified, those areas suitable for synchronous ICT will rather stay restricted to a minority of purposes and phases within learning. But nevertheless in an adequate and well designed mix they will play an indispensable role in eLearning settings of tomorrow. One of those areas of strategic importance can be assumed in phases of intensive small group learning collaboration, when overcoming the borders of one single educational institution offers additional value (e.g. project cooperation amongst schools of different types and different countries, schools and companies, schools and universities, schools and other groups of society).
12 DESIGNING EDUCATIONAL FACILITIES

12.1 Adapting to technologies?

It seems quite natural to consider to which extend substantial changes of learning and learning environments induced by the use of educational ICT (amongst others) will require a respective adaptation of educational facilities. This induces rather obvious considerations: Do I need more space per student in a classroom, when I have to add space for a PC and a screen for every student? How many network sockets I need per student or square meter in a classroom? What about an adaptation of electricity infrastructures like sockets?

The obvious and natural those questions seem, they can nevertheless be strongly misleading. Lets start early. Educational facilities as we see them now are not reflecting only and completely a rational analysis of the special demand of a traditional teaching environment in general, they are rather an outcome of the educational heritage of a certain country or region. Take the example of the decision, how ‘representative’ a school building or university building should be to make visible the value of education to the society as a whole.

If we study the building structure and the obviously underlying concepts of schools, teaching and learning in different areas like Scandinavia, the UK (and specifically Scotland) contrasted with schools e.g. in Germany, Italy or France we see substantial differences. While in Germany, Italy and France classrooms dominate completely school with some efforts on specific subject rooms (chemistry, physics, sport, arts) and with only a minimum of additional rooms of a back office type (room for the teaching staff, school administration), a typical rural Scandinavian school is characterized by a much bigger variety of specialised resources: classrooms, a spacey library with different functional zones, sitting corners in alleys, foyers, an aula for performances including events linking the school community to the local society, a dining area, place for small group and independent activities, often outdoor-learning facilities. It is quite obvious the pedagogical models and the place of a school in the local society mirror in quite different types of architecture.

Starting from that analysis we see substantial differences in the pedagogical model underlying traditional teaching and learning in schools. We know, educational ICT over a longer period (for sure not less than ten years) will change the pedagogical models and goals of schools. Nobody can predict exactly, into which direction, when, where and with which shares on learning processes in general this change will happen. What we can predict for sure: the variety of models used in parallel in almost each educational facility will substantially increase and we will have substantial changes over time, which will not offer to us a comfortable ‘stable status’ over a longer period, because the only constant will be the permanence of change.

12.2 Flexible educational facilities

The only recommendations possible based on that seem clear: try to provide educational facilities, which by their basic principles and their technical details offer maximum flexibility in use and allow to change functionalities substantially and with an investment as low as possible, when new requirements become obvious. It seems any educational facilities policy is on the saver side, if it starts design from a variety of spatial settings rather than from a single purpose model, which is highly specialized and tailored, into which direction and based on which model ever.
There seems to be some empirical evidence on an admitted not very systematic and sound basis. If we agree on the description of the different educational facilities’ cultures in Scandinavia and the other named countries, we find in general studies on ICT triggered innovation in schools (e.g. e-Watch) a quite interesting “correlation” (of course not in a statistics definition). ICT use seems to have a strong and general impact on innovation in schools in general (including teaching style, pedagogic concepts, organisational structures, teacher attitudes and qualifications, relations of a school to its surrounding community and many more) in Europe predominantly in the Scandinavian countries (including leading examples from Island and Norway) in the UK and partly in the Netherlands. In contrast the countries where effects are mostly limited to some single acting ‘heroic pioneers’ without triggering general innovation for the respective schools as organisations had been found mostly in Germany and Italy. Maybe this could be interpreted in a way, the more ‘multimode’ architecture in those ‘innovative schools countries’ facilitates the broader use of new, non-classroom forms of learning compared to the ‘classroom centric’ school buildings e.g. in Germany.

The description of this interdependency at the moment is not more than a first hypothesis. But it would be of high interest to find evidence in detail about the effects of those ‘flexibility optimised’ educational facilities in order to create suitable environments for various new approaches and by that to support permanent processes of innovation on organisation and learning concepts.
To sum up this paper its consequences for the overall lines for ICT and educational resource policies should be outlined:

13.1 Research issues at stake

As argued in detail a lot of targeted research is necessary to raise substantially the level of clarity on all the interdependencies between educational ICT, educational resources and educational policy. Hopefully it had become clear, this research has to concentrate on the analysis of structural processes and interdependencies rather than on large scale statistical correlations, which may deliver figures of rather unclear meaning instead of explaining results (and processes behind) including a sophisticated contextualisation, under which conditions what happens (and under which not).

Required is a methodology, which is centred around strong and feasible hypotheses on the finally interesting intermediate processes between input and output. It has also to emphasize the mutual interrelation between resources and different pedagogical concepts, means to which extend specific resources channel/facilitate/demand specific pedagogic concepts and vice versa to which extend and where specific concepts require which profile of educational resources. By such an interaction view the not really helpful ‘chicken-and-egg perspective’ on the relation between educational resources and pedagogical goals/educational outcomes can be overcome. This type of interdependencies centred research needs rather sound qualitative instead of large scale quantitative data, hypotheses, interpretations.

13.2 Observation issues at stake

Qualitative research in education needs urgently implementation areas, which are complete, representative and relevant. Those cases therefore can’t be set up out of research interest only. Due to the always limited resources of research their scope would normally rest too small to be relevant for mainstreaming processes. It is indispensable to access relevant cases of good practice, which in the best case have already demonstrated their potential to influence innovation strategically in a nation, a region or a sector as a whole. To be rather complete than punctual in identifying those good practice cases and to ensure, the methodology and the content grids, how to analyse and describe (and finally to a certain extend to compare) those cases needs more than a punctual and by chance accumulation of case studies as a result of quite different uncoordinated small research activities.

Specifically this is − sad to say − to a certain extend the description of the research situation concerning educational innovation case studies at the moment. Most important strategic issue at stake for observation is to create coherence, representative coverage and methodological standardisation of observatory work, including a strong element of sustainability to be able to follow the development of case studies over a longer period than the initial implementation and by that to be able to learn out of more than one cycle of policy definition, implementation and assessment.

The European Union within its eLearning initiative demonstrates to have understood that need to set up new more coordinated and networked types of bigger and more sustainable observatory systems. Such a observation network specialized in the field of educational resource policies and ICT seems to me still missing, at least on the global level. To come to solutions to improve this actual situation substantially is urgent.
13.3 Benchmarking in education: the underlying philosophy

The more educational policies direct their view also outside the own area of responsibility, the more orientation by comparison to others becomes a need. This again is a sign that process of educational policy is getting mature and comparable to other first line priority policies. What we see at the moment are quite a variety of punctual ranking and comparison activities, which happen in a rather unplanned and incoherent way. OECD seems to be by far the progressed global institution to start a coherent strategy to develop and set in place the tools to start continuous global benchmarking processes.

To promote that necessary development we need to understand an underlying educational benchmarking philosophy of proven usefulness (see BENVIC) and to develop consensus to apply it. Educational benchmarking would rest useless (or may even be damaging), if it would be restricted to punctual and strongly value flavoured rankings based on one or very few output indicators. The subsequent ‘flat’ perception in one country e.g. “Our system is amongst the best” is equally unproductive as a perception “Our system is amongst the worse”.

Obvious evidence for that statement comes from the national perception of the PISA study in Germany, which created by far the biggest public awareness in all the participating countries, because it caused an enormous divergence between Germans’ deeply founded self understanding as a leading educational nation and its pretty poor PISA rankings. A perception of the PISA results restricted to the quality of outcomes triggered a completely chaotic discussion confronting all types of assumptions and hypotheses on the processes behind these results and necessary intervention policies, which would improve the situation. Further on based on that absolute unclear and unproductive discussion since the publication of the PISA results we face in Germany a remarkable lack of any substantial policy decisions to innovate the educational system, a type of a paradox effect.

The lesson to learn seems clear: As in its industrial area of origin a framework of indicators, in which I can localise my situation or my institution in a candid way is needed to benchmark also educational institutions and systems. Only based on that the respective responsibles are able to and need to compare this position achieved with the goals intended. An analysis of the differences is possible by the specificity of those positioning information. The relations to underlying processes become more feasible, intervention methods can be selected and developed in a more targeted way. We can assume a strong potential will develop to stepwise improve our educational intervention potential for one specific institution or system.

13.4 Benchmarking in education: The learning organisation approach

We need to understand the role of benchmarking as a valuable tool and outside point of reference also for education, where each institution continuously can monitor its relative position, create consensus inside the institution how to interpret this position, support a process of collective dialogue to identify priority areas where and into which direction to change that positioning and allow to continuously monitor the effects of interventions measured against the desired directions of change. Based on that we are able to set up and use permanent benchmarking as an approach to develop educational institutions into ‘learning educational organisations’, means into institutions which permanently are aware of their position compared to others to better understand the functions of that institution within the society and to learn more systematic from own experience in a consecutive way by a process of continuous improvement.

In that way educational policy may develop from a type of art, where genial intuition of individuals may produce miraculous results (but the absence of those lucky geniality will dramatically increase the danger to waste mayor investment) to policy processes, which become more candid, more participative, more effective and maybe with a fair chance to enter into mechanisms of continuous improvement processes for the quality of policy itself.