ICT in Education: literacy, enhancement and personalization[1]

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Abstract

In this document we will address ICT in education in a broad perspective: 21st century skills including digital literacy, enhancement of the learning and personalization of the organization.
These aspects are considered within three generally formulated objectives for education: to bring pupils to self-fulfilment, to create responsible and involved citizens and to prepare them for a future working career. To take this threefold assignment seriously we should reflect the outside world into the school. And so ICT should be a not negotiable, integral part of the learning environment. With this starting point we do not have to "prove" that ICT is improving education. Of course the educational community has still the obligation to use ICT in a way that it leads to the best possible outcome.
If we accept to use ICT we have to make children ICT literate in various ways. We will show that this ICT literacy is part of so-called 21st century skills. We will group these skills into four categories: (1) learning and thinking skills; (2) social skills; (3) ICT skills; (4) life and career skills. Given the availability of ICT in the learning environment - we should also use it to enhance the learning: for illumination, as dedicated educational software and to use open software for supporting the learner. We will mention some studies showing that the use of ICT is activating and motivating the learner.
Finally we consider a move to a different organization of learning, a more personalized and tailor-made approach. This ensures that students can learn on their own level, time and place independent, tailored to the individual learning styles and interests, and adapted to the individual progress through the application of learning analytics.
We will end with a cry for more freedom for teachers and learners to realize a better outcome:
- make a smaller part of the curriculum obligatory, say 50%;
- use 30% of the time for developing the skills in individual and collaborative projects;
- spend 20% educational time on the development of individual talents.

[1] This paper was commissioned by the UNESCO International Bureau of Education (IBE). It has not been edited nor published by the team. The views and opinions expressed in this paper are those of the author and should not be attributed to the IBE-UNESCO. The paper can be cited with the following reference: "Paper commissioned by the UNESCO International Bureau of Education (IBE), ICT in Education: literacy, enhancement and personalization, please contact ibe.info@unesco.org"

1. Introduction

Starting in the early eighties of the past century the educational community - practitioners, teacher trainers and educational researchers - has been working on the introduction and implementation of computers in education. These efforts were attached to the notion that society was entering a new phase. Beniger ([i]) showed that the term "Information Society" was one of the many notions used to described this change from an industrial society to a society where information plays a dominant role in economics, politics, culture and …. education. At first, there were attempts to familiarize young pupils with the achievements of the "new era". Educational materials were written to practise working with computers, educational software was developed for applying in the different disciplines, national projects were established to supply schools with computers, mostly in separate computer labs, courses were given to make teachers familiar with the new technical and didactical aspects of computers. There were two main reasons for all these activities:
(1) pupils should learn to be skilled in using information technology (IT) as part of the core curriculum ("computer literacy");
(2) at least politicians and educational forerunners thought that IT could improve the outcome of the educational process (and as a side effect, make education less expensive). This type of support by IT was called CAL, Computer Aided Learning.
Looking back at a course book for teachers written in 1990 ([ii]) it is striking – in relation to the themes of this document - that courseware (in MS-DOS design!) was considered to be the panacea for improving the educational process by motivating the learner. Also it was mentioned that teachers often complained that 8 computers in a computer lab were not sufficient for a class of 30 pupils. In the course is was prudently suggested that one could use computers for remedial purposes, so that not all children had to use the equipment at the same time. It was an innovative thought for a traditional class-teaching school system.

Since the early stages of computer usage a lot has happened. Just some highlights. In the nineties internet popped up as a source of information. Windows brought a much more attractive design for the software. Computers appeared in the classroom – at the back of the room or at the teachers desk. Projectors could be used for demonstration purposes. Administrative software was developed and replaced written reports. Assessment tools became available, electronic calculators changed the mathematics curriculum, word processors made spelling less relevant. IT became ICT! It was not any longer only about the rather static use of data and information, but the digital revolution changed the way of communicating. And in bird's-eye view we arrive in the 21st century.
We see devices appearing in every child's pocket. We see a tremendous growth of information available. A lot of communication is digital, with all kinds of positive but also negative side effects. The iPad is invented, and children from the age of one year old are using this equipment like they were born with it. The "digital native" emerges, but is s/he armed for all the challenges ICT brings along?
Still there is debate: some doubt if the school should not just resist to the use of ICT in the safe and protected environment of the school. Other educational experts investigate the added value of educational computer programs but are hardly capable of "proving" the positive effects. The investments of schools in ICT infrastructure are enormous and the vulnerability of the systems is a thread for a continuous and stable educational environment. So it may be a good moment to mark time and consider carefully why we should invest in the usage of ICT in education. Where are we today concerning ICT in education? And what should be the perspective for the next 10 years?

In five successive paragraphs we will address five main reasons for using ICT in education. In paragraph 2 we will present the usage of ICT in schools as an inevitable fact. Following that starting point in paragraph 3 ICT will be described as a subject to learn about. Paragraph 4 is dedicated to the 21st century skills. The paragraphs 5 and 6 are about the enhancement of teaching and learning by ICT and the possibilities to reorganize the teaching and learning process. These two paragraphs will be accompanied by examples. Paragraph 7 will present a personal charcoal drawing of a future perspective.
We will end this document with some recommendations for ongoing debate.

This paper does not have the pretention of being complete in its description of the use of ICT in education. It highlights some major aspects that will, in the view of the author, be important in the debate on innovation in education in general, and the role of ICT within that innovation in particular. The scope of this paper is secondary education, between the ages 12 and 18 years, but in a more general sense also applicable for primary and higher education. The paper is meant to stimulate debate and to challenge the reader to be engaged and creative, to attack the problems raised and to communicate and collaborate within and outside the educational community to improve the future of ourselves and our children. The aspects dealt with in this paper, could seem relevant to the richer countries, provided with a good ICT-infrastructure and with a vivid debate on the results of the use of ICT in education. At the same time it should be a good cause that the less developed countries are fully involved in the debate that is going on so that pitfalls and ineffective learning paths can be avoided ([iii]).

2. ICT and Education, an enforced marriage?

Society is rapidly changing due to the advent of ICT. This is not the place to present a comprehensive analysis.
We all experience the significant changes in the economic systems, varying from global operating multinational enterprises to new local economies of exchange. Subsequently labour and jobs are evolving. Robots make jobs change or disappear.

Politics are changing. In democratic societies politicians use social media to get elected. The same social media enforce major changes in political systems, with varying consequences.

The culture, in a broad sense, is changing. Series and soaps are being watched on a computer or tablet. Illegal copying of music and movies is a global habit. Social interactions, for example with Facebook, LinkedIn, Instagram and so many other sometimes quickly appearing and disappearing platforms, have substantially changed the way people communicate. Small children skype with their grandparents, fairy tales are on YouTube. While individualization is increasing, young people are more connected to each other than ever before, over the borders of their direct environment, exploring a broad range of contacts. At the same time the bullying is done digitally. Loverboys are operating by smartphones and dating sites.

All this cannot remain without consequences for education. Pupils growing up in the 21st century would consider a school without ICT as an unworldly situation. Prensky (2001, [iv]) used the term “digital natives” for children born after 1990, as a contrary to the older “digital immigrants”. The difference is that the digital native does not know a world without digital equipment always available, an immigrant had to adapt to that “new” world. Another term is “Generation Z” ([v]), for

people born between 1995 and 2009. This generation is characterised by words as global, social, visual and technological. For pupils who are now growing up the word “Net Generation” is often used ([vi]). McCrindle ([vii]) uses the notion of “Generation Alpha”. Citation: ”They were born into a world of iPhones (in fact the word of the year in 2010 when they were first born was “app”), YouTube (there are now 100 hours of YouTube videos uploaded every minute, and in this environment they are more influenced by the visual and the video than the written and the verbal), and Instagram (where life is photographed and shared instantly and globally).”
So these are the kids we have to offer education at this very moment. Often in an old fashioned environment, with a formal curriculum, books from the past and teachers (and parents!) who mostly have no idea of what is going on in the daily life of the pupils under their care. This situation calls for action.

And it is probably just for this reason that, all over the world, initiatives are emerging to turn over the ways we educate. A class full of youngsters, growing up with new technology all around them, cannot be approached by old fashioned methods, learning materials and curricula. In a new learning environment ICT should play a significant role, clockwise or counter clockwise. So We would state here that education and ICT is an enforced marriage. All other reasons to use ICT are arising from this first notion: we cannot place teaching and learning in an environment that is not mirroring and reflecting the world outside the walls of the school. Visualizing this is quite simple, see fig. 1.

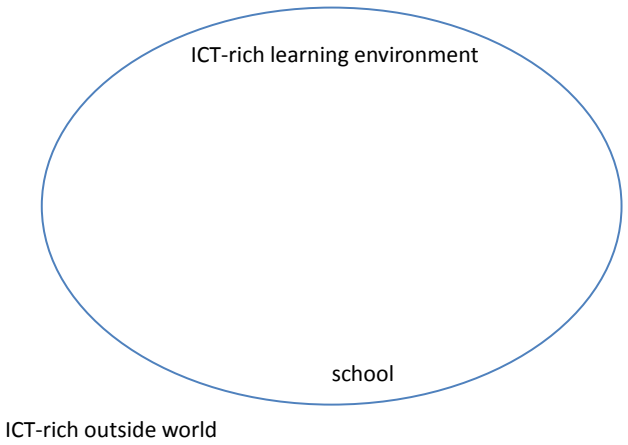

fig.1 The school reflecting the outside world

It is good to articulate this premise here again clearly, because there are opposing views. One of the most well known is the view of the German sociologist and pedagogic Thomas Ziehe (1999, [viii]) who has been fighting since the 1970s for an education that offers students insights and methods just disconnected from their experiences outside the school, called "Alltagserfahrungen" . This kind of noise is also heard in columns in the newspapers and in associations of concerned parents and teachers, with reference to their own childhood and the - often idealized - past.

From the foregoing it will be clear that we should regard these views as background battles, comparable with opposing the (“pernicious”) art of printing in the 15th century, the (“dangerous”) transport by train in the 19th century, the (“hazardous”) driving in an automobile or watching television in the 20th century.

In our view the educational community is obliged to itself to explore new paths for teaching and learning, with conservation of the numerous good elements from the traditional ways of teaching and learning.

3. ICT as a subject

Since we now have established the absolute necessity for an ICT-rich learning environment, the need arises to give attention to learning *about* ICT. Of course this is not a new sound. Since the 1970s, the educational community has been discussing the character of insights, knowledge and skills of ICT or ICTs. The names of the learning area vary and evolve. While the term IT developed into ICT, the original name “Computer Literacy” has been replaced by “Information Literacy”, also called “ Media Literacy” and again “Digital literacy”. This area consists of a series of communication competencies, including the ability to access, analyze, evaluate and communicate information in a variety of forms, print and non-print-including messages." ([ix]).

In most countries there are objectives, a curriculum and materials available for teaching and learning this particular area ([x]). However there is often debate about the extent to and the intensity in which the subject is taught in schools. In the Netherlands, for example, until the early 1990s it was left to the schools how they wanted to implement “information science”. In 1993 lower secondary education was reformed and the goals of the subject became obligatory. In 2001 these goals were rephrased and integrated into other disciplines, arguing that students leave primary education sufficient "literate" to step into the secondary school. The same oscillating movement we have seen in other countries. Also, it is often unclear who should teach this subject. In practice this ranges from the librarian to art teachers, from the mathematics teacher to the teacher of physical health. Almost nowhere a separate substantial training program for being a teacher of Information Literacy has been set up.

There are numerous descriptions of this subject. Good examples are the new curriculum that has been developed recently in Australia (2013, [xi]) or the somewhat older Standards for Technological Literacy from the International Technology and Engineering Educators Association ITEEA (2006, [xii]). Other recent examples are from the British Open University with the publication "Integrating IL booklet" (2010, [xiii]) and the Ancil project with a description of information literacy (2011, [xiv]).

At this moment the pendulum is at the side where governmental bodies at a large scale recognize the necessity of some kind of obligatory informatics curriculum. Although pupils might be "digital native", it seems more necessary than ever to learn children how to deal with information, which ethical and legal aspects of digital information are involved, how to deal with social media on issues such as bullying, or privacy, and how to guard yourself against being constantly on-line and therefore not being able to concentrate on a more difficult learning task. This in addition to a second part of the subject: learning how to use digital resources, applications and programs properly. This part of digital literacy is also important for vocational education: being able to use computer programs within the context of specific future jobs.
The third part of the literacy is the somewhat "harder" side of ICT: computer science or preferably informatics. It is about the skill which is sometimes referred to as "computational thinking" (Wing, 2006, [xv]), which consists of programming and logical, algorithmic thinking. Very recently (March 2015) the BBC took the initiative to deliver small microcomputers, called Micro Bits, a coding device

for initial steps in computer programming, to all British schools in the autumn of 2015. Programming will be obligatory in the UK for children of age 11 and above. In most policy papers one can find the recommendation of putting some form of Information Literacy on the agenda again. While the deeper understanding of computer technology, software development (programming) and information analysis are often recommended to be part of a separate discipline.
In a recent publication the European ACM (Association for Computing Machinery) highlights once again the importance of learning about informatics and digital literacy. Four recommendations are proposed: (1) all students under 12 years are entitled to education in this area, (2) computer science must be considered as a separate discipline for the older students, (3) a large teacher training program should be launched and (4) uniformity should be developed about the content of an informatics curriculum (2013, [xvi]). Attention for this area of learning is also required in connection with the shortage of ICT-skilled workers (2014, [xvii]). The European initiative "Digital Agenda for Europe" is a corollary of this notion.
In fig. 2 we have placed digital literacy, ICT as an apart subject, within the learning area of the school.

Since we now have elaborated a bit on the necessity of “digital skills” it is time to place this in a broader perspective.

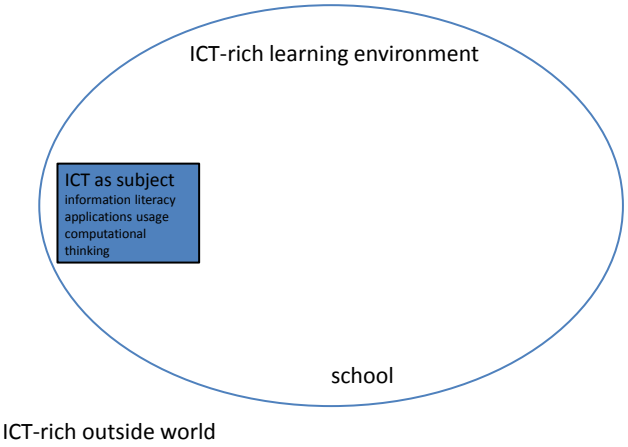

fig.2 ICT as a subject, to be taught in the school

4. 21st century competences and the role of ICT

In this document we will use a set of three main objectives for the education of children:

(1) to become well developed adults with a reflective view on their own personal growth;
(2) to be responsible, participating citizens who have an understanding of ethical, (cross-)cultural and moral values (citizenship);
(3) to become economically independent beings prepared for (future) jobs, which in many cases do not even exist nowadays.

These goals can be completed by acknowledging the necessity that students should be educated for a life of continuous learning, the *lifelong learning paradigm*.
In paragraph 2 it was argued that the modern generation of children is facing an outside world which

is very different from the world older people know from their childhood. The question arises if the traditional skills, incorporated in the existing curricula, are still suitable to reach the three main objectives of education and to prepare kids for lifelong learning in this new ICT-rich outside world. Posing the question is answering it. No, there is a need for other skills!
The past ten years common sense has been originated about the fact that education should focus more and more on a more or less complete set of old and new competences. The European Union published a set of 8 competences which cover a wide area of education as a whole (2006, [xviii]): communication in mother tongue, communication in foreign languages, mathematical competence and basic competences in science and technology, digital competence, learning to learn, social and civic competences, sense of initiative and entrepreneurship and cultural awareness and expression. Organizations like Partnership for 21st century skills (P21, [xix]), NET/ISTE with the National Educational Technology Standards (2007, [xx]) and Assessment and Teaching of 21st century skills (ATCS, [xxi]) have performed research in the past years to establish the "ultimate set" of competences needed for the 21st century. Voogt & Pareja Roblin (2010, [xxii]) concluded in a comparative analysis that all of these studies have in common that they focus on conceptual and meta-cognitive knowledge and skills with respect to communication, cooperation, socio-cultural awareness and ICT skills.

Most of these skills are not new. But they seem to become more and more important than before, leading to the idea that education time should be spent on developing these competences, rather than on traditional learning of content and specific subject skills. In a recent Dutch study (2014, [xxiii]) Thijs e.a. compared several most used frameworks with each other and with the framework of Voogt & Pareja Roblin (2012, [xxiv]). Among them the KSAVE model by Binkley (2010, [xxv]), the Framework for 21st century learning (P21, [xxvi]) and the 21st Century Learning Design program (LEAP21, [xxvii]).
This comparison leads to the table of figure 1 (used with permission of SLO).

Models for 21st Century Skills, Voogt & Pareja	KSAVE model	Framework for 21st century learning (P21)	Innovative Teaching and Learning (LEAP21) project
• Creativity	• Creative and innovative thinking	• Creativity and Innovation	• Innovation (and problem solving skills)
• Critical thinking • Problem solving skills	• Critical thinking, problem solving skills, decisions • Learning to learn (meta cognition)	• Critical thinking (and problem solving) • Knowledge	• Problem solving skills (and innovation)
• Communicate	• Communicate	• Communication	• Communication
• Collaborate	• Collaborate	• Collaborate	• Collaborate
• ICT literacy	• Information skills-present • ICT skills	• mentioned apart: Information literacy, media literacy and ICT skills	• Use of ICT for learning
• Social and cultural skills (including citizenship) • Productivity (including self-regulation)	• Citizenship (locally and globally) • Living and working (self, flexibility, planning skills) • Personal and social accountability (cultural awareness, empathy, self-control)	• mentioned apart: Career and life skills (including flexibility, self-regulation, productivity, leadership, responsibility)	• Self-regulation (responsibility, planning, monitoring, dealing with feedback)

Table 1, Source: Digital literacy and 21st century skills in basic education, SLO, Enschede, translated

From this comparison it is obvious that there are many similarities between the various models, but also some differences. As to be expected, the ICT-skills are present in all models. And it seems to be possible to determine a common base of competences. An attempt to define four more or less distinct areas of competences:

(1) Learning and thinking skills: critical thinking, problem solving, learning to learn, creativity, imagination;
(2) Social skills: communication, collaboration, responsibility, accountability;
(3) ICT-skills: information, media and technological literacy;
(4) Life and career skills: citizenship, cultural awareness, self-regulation, leadership.

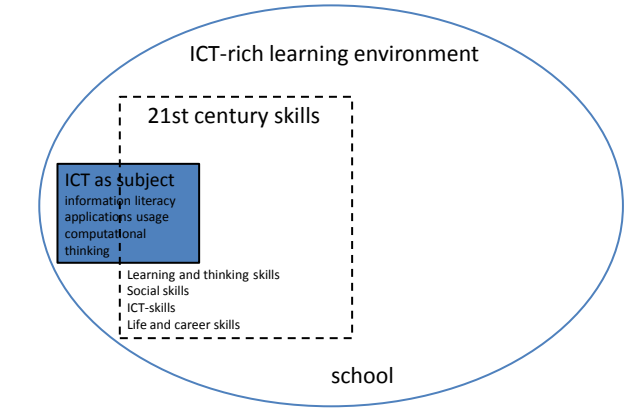

fig.3 21st century skills, including digital literacy

In fig. 3 we include the ICT-skills in the broader area of the 21st century skills.
Defining these skills on different levels is one a major task. It makes a difference for example to communicate in your mother tongue language, or in a foreign language. But if we could develop rubrics for all of these skills the next challenge is even bigger: educating the children in 21st century skills. It is about creating an environment and a curriculum where all of these skills can be practiced and assessed. Curriculum elements in which these skills are taught and in which they play a massive role can be found in all subjects in secondary education, in project based education, in inquiry based learning, in more informal outside school learning activities like excursions and internships. In most of these curriculum elements ICT plays a supportive or even dominant role. So the boundary between teaching and learning these skills and using ICT for enhancement of the learning in general is in most cases not very strict.

5. ICT-usage for enhancement of teaching and learning

So far the reasoning in this document to use ICT in education is as follows:
- Children are facing and living in a new ICT rich outside world. To reflect this world and to prepare them properly for a life after school we are obliged to deliver an ICT-rich learning environment.
- Children should be able to handle ICT within in this learning environment and outside school. For that reason ICT skills must be taught: handle information, being able to use computer programs and have some awareness in computational thinking.

- The mission of education is threefold: personal development, responsible and participating citizenship and preparation for future jobs. In the society of the 21st century traditional knowledge is not enough. ICT-skills are part of a bigger collection of so called 21st century skills, which have to play a much more prominent role in the teaching and learning practise.
- To design that practise we have to integrate the use of ICT in every learning situation where it is possible and appropriate.

This last appearance of ICT in education is often considered as a goal in itself. The claim is that the use of ICT is improving the learning results, raising the outcome of the educational process. In general it is expected that ICT usage is a new didactical means for better memorizing, understanding, application and problem solving. Voogt (2012, [xxviii]) mentions six rationales for using ICT and 2 of those rationales are about just this idea: the "pedagogical rationale" which states that ICT will enhance the teaching and learning and the "cost-effective rationale" which tells us that ICT usage is expected to reduce costs of education. At the end of this paragraph we will come back on the proofs for these claimed improvements.

The range of activities where ICT is used for pedagogical purposes, is enormous. We will distinguish five categories of usage and types of ICT, from small, simple dedicated software to the most open, generically usable environments.

Illumination
In simple forms educational software can be used for illumination of the content. Or apps when we also take the use of tablets and mobile devices into consideration. A biology teacher presents a short movie about the way penguins live, a geography teacher projects a digital map on the screen, in physical education the perfect Fosbury Flop is shown on Youtube, in art paintings can be discussed with the whole class. Teachers can project the time table of the lesson or a specific assignment on the screen, which they have prepared at home, and with no waste of time in the lesson.
The advantages of this type of usage are obvious: it is easy doing, motivating, clarifying, clear, and cost effective. Although the last advantage could be questioned, because the projector is an investment, the bulb has to be replaced , there has to be internet connection for some purposes, you always have to be prepared for a failure of the equipment.

Digital add-ons
A second category of educational ICT is the ICT add-on to the folio learning materials, sometimes called "iPacks" of "e-packs". Author teams of educational textbooks have made strong efforts to invigorate their courses with ICT assignments, graphics, exercises, short movies etc. The advantages are easy to determine. The teacher can still use "old fashioned " materials, within his or her traditional approach. It is easy to use these little extras for homework, lost moments in the lessons and extra work for remedial or deepening usage. It has also been the ultimate reaction of the educational publishers to this innovation of their text-based learning materials. They do not have to change their business models completely and can just go on selling books as they were used to. The disadvantages are also obvious. ICT is playing a marginal role in the teaching and learning and there is no proof whatsoever that this type of use raises the outcome of the educational process or even the motivation of the pupils. It just modernizes the traditional teaching and learning a bit.

Dedicated educational software

More advanced is the use of specific educational programs. Examples are again numerable. See e.g. the list for educational programs on Wikipedia ([xxix]). Simple programs can be used for exercising foreign language words, topography, historic timelines, chemical reactions, fill in exercises, texts with missing words, multiple choice quizzes, etc., etc.

Complete and more open environments are available e.g. in mathematics: to practice calculating, to draw graphs, explore geometric figures and make algebraic or statistical calculations; in music's we have the composing programs, in physics there is software for constructing electrical circuits, we have drawing-programs, programs for book-keeping, etc., etc.

There is hardly any debate on the benefits of these type of programs. They are efficient in using, easy to handle and set up, they make learning activities possible, that were far out of reach before. Yet there are complaints. The strongest are that students do not learn to spell anymore, they can't make simple calculations, they lose sight on the basis elements of more complex processes.

Simulation software

A fourth category of educational computer programs is the simulation game. The term "gamification" describes situations in which game thinking and game mechanics are used in non-game contexts such as education. Subcategories are adventure games, puzzle games, role-playing games, strategy games, sports games, and even first-person shooter games (2006, [xxx]). Examples of simulation games are text adventure games, SimCity, a blood typing game, management and business simulations, global warming, soccer playing, etc., etc.

Benefits of using games in an educational setting have been measured when the games are used in a proper context, for a specific goal (2002, [xxxi]). They can increase student motivation, stimulate interaction and discussion between students, place learning stuff into a broader and more relevant context. At the same time it is quite difficult to establish the actual learning effect of the game, surely when the assessment is still aimed at the more traditional learning content.

Generic tools

While almost all of the programs mentioned above are dedicated to one specific discipline, subject or curriculum element, a more general way of using ICT in the classroom is the application of generic tools. This category contains the word processors, spreadsheets and presentation tools, which of course are also usable in many other outside school contexts. Even more generic is the usage of programs like Google apps, Dropbox, etc.

There are also generic programs, especially developed for usage in education. First of all there is the digital assessment software. This again varies from dedicated tests, sometimes as a part of specific learning material, which actually belong to the second category mentioned above. Then there are the very successful sites for training exam tests. Thousands of students know how to find these sites without any advice from the teacher. At the other end of the spectrum we find open assessment tools in which one can import professional tests or in which teachers can develop tests themselves. There exist free to use programs like Testmoz or Questbase, and more sophisticated commercial programs like Question Mark and Quayn. Sometimes assessment tools are integrated in the more complete Digital Learning Environments, which will be discussed in the next chapter of this document. Other examples of generic programs are Socrative, which enables teachers to engage their students in a class discussion being active with their tablets, laptops or even smartphones by real time questioning and visualizing the results; Mindmeister, which enables teacher and students

to make mind maps of their ideas, foreknowledge, solutions, brainstorms: StickyMoose is a tool for collaborative decision making; etc.
When we look at the usage of iPads a lot of generic tools are available. We mention some examples: Book Creator or iBook can be used to make your own teaching material or for kids to make their own reports of a project; Explain Everything for writing, importing images and video in one environment; Vittle Free, an interactive whiteboard video recorder to teach concepts and show presentations; iMovie to make or use videos, GarageBand to compose and make Music, etc.

The most open type of software in education is the Digital Learning Environment. We will discuss this in the next paragraph of this document, because it influences the organization of the teaching and learning.

The advantage of open generic software is indeed the fact that it is open: teachers and students can use it for multiple purposes, at school and at home, at moments they can choose themselves. You may see in schools that pupils are just using this software at their own convenience. This usage contributes to the more or less informal learning of ICT-skills (from paragraph 4) or the informal achievement of ICT-objectives (from paragraph 3). At the same time the usage by teachers as a learning tool in the classroom is limited since it is often very time consuming to organize the usage or to develop usable content.
In fig. 4 we suggest to add the use of ICT in relevant situations for enhancement of the learning.

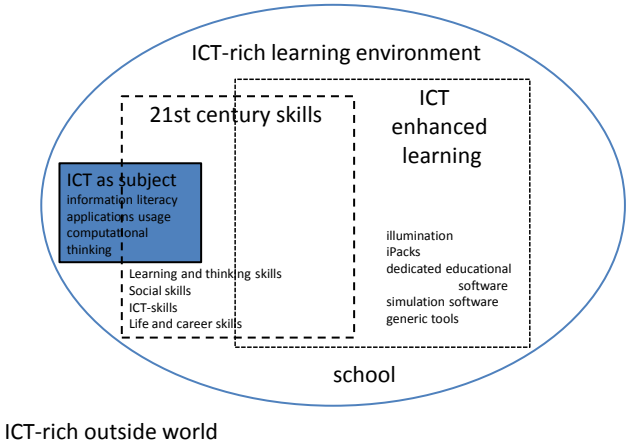

fig.4 Enhancement of the learning by using ICT tools

The effect of using digital material for educational purposes
Over the past 30 years a lot of research has been conducted to "prove" the positive effects of ICT on the learning outcome. Well-known is the work of John Hattie who studied 76 meta-analyses of almost 4500 papers using statistical methods to compare the effectiveness of all kinds of teaching and learning strategies and circumstantial conditions (2009, [xxxii]). In this meta-analysis research on the effect of ICT usage is very well represented. Yet in his "top 10" of aspects which are most effective the use of ICT *as such* is not mentioned. But indirectly one can say that some teaching

strategies do benefit from the use of ICT. In a comment Steve Moss (2014, [xxxiii]) identifies six aspects from Hattie's study which should have most effect on the learning outcome. And for educationalists these aspects are not really surprising: diversity of teaching strategies, multiple opportunities for learning, the student has got control of his/her own learning, peer-learning and feedback mechanisms are optimised. Finally, also not very surprisingly, teachers should be pre-trained to use ICT as an educational tool.

In an earlier stage Noeth and Volkov evaluated the effectiveness of technology in schools (2004, [xxxiv]). They found that the use of computers, if combined with traditional instruction, can increase student learning in the traditional curriculum and basic skills area. Students learn more quickly and remember better, as they are more motivated to learn. They found the best effects when ICT was used for low achieving students. And they also stated that adequate teacher training is an absolute condition for successful usage of ICT.

Research on the effectiveness of ICT-use will go on. That is good because the problem is not *if* the use of ICT is effective, but *how* we should use digital tools to enhance our education and develop the most effective ways of teaching. We will give one example of this type of research. Since 2012 Kennisnet, the public educational organization which supports and inspires Dutch primary, secondary and vocational institutions in the effective use of ICT, has published a series of 7 magazines in a row with research on the benefits of using ICT. The magazines are called: "Know what works and why". Two of them are available in English (2013, 2014, [xxxv]). Some examples of research in which a positive outcome of ICT use is shown: using software which is based on a didactical model (e.g. adaptive software), the use of learner tracking systems, the use of games to further citizenship, a paper on handwriting versus typing, learning with multimedia, how to learn pupils to acquire knowledge with information from the internet, determining the quality of digital learning materials.

Each of these studies shows a positive effect of the use of ICT but in every case under certain conditions. In most cases these conditions concern the pedagogical way of working in the class and the professionalism of the teacher. From all of the above mentioned articles it is obvious that it is difficult to actually "prove beyond reasonable doubt" that the use of ICT as such improves the outcome. Sometimes positive results have been found in saving time or being able to better monitoring results. Also there are differences between pupils: some benefit, some don't. The circumstances for research are always difficult, there are (too) many factors that influence the results and the realization of (comparative) experimental set-ups is hardly possible. That brings us to the next reason to fully commit ourselves to the use of ICT in education!

6. ICT-use for changing the organization of learning

The boundaries between the different types of usage ICT and accessory objectives are not always strictly determinable. Yet there is a category of programs and digital environments which are primarily meant to use as tools supportive to the organization of the teaching and learning process. It is emphasized here that this type of use could be the most far-reaching. It really could change long lasting traditional paradigms in education and contribute to the aspects that were mentioned in the previous paragraph that are most effective to improve the learning outcome.

Two basic leading principles could change the traditional way of teaching. The first is the recognition that every child is unique. So teaching is most effective if it meets the individual needs of the students and if the responsibility of the learning is basically given to the learners themselves.
The second basic principle is that collaborative learning, peer-learning, group work are effective ways to organize learning situations. In the contemporary reality of schools these principles are hard to realize. Many factors, such as class size, available, often scheduled time, lack of usable learning materials, hinder teachers to respond to differences between pupils and make collaborative arrangements impossible. We will elaborate a bit on both principles in relation to the use of ICT and also try to combine the principles because at first sight they may seem a bit contrary to each other.

Personalization
The UNESCO Policy Brief on personalised learning (2012, [xxxvi]) presents different definitions of personalized learning. Here we will use the following definition:
Personalized learning is a way of organizing the learning process in terms of content, learning environment and learning outcome, so that it meets the personal (cognitive) abilities, learning style, interest and context of the learner in the best way possible.
Personalized learning can be accomplished in three different stages: working independently, independent learning and self-responsible learning. In the first stage pupils work on their own on assignments given by the teacher. If the students themselves are in control of the way they want to achieve the learning goals, we speak of independent learning. What the goals are and how they are assessed is still determined by the teacher. Self-responsible learning is the situation in which students determine themselves (part of) the objectives and the way the assessment takes place.
In all of these different stages ICT can play a crucial role to realize personal learning paths. Let us sum up the advantages of this way of organizing the learning:
- students can learn on their own level of cognition; this also means that learners do not need to be put together in homogeneous groups; pupils of different ages and abilities can be mixed up and work side by side to each other;
- the learning is less bound by time and place, although this also depends on the freedom the school presents in scheduling the learning activities; even holidays can be customized to the wishes of parents and to the need of the children;
- various learning styles and various interests can be accommodated;
- because of these two aspects the learner's motivation will increase;
- the learning can be recorded and constantly monitored by the pupils themselves, by teachers and/or the parents;
- if these data are correctly analyzed, the learning can be made much more adaptive to pace and level of the pupil and make suggestions for the next steps or interventions in the educational process; in this context we speak of a new area of expertise: the so called "learning analytics";
- if performed with a proper set up and accompanied by proper coaching the students can better understand their own learning, the develop the valuable skill of "learning to learn".

In fig. 5 we suggest to personalize about half of the educational time in order to leave room for other ways of working.

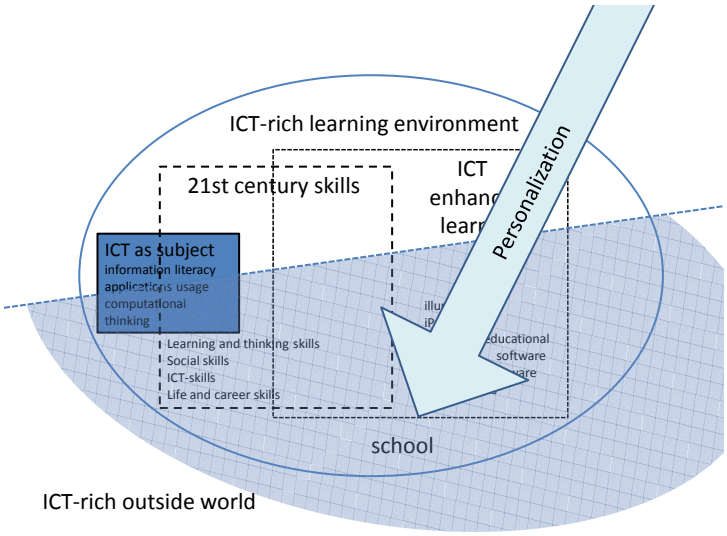

fig.5 Personalization can play a role in about half of the time in (and outside) school

Collaboration

Personalization does not mean that all learning activities should be strictly individual. On the contrary. Many activities could be carried out collaboratively, in social and intellectual peer groups. Also in peer-groups the nature, level and pace of the assignments can be harmonized with the individual demands of the learner. In fact we can distinguish here similar stages of involvement like we did for personalization: We can organize cooperative working when students are allowed to work together on a certain assignment. If the way of performing a learning task is left to the group, we can speak of collaborative learning. If the group decides itself about content, methodology and way of presenting the outcome, we could speak of learning with collective responsibility.
Some schools experimenting with different types of learning, individually and collaboratively, have built common educational areas, so called “learning squares”. On those squares pupils of different level and age are mixed, working alone or together on different tasks. Teachers and other coaches are walking around to give support, and ask the right questions.

ICT arrangements for re-organizing the learning, e-learning

Having set the two basic principles of new ways of learning, we can search for using ICT in these settings. If the learning is completely ICT-driven we speak of e-learning. A new methodology for that is the MOOC, the Massive Open Online Course. This is an online course aimed at open participation for all through the web. Some MOOCs provide additionally communities for interaction between learners and teachers. This way of learning is a new phenomenon used at Open Universities, commercial training, but not too much in primary and secondary education. MOOCs are new and therefore there is not much research available on their outcome and effectiveness. First experiences tend to the conclusion that it takes very self responsible learners to perform a MOOC until the very end. Less extended ways of online learning can be found for instance at the Khan Academy where more than 150000 smaller and larges courses at all levels are provided.

Blended learning

In basic education e-learning is still not very much used. The reasons are well-known. Schools are held responsible to a large extent for the learning outcome, often have to deliver according to the law a specific amount of education time, and therefore hesitate to hand over the responsibility for the learning to the children.

But as we have seen, it could be very profitable for the learning effectiveness to just do that. And there we arrive at the term blended learning. In most cases this is defined as a mix of traditional and online or ICT-driven educational settings. Furthermore Oliver and Trigwell, who presented the term first, point out that blended learning also involves different types of instruction, behavioural principles and strategies (2005, [xxxvii]).

Of course all sorts of educational software mentioned in the previous paragraph, can be used in different intensities in teaching and learning settings. This intensity determines if one would call the learning blended or just traditional with a modern flavour.

Digital Learning Environment

Personalization and customizing the learning to the learner could also be derived from the intensity with which a Digital Learning Environment (DLO) is used by the school or the individual teacher. Such an environment enables teachers to plan lessons and homework, to place individual or collaborative assignments and tests, to monitor results and learning reflections. DLOs are not new. In 1997 we already presented a model for “An educational tool for planning and monitoring the teaching-learning process in Dutch secondary education” (1997, [xxxviii]). Despite of a lot of effort the actual construction of the tool never took place.

Now there are numerous DLOs available. Because of high development costs, most of them are commercial. Moodle is a well-known DLO, free of charge. ITunes U for iPads makes it possible to present all kinds of assignments and materials to the learners and colleagues in and outside the school. ZuluDesk Teacher is a mobile device management tool for iPads with which teachers can manage the learning at the students devices.

The functionality of DLOs differs. At a minimum level they comprise the possibility of planning, arranging and supporting the teaching and learning process. They differ in the way they offer the possibility to arrange different learning paths, to approach learners individually, to use portfolios facilities, to monitor results through learning tracking and management reporting tools. Especially the portfolio functionality is important. A portfolio allows students to store their learning activities, to present results and to reflect on their own process. Just those features make a portfolio suitable for self responsible learning.

Flipped classroom

Another very promising way to change the organization of the teaching is flipping the classroom. In essence this is a form of blended learning where instruction and processing are interchanged. The homework consists of the watching of an explanation or instruction of a certain phenomenon before the school class starts. In the class students can work out assignments with the things they learned in the video with guidance of the teacher, or they can have extra instruction or explanation. There has not been done much research yet about the learning effectiveness. Jensen e.a. (2015, [xxxix]) found that the "flip" as such does not benefit the learning. But in this research arrangement the flipped classroom was embedded in a constructivist pedagogy, meaning that students were actively engaged in the material. And this combination lead to improvement of the learning results.

Internationalization

In order to match the goal of citizenship and cultural understanding it is useful at this moment to mention collaborative international projects for children. Initiatives as IEARN (worldwide) and eTwinning (in Europe) provide many possibilities for projects were pupils collaboratively work together on a certain topic. In a "whole school approach" there is also a collaboration between teachers of different disciplines and levels, to manage and coach multidisciplinary and multilevel projects (2007, [xl]). This type of education is different from traditional methods. It leads to unexpected learning outcomes and is therefore hard to assess. The projects are also quite time consuming for both teachers and students. But the rewards are tremendous as masses of products and proud students in movies on the web prove.

Pupils: it kicks

Finally in this chapter we want to suggest reading a little booklet called: Pupils: it kicks (2008, [xli]). This gives some examples in Dutch secondary education of new ways of learning with ICT. In the booklet a model is presented which characterizes educational settings along three dimensions. The first one is the axe of the learning context. This varies from theory based (the subject is the core) to practice-based (applications and practical issues are central). The second dimension is the extent to which the pupil is self responsible for his or her learning. It varies from teachers determination up till the situation were pupils are fully in charge themselves. The third dimension is the pedagogical relationship: from the subject-expert role up till the coaching guiding role.

7. Four main challenges for personalizing education

Children differ. And these differences seem to grow. At least we are better able to recognize individual talents, interests and learning styles on the one hand, and individual talents and possibilities, deficiencies and special needs on the other hand. This calls for a more differentiated approach of the learners in the classroom. In a time frame in which budgets are reduced and society is becoming more and more complicated, the demands from parents, politicians and pupils themselves are enormous. Parents want to have the best treatment of their child, politicians want the best performing education in the world and the pupils seek for a school which can compete with the ever changing and challenging environment.

In fact personalization is not new in education. Maria Montessori was the intellectual founder of schools characterized by an emphasis on independence, freedom within limits, and respect for a child's natural psychological, physical, and social development (1975, [xlii]). Helen Parkhurst founded in Dalton a school in which the development of the whole child is of primary importance (1922,[xliii]). ; Rudolf Steiner related a humanistic approach to pedagogy on a base of anthroposophy (1907,[xliv]). There is not much research that really proves that these types of education lead to better results on the traditional objectives of most curricula. There is however much experience that they do deliver people who are more self confident and self reflective, more socially skilled and communicative, who show more initiative and entrepreneurship, who work more methodically and efficient. And these qualifications are just the skills needed for the 21st century! Students from higher education with an education at these types of schools often report differences on these aspects between them and other students. If the outcome of this type of education is more accepted and wanted, we should not hesitate to develop the educational system in that direction.

These wishes, developments and beliefs are leading to a new approach in education: a much more personalized learning environment (PLE) as elaborated in the previous paragraph. This should not be confused with individual learning (we still want pupils to collaborate, learn and work together). ICT can be the key to realize such a PLE.
We will here propose a set up to meet the challenge of a more personalized approach within education. The challenges are related to four main issues: a change of the curriculum, an ICT enriched personalized learning environment, teacher training and the ultimate need for a better performance.

a. The proposed curriculum in lower and higher secondary
In most countries learning objectives are obligatory, nationally or state wise. Sometimes the way the objectives are reached is up to the professionals in the schools, sometimes even the curriculum is more or less established. In all cases there is few space for personal learning goals, and individual growth. We propose here to diminish the core of the obligatory curriculum in *general education* to some 50% of the present size. 30% of the curriculum should be focused on the achievement of 21st century skills, 20% of the learning time should be dedicated to the development of strictly individual talents.
Let us elaborate a bit on these thoughts.
Diminishing the core curriculum to 50% means cutting away a lot of traditional objectives. An example of such a core curriculum for general education could be as follows, just to provoke the discussion:
- mother tongue: speaking, reading comprehension, writing;
- one foreign language: speaking, communicating, reading;
- humanities and social studies: modern history, social geography, general economics, citizenship and cultural understanding;
- mathematics: basic elements of algebra, solid geometry, statistics, problem solving;
- science: multidisciplinary content from biology, physics and chemistry, inquiry learning;
- art and culture: creativity, cultural heritage, handicraft;
- digital literacy: information literacy, using ICT programs, computational thinking;
- physical education

The 30% educational time for achieving skills is also attached to content. But this content should be at the choice of the experts: the teachers and their pupils. They should be able to choose projects with content from selected topics which are most suitable to achieve the skills mentioned in paragraph 4. This content can be derived from nowadays curricula in all the above mentioned subjects and other non-core subjects like for example Latin, philosophy, informatics, a second or third foreign language, etc. But also topical issues and topics chosen because of specific interests of the teacher and/or the learner could deliver suitable content for practising all of these skills:
an international collaborative project on cultural differences, an excursion to a science museum, a internship for vocational skills, setting up a company, making a website, etc., etc.
The objectives of this rather free part of the curriculum are to be arranged within rubrics related to age and ability-group. The personal development should be kept up in a digital portfolio. Assessment should be done twice a year by independent assessors in order to make a distinction between the own teacher in a coaching and supportive role, and the assessor who is also monitoring the quality of the education.

The third part of the curriculum in this proposal is a one-day-per-week opportunity to develop a child's own talent. We know the eight (or nine) intelligences formulated by Gardner (1983, [xlv]): musical–rhythmic ("music smart"), visual-spatial ("picture smart"), verbal-linguistic ("word-smart"), logical–mathematical ("number/reasoning smart"), bodily–kinaesthetic ("body smart"), interpersonal ("people smart"), intrapersonal ("self smart"), and naturalistic ("nature smart"). Later on Gardner suggested that existential and moral intelligence ("value-smart") may also be a valuable add on.
We suggest that pupils – under parental and educational supervision - work on an average level of one day per week on some kind of master thesis on a topic they choose themselves, with the objective to discover their individual talents and to develop those talents.
This could be a musical performance, a debate contest, an investigation on a specific mathematical problem, an artistic painting or sculpture, a piece of research from science or a technical innovation. The results of the master thesis's at the end of every period should be presented towards an external expert, parents, teacher or peer group. In fig.6 we visualize this in the previously created picture.

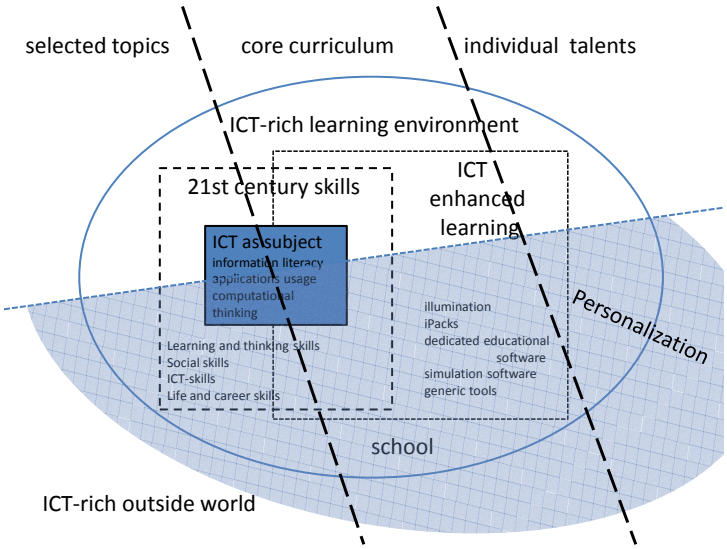

fig.6 A proposal for a more personalized curriculum

For vocational education practical (and specific elements of) subjects such as engineering, nursing, accountancy, construction, etc. should be replace some general content and can also be profitable to developed the skills mentioned.

There will be a lot of debate about the nowadays topics in the different curricula which can be "missed". Few people will be ready to accept that the content which is taught at this very moment may be not so important any more. One way to approach this debate is to leave it to the professionals in the field, the teachers and the pupils. Better than anyone else they are capable to determine content that is relevant, topical, interesting and challenging for themselves. What we need here is trust in teachers, as well as in the kids. Another way of reaching the right core curriculum is to collect experts - not attached to education - to make clear what is needed in a future society and working environment.

By proposing these rather provocative ideas we hope to stimulate that people involved in education (and who isn't?) will argue education fundamentally and are prepared to make a jump into the future.

b. A digital personalized learning environment

The above mentioned Montessori, Dalton and Steiner Schools realized personal growth with paper notes, self made assignments, learner tracking on paper and a lot of effort of the teachers who believed in these types of education. But if we want to realize a more tailor-made learning environment to make personalized education possible on a broader scale, we now have the opportunity: a digital personalized learning environment (PLE). An ideal PLE can differentiate between content, presentation and instructional methodology. This leads, again ideally, to an environment which is adaptive to the starting situation and progress of the individual learner, their level, attention, learning style, gender difference. This makes a more personalized learning path possible and allows the teacher to manage the differences between the students in the group and follow the different learning paths and outcomes.

In the previous paragraph we mentioned several ways to use ICT to personalize education. The ultimate challenge here is that we combine the opportunities provided by the DLEs already available, with the tremendous job to develop (digital) materials that is adaptive to all the differences mentioned. This must be done in another way than traditionally: learning materials and courses mostly developed by educational publishers and through subsidized development projects.

On the one hand we need strong networks of teacher communities to develop *together* materials and common practice. On the other hand we need small new creative organisations and companies to develop materials for specific parts of the curriculum, to create selected topics and to arrange digital sources in a way that they are usable as educational assignments.

c. Teacher training on skills and attitude

A third major challenge here is the professional development of the teachers. In order to use ICT properly and adequately teachers have to be trained in the basic ICT skills with software and hardware. They have to be familiar with social media, the educational use of those platforms, and also with the dangers and threats (such as bullying) which come along with these new ways of communicating. They have to be aware of the didactical possibilities of educational software. They must be able to use learning tracking systems and administrative software. For an extensive overview of teacher's ICT skills see the UNESCO ICT Competency Framework for Teachers (2011, [xlvi]).

To reach the goals of the proposed educational change teachers should also be made aware of their changing role; more coaching and mentoring the learner, prepared to co-learn with the pupils, and more creator and arranger of the educational content.

Last but not least they must be convinced internally that the use of ICT is not an extra worry, but a means to improve the outcome of their teaching activities and to raise the motivation of the pupils. We think that the best way to realize this positive attitude and changing roles is in communities of practice. In the 90s, we created in the Netherlands small networks of some 15 teachers from different schools, working on a specific aspect of their subject (1997, [xlvii]). These networks were homogeneous and worked together for one or two years on implementing new digital methods in the daily teaching practice. Although the available resources were limited and of rather poor quality, compared to the present situation, the measured involvement of the teachers grew from 2.6 to 3.7 at a scale of five at an adapted CBAM-scale.

Of course it is also a good thing to adapt the way of professionalizing the teacher to his or her own style of learning, level of involvement and other contextual circumstances. The Dutch Inspectorate of Education published 6 portraits of teachers, successful in using ICT, interviewed to determine their personal learning path's (2006, [xlviii]).

d. Performance

The final issue here is the performance: the assignment from society to improve general outcome of education. A lot of renewal of the education system in countries all over the world has been enforced because of a low ranking on international comparative scores. It is important for politicians to realize a better ranking as a result of their policy. As we have stated before, we should not use ICT because of the assumption that the outcome will be improved immediately. ICT is just a basic element of the learning environment, as it is in daily life.

And of course: if ICT is that standard part of the learning environment, we should use it in a way that the results are the best. And we - as professional educational community - should be fully accountable for better, more effective education and improved outcome. With the additional remark that outcome should be measured not only in traditional assessment scores, but also in terms of achieving 21st century skills and showing personal growth.

8. Recommendations and questions to be raised

We will end this paper with some recommendations and questions, following from the topics addressed.

- The public debate on the usefulness of using ICT in education is not very relevant any more. We should stop arguing the effectiveness of ICT usage as a reason for using ICT.
  A learning environment, preparing children for a future place in society, as citizen and as professional, is just not complete without ICT. Because of the dominant role of ICT in the modern society we must teach children about ICT: information literacy, using applications and computational thinking. Digital literacy should be an integral part of the curriculum in every level in secondary education
- Achieving ICT skills is part of the broader objective: achieving 21st century skills. The achievement of these skills should also be an integral part of the different curricula.
- To reach these goals we must focus on the best ways to use ICT effectively in our pedagogy. There is a broad variety of ICT applications available to enhance the learning.
- There must be a political debate on the extent of the core curriculum in secondary education, in relation to the time spent on achieving 21st century skills and the development of specific talents of children.
- Within this debate we should think of other ways of assessment to provide accountable measurement.
- Teachers should be trained in basic ICT skills, in the effective use if ICT and in a role which is more coaching and supportive than expert like.
- Schools should realize themselves that a successful ICT implementation path is based on four aspects in balance: vision, professional development of teachers, the availability of digital learning materials and an adequate infrastructure.

Finally we think that personalized learning is the future. In this document we mentioned a series of advantages to shape education along this line of personalization (see paragraph 6). By realizing an educational setting in which personalized learning and teaching is the dominant way of working, we can realize better education, more motivated learners and teachers, and with an improved outcome as a result. But we have to meet several challenges (see paragraph 7). Along with these challenges some questions should be raised and answered.

Challenge 1: a change of the curriculum

- What is needed for policy-makers to open up the teaching and learning and diminish the obligatory core-curriculum? What is needed to reassure them that explicit attention for skills and talents is not counter-productive?
- How do we get convincing examples of projects with which pupils can develop their 21st century skills? How can we create valuable and differentiated educational settings for the development of talent?

Challenge 2: a digital personalized environment

- What organisational and legal issues are to be solved to implement personalized learning adapted to different levels and interests?
- How can we involve the countries lacking resources in this movement given the lack of equipment?

Challenge 3: teacher training on skills and attitude

- Is it useful to distinguish, also legally, between the expert role of teachers and the coaching and mentoring role?
- How should we adapt the framework of ICT abilities of teachers in order to enable them to work with personalized learning situations?
- What are the best settings and pedagogy for teacher training in this perspective, given the fact that it should reflect “teach as you practise”?

Challenge 4: Performance

- How can we gradually change the circumstances to move into this new paradigm?
- How can we measure and assess all the skills mentioned? Can we develop rubrics for attainment levels of these skills? Can we develop formative and summative testing procedures? Should we assess the development of talents?

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