Policy Brief
April 2012

United Nations Educational, Scientific and Cultural Organization
UNESCO Institute for Information Technologies in Education

UNESCO Institute for Information Technologies in Education

ICTs FOR CURRICULUM CHANGE

CONTENTS:

CONTEXT AND OUTLINE OF THE PROBLEM

The development of ICTs in society results in the emergence of new jobs and changes in existing jobs and calls for new curricula at all levels of education. Because of changes in society, it is necessary for students to master ICT literacy to become full-fledged members of society. While the potential of ICTs as a medium for teaching and learning is recognized by many, the implementation of ICTs is often problematic, resulting in the fact that relatively few students worldwide are offered the opportunity to learn with the help of ICTs. Due to changes is society, the concept of schooling is changing as is the concept of curriculum. These changes require policy and leadership practitioners and researchers to develop new partnerships for the development of strategies for implementing ICTs in 21st century curricula, including the utilization of ICTs as a learning tool and as a learning goal. This Policy Brief discusses the roles of ICTs in the curriculum and their implications for teaching and learning.

CONCEPTUALIZATIONS OF COMPUTER USE IN EDUCATION

The development of computer technology from processing information to also supporting communication augmented its potential for education. In particular, the immersion of computers in everyday life, as well as different forms of digital technologies (e.g. tablets, smart phones, robots) require researchers, policy-makers and professionals to rethink the potential of ICTs for education. The term computer technology, often used in the 1960s and 1970s, has been replaced by information and communication technologies (ICTs) or information technologies (ITs) or just technology.

ICTs refer to all technologies used for processing information and communication. Because of the integration of computers with communication systems including audio and video technologies, such terms as multimedia or digital media are also used. Although we realize that the term ICTs has its limitations, it will be used in this Policy Brief because it is a rather well-known term around the world. ICTs refer to a broad concept. Its impact on curriculum, pedagogy and student learning can only be discussed from the perspective of specific ICT applications, either hardware or software that are used in the teaching and learning process.

CURRICULUM PERSPECTIVE ON ICTs IN EDUCATION

Conceptualization of curriculum

Curriculum deals with the goals, content and organization of learning at several educational levels [1]. Increasingly, assessment is also seen as an integrated part of curriculum. A comprehensive approach in which these curriculum components are well attuned to each other is essential to successful curriculum innovations [2], such as the integration of ICTs in the curriculum.

For a long time, the implementation of ICTs was perceived by policy-makers as a matter of provision of hardware and software only. More recently, attention has been paid to the implications of the use of ICTs for curriculum content, learner activities, teacher roles, assessment practices, etc. [3]. The integration of ICTs in curricula is a complex endeavor in which many stakeholders are involved. To better understand the problems related to the implementation of such complex changes as the integration of ICTs in education, a distinction is often made between the intended, the implemented and the attained curriculum [2, 4][1].

[1] Intended, implemented and attained curriculum refers to different curriculum representations. The intended curriculum is the curriculum as intended by policy-makers, as written down in policy documents and curriculum documents. The implemented curriculum refers to the way teachers understand and implement curriculum policy in educational practice. The attained curriculum describes the outcomes of the curriculum: how did students experience the curriculum and what did they learn. These curriculum representations offer a useful framework for understanding and studying the gap between curriculum policy and educational practice.

The competencies needed for citizens in today's knowledge society [5, 6] can be regarded as the intended curriculum – the rationale and goals for learning. However, there may be a gap between the needs of the knowledge society as expressed by policy-makers and the way these needs are understood by teachers and taught in schools, the implemented curriculum. The attained curriculum describes the learning outcomes of students. It is obvious that these learning outcomes are particularly influenced by what has been taught – the implemented curriculum. One of the major challenges in realizing sustainable curriculum change is to create consistency and balance between these different curriculum representations.

Lessons learned:

- Different stakeholders (policy-makers, curriculum development and examination agencies, inspectorates, hardware and software manufacturers, textbook publishers, school leaders, etc.) responsible for the implementation of ICTs in education need to be identified and involved in policy development from the very beginning.
- An implementation plan for the integration of ICTs in education needs to be comprehensive. Investments in hardware and software should be accompanied with investments in teacher professional development and aligned with curriculum and assessment policies. This implies that curriculum content and goals need to be reviewed and examination programs revised.

Rationales for ICTs in education

Rationales form the backbone of the intended curriculum. Rationales for ICTs in education provide policy-makers and other stakeholders (e.g. industry, academia, professionals in education) with arguments for the utilization of ICTs in education. As early as 1990, Hawkridge [7] provided six rationales, which today are still relevant in understanding discussions about the purposes of ICTs in education. In brief, these rationales are:

- *Social rationale:* the need to teach with basic ICT skills in order to prepare students for their place in society.
- *Vocational rationale:* the importance of ICTs in giving students appropriate skills for future jobs.
- *Pedagogical rationale:* the enhancement of teaching and learning with the help of ICTs.
- *Catalytic rationale:* the role ICTs may have in realizing educational change.
- *Information technology industry rationale:* the promotion of the ICT industry in education.
- *Cost-effective rationale:* the expectation that ICTs will reduce costs for education.

Although all these rationales could be recognized in many ICT related policies around the world [8], three rationales are very prominent in the reasoning for the integration of ICTs in the curriculum: the social rationale, the pedagogical rationale and, particularly in vocational education, the vocational rationale.

ICTs in curriculum

ICTs in the compulsory curriculum often emphasize the perceived need that students have to learn about ICTs in education (the social rationale). The term literacy is often connected with this use of ICTs: computer literacy, information literacy, media literacy and digital literacy are common terms used for learning about ICTs. Students have to become literate users of ICTs [6, 8], which is becoming even more important now that ICTs are omnipresent in society [6, 9].

The digital literacy curriculum is either offered as a separate course, or as an integrated part of the curriculum [3, 6]. Apart from a perceived need to prepare all students as literate users of ICTs, more specialized courses also became necessary due to new jobs that emerge through the impact of ICTs on society. It resulted in a call for specialized courses in the curriculum [10], such as computer science courses in the curriculum of upper secondary education.

Because of the emergence of new jobs and the change in existing jobs due to ICTs, the curriculum of vocational education programs is affected. Future car mechanics need to know how to use the computer as a testing device. Future metal workers need to be able to operate a computer-controlled lathe. Being able to use specific ICT applications is increasingly becoming a part of the final qualifications that vocational education students are expected to meet. Due to the fact that in many professional sectors the use of ICTs is essential, the integration of ICTs in programs for vocational education often seems to follow a natural course [3].

Currently, policies in many countries also highlight the pedagogical rationale. ICTs are used as media for teaching and learning. Often this perspective also reflects the catalytic rationale, according to which ICTs are means to transform education [e.g. 11, 12], reflecting the catalytic rationale.

Lessons learned:

- Policy about ICTs in education need to address three roles of ICTs in the curriculum: (1) ICTs as an object of study (at the level of ICT literacy, and at the level of specialized courses); (2) ICTs as an aspect of education, as is the case in vocational education; and (3) ICTs as a medium to enhance teaching and learning.

POTENTIAL AND REALIZATION OF ICTs TO ENHANCE TEACHING AND LEARNING

Potential of ICTs to enhance teaching and learning

Dede [13] described how ICTs are applied to enhance teaching and learning in different theories of learning: behaviorism, cognitivism and constructivism.

In the behaviorist perspective ICTs are used to better attune to the individual characteristics of the learner. Drill-and-practice applications as well as simple tutorials allow the learner to master knowledge and (routine) skills at own pace.

Cognitive theories focus on cognitive understanding of complex concepts and skills. Intelligent tutorials help the learner in developing reasoning and problem solving skills for well-defined content and skills in specific subject matter domains.

Constructivist theories assume that the learner has to (co-)construct new knowledge and understanding through active participation in the learning process. Constructivist approaches to teaching and learning align well with the competencies that are considered essential in the knowledge society [6, 9]. A broad range of ICT applications can be incorporated in learning environments that support constructivist learning, such as general productivity tools (e.g. wikis, blogs, spreadsheets, websites), specific ICT applications to help individual learning (e.g. simulations, data logging, multimedia cases), as well as ICT applications that support collaborative learning (e.g. discussion forums, shared workspaces, virtual worlds). From a constructivist perspective Dede [14] provided an overview on how ICT applications may contribute to curriculum enhancement, which is still relevant and challenging today:

- Realize a curriculum that is centered on real world problems.
- Have students involved in virtual communities of practice.
- Use advanced tools similar to those in today's high-tech workplaces.
- Facilitate guided, reflective inquiry through extended projects.
- Utilize modeling and visualization as powerful means of bridging between experience and abstraction.
- Enhance students' collaborative construction of meaning via different perspectives on shared experiences.
- Include pupils as partners in developing learning experiences and generating knowledge.
- Foster success for disabled and disenfranchised students.

In addition, and as a further elaboration on the last bullet, ICTs can also be a means to realize social inclusion in education through assistive technologies as a response to the needs of disabled students and by providing culturally responsive education for minority students [15]. With the help of ICTs educational resources and their delivery can be relatively easily customized for students with disabilities [16].

ICTs can also serve as a means for preserving the cultures of minorities. On the one hand, ICTs can contribute to the loss of culture, on the other – ICTs can also empower minorities to create culturally relevant content to enhance education [17].

Use of ICTs in educational practice

One should realize that, although constructivist approaches to education may be of interest to scholars, mainstream educational institutions still largely practice a more traditional approach to education. The picture that results from large-scale international monitoring studies shows that the inclusion of computers in the curriculum is still scarce and that there is a big gap between the expectations one might have about the added value of ICTs for the curriculum and the classroom reality [19, 20].

However, a more optimistic picture emerges despite these facts. The data of the Second International Technology and Education Studies (SITES) [21, 22, 23] show that a substantial group of schools and teachers worldwide incorporate teaching and learning practices that support innovative pedagogies with a clear and indisputable role for ICTs. The three SITES studies provide a rich international database for understanding the characteristics of these ICT-supported pedagogical practices that try to comply with changing requirements for education in the knowledge society.

The findings suggest that in ICT-supported pedagogical practices students are actively involved in their learning in (research) projects through searching for information and through creating and presenting/publishing products. Students have more opportunity to plan their own learning and increasingly play a role in the assessment of their own or their fellow students' performances. Such student practices foster the realization of goals that are considered important in the knowledge society.

Commonly available ICT applications, such as the Internet, word processing and presentation software support the realization of these innovative pedagogical practices more than ICT applications specifically designed for educational purposes. Although ICT-using teachers still report that their students are more frequently involved in activities that comply with traditional education, they consider practices that align with the knowledge society as important [18]. The findings of the SITES studies also suggest that curriculum content does not change much in the ICT-supported pedagogical practices. The reason is that curriculum changes are often limited by national policies which determine what content should be taught and examined.

It appears that often national policies are not yet in place to mobilize ICTs in support of significant curriculum changes and education reforms [24]. Instead of new curriculum content, new goals are aimed at competencies needed in the knowledge society, such as information handling, meta-cognitive skills and collaborative skills. An important finding is that ICT basic skills are not often offered as a separate course in the curriculum, but are part of other competencies relevant for the knowledge society [24].

Lessons learned:

- The integration of ICTs in education offers possibilities to develop curricula that align with the challenges of the knowledge society. However, national curriculum policies often do not support and facilitate such use of ICTs.

IMPLEMENTATION OF ICTs IN EDUCATION: INHIBITORS AND DRIVERS

Inhibitors for implementation of ICTs

There are a variety of obstacles that hinder the integration of ICTs in the curriculum. A major problem is the lack of communication and leadership between macro-, meso- and micro-levels in education. This lack of communication results in limited access to ICTs in schools, problems with tuning ICT-enhanced learning environments with the curriculum, a lack of a shared vision at the school level and insufficient ICT integration competencies of teachers [25]. Curriculum-related problems impeding the integration of ICTs deal with the way ICTs are present in national curriculum standards and student textbooks. Although many student textbooks nowadays contain integrated software packages or links to websites, more advanced uses of ICTs are often lacking. In addition, advanced use of ICT requires more time than available in lesson periods of 45 minutes, in which many schools have organized their curriculum [3]. These obstacles also refer to a broader discussion about curriculum goals, content, structure and the role of ICT in a curriculum that matches requirements of the knowledge society [6].

Drivers: teacher as a designer of ICT-enhanced curricula

Teachers are seen as key to the integration of ICTs in the curriculum. The way they use ICTs is affected by will (attitudes toward IT), skills (ICT competencies) and access to ICT tools [26]. ICT competency is not limited to basic ICT knowledge and skills, because the meaningful use of ICTs in education requires teachers to develop knowledge and skills that enable them to integrate ICTs with a suitable pedagogical approach for teaching specific subject matter in a certain context [27]. Koehler and Mishra [28] introduced the term Technological Pedagogical Content Knowledge (TPCK) to highlight the importance of interaction between subject domain knowledge, pedagogical knowledge and technological knowledge as a conceptual framework for describing the kind of competencies teachers need to integrate various ICT applications in their curricula. On the one hand, there is a need to develop teachers' competencies to integrate ICTs in education effectively. On the other hand, there is a growing understanding that teachers need to be actively involved in shaping curriculum innovations, such as ICT-enhanced curricula [29, 30], and that the relationship between teachers and curriculum innovations should become more reciprocal [31]. From this perspective teachers' active involvement in the design of ICT-enhanced curricula is seen as a promising approach [32, 33, and 34].

Integration of ICTs in curriculum as systemic change

Studies on the implementation of educational change clearly show that teacher change alone is not enough to make educational change happen. Teacher change should be part of a systemic change effort. School-wide integration of ICTs is an important factor to foster sustainable ICT implementation [35, 36]. At the school level a shared vision, opportunities for teacher development in ICT integration and the provision of technical and human support structure are necessary for the successful implementation of ICTs [36]. Factors that foster school-wide integration of ICTs include a strong connection between pedagogical aims and ICTs, strong leadership, school-wide adoption of ICTs, a focus on the process of ICT implementation, a collaboration with external partners (including those from the private sector) and with other schools (to share ideas and approaches) and being able to cope with new trends [35]. These findings emphasize that it is very difficult for isolated teachers to realize the changes that are needed. Also policy supporting educational change towards teaching in the knowledge society is affecting teachers' orientations towards

ICT. The important role of policy is shown in a study of Law, Lee, and Chan [37]. Their study found a decreasing orientation towards 21st century learning of teachers in some European countries in the early 2000s, and a growing orientation in some Asian countries in the same period could be traced back to a change in the respective national policies. For instance, the 1997 and 2003 Ministry of Education of Singapore's masterplans for ICT in education serve as an integrated part of a broader educational reform initiative. The implementation plan includes teacher professional development and specific initiatives to align curriculum, instruction and assessment innovations supported by ICTs [37].

Lessons learned:

- Successful implementation of ICTs in education requires the school-wide integration of technology.
- Formats for teacher professional learning on ICTs in the curriculum need to be based in the workplace and focus on teachers' active involvement in designing ICT-enhanced processes.

RECOMMENDATIONS FOR POLICY AND PRACTICE

- Ministries of Education need to develop clear policies on how to support the implementation of ICTs in the curriculum by setting standards for students, teachers, professional developers and administrators (e.g. http://www.iste.org/standards; and http://unesdoc.unesco.org/images/0015/001562/156207e.pdf39).
- Developments in the knowledge society ask for new types of literacies. Digital literacy should not be regarded as a separate set of skills, but should be integrated in skills needed in the knowledge society and in core subjects [38].
- There is a growing need to prepare students for jobs that require specialized uses of ICTs. Although vocational education usually offers such programs, the question remains whether we need to make students aware of the possibilities of ICTs as a professional opportunity. From this perspective specialized ICT courses in the general curriculum need to be reconsidered [10].
- Changes in society imply that the concept of schooling is changing, with the virtual high school in the US (http://thevhscollaborative.org) and the Khan academy (http://www.khanacademy.org/) being clear examples. The restructuring of schools is a major undertaking that requires effective leadership and engagement of all stakeholders in developing partnerships between public and profit-making enterprises involved in education, in assuring quality and in finding new models for the organizational development of networked schools [38].
- New approaches to teacher professional development, those that are closely attached to learning in the natural setting of the workplace, should be adopted. While involvement in educational design both fosters teacher professional development and sustainable curriculum innovation, budgets for teacher professional development should be allocated to provide teachers with an opportunity to collaboratively design and implement ICT-enhanced curricula.
- For social inclusion with the help of ICTs to occur, cultural leaders, policy-makers, educational innovators, and the private sector must establish partnerships to help communities build capacity to access ICTs and foster their use in education and other sectors [15].

- Finally, policy-makers, practitioners and researchers need to work closely together to incorporate ICTs in 21st century curricula, including the utilization of ICTs as a learning tool and as a learning goal. To realize such collaboration, a global community of policy-makers, researchers and teachers, such as the one that is being built by EDUsummIT [38], is a sine qua non for moving education systems into the digital age.

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Three rationales are prominent in the reasoning about integration of ICTs in the curriculum: the social rationale, the vocational and the pedagogical rationale. All students need to master ICT literacy to become full-fledged members of society (the social rationale). Because of the emergence of new jobs and the change in existing jobs due to ICTs, the curriculum of vocational education programs is affected (the vocational rationale). While the potential of ICTs as a medium for teaching and learning is recognized by many (the pedagogical rationale), the implementation is often problematic, resulting in the fact that relatively few students worldwide are offered the opportunity to learn with the help of ICTs.

To effectively integrate ICTs into educational practices teachers need to develop competencies which will help them to integrate domain knowledge, appropriate pedagogy and knowledge about ICTs. Teacher development should be part of a systemic change effort focusing on the school-wide adoption of ICTs.

Author: Joke Voogt

Published by the UNESCO Institute
for Information Technologies in Education
8 Kedrova St., Bldg. 3
Moscow, 117292
Russian Federation
Tel: +7 (499) 129 29 90
Fax: +7 (499) 129 12 25
E-mail: Liste.info.iite@unesco.org
http://www.iite.unesco.org

Printed in the Russian Federation

ISSN 2221-8378