

NUMERACY AS A BASIS FOR LIFELONG LEARNING IN THE EUROPEAN UNION COUNTRIES

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ABSTRACT

The European Commission describes literacy and numeracy in combination with problem solving, as key components for being successful in society. Most people are aware of the need of literacy, but numeracy is still not seen as being crucial to survive in society. However, results from international studies show that in general people with lower education perform less well in literacy as well as in numeracy than people with a higher educational background. Being numerate in particular will become more and more important in the contemporary and future society. Literacy and numeracy are the key for lifelong learning and for social inclusion.

This article emphasizes the need for numeracy as part of lifelong learning. The first section describes how the concept of numeracy evolved from basic skills to key competencies. In the second and third sections learning and teaching methods in adult education have been explained. In the fourth section the European Numeracy Framework has been explained as part of the formal education system in Europe and embedded in the European Qualification Framework.

Keywords: education, numeracy, literacy, adult education, numeracy education, literacy and numeracy, social inclusion.

MATEMATIČNA PISMENOST KOT TEMELJ ZA VSEŽIVLJENJSKO UČENJE IN DRUŽBENO VKLJUČENOST – POVZETEK

Evropska komisija opisuje pismenost in matematično pismenost v kombinaciji z reševanjem problemov kot ključni komponenti za to, da je človek uspešen v družbi. Večina ljudi se zaveda potrebe po pismenosti, matematični pismenosti pa se še vedno ne pripisuje bistvenega pomena za preživetje v družbi. Vendar rezultati mednarodnih študij kažejo, da ljudje z nižjo izobrazbo na splošno niso tako uspešni kot ljudje z več izobrazbe. Še posebej matematična pismenost bo postala čedalje bolj pomembna v sodobni in bodoči družbi. Pismenost in matematična pismenost sta ključnega pomena za vseživljenjsko učenje in družbeno vključenost.

Prispevek poudarja potrebo po matematični pismenosti v procesu vseživljenjskega učenja. Prvi del opisuje, kako se je koncept matematične pismenosti razvil iz osnovnih veščin v ključne kompetence. V drugem in tretjem delu se pojasnjuje načini učenja in poučevanja v izobraževanju odraslih. V četrtem delu se pojasnjuje Evropski okvir matematične pismenosti kot dela formalnega sistema izobraževanja v Evropi, ki je del Evropskega okvira kvalifikacij.

Ključne besede: izobraževanje, izobraževanje odraslih, matematična pismenost, pismenost, socialna vključenost.

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LITERACY AND NUMERACY IN EUROPE

Over the last fifty years lifelong learning has become more and more a substantial part of education in general, mainly due to technological developments in society. Adults are supposed to keep up with and adjust flexibly to new developments that may influence their ways of

functioning in work situations and their participation in society. In practice it appears that this is easier for adults with higher educational backgrounds than for adults with lower education. The latter are more vulnerable in situations of company reorganizations and at risk

for losing their jobs. An average of about 8.5 percent of the citizens in European countries are unemployed in the year 2011¹. The current global financial and economic crisis is even worsening the situation. Today the need for social inclusion is an essential issue.

Since the foundation of UNESCO² in 1945, after World War II, the problem of illiteracy has been a worldwide concern. Today, about 800 million adults all over the world are still illiterate. Two thirds of them are women. In Europe this is about 30% of the population. (OECD, 1997). Since 2000 around 69 million children worldwide have yet remained out of primary schools. The UNESCO defines literacy as the “ability to identify, understand, interpret, create, communicate, compute and use printed and written materials associated with varying contexts. Literacy involves a continuum of learning and enabling individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society.”³

Over the years the definition of literacy has changed several times and has been adjusted to the developments of the information society, in which technology is becoming more and more important in every individual’s life. Today, there is still no universal definition of literacy, but there is a clear agreement that it must include reading, writing and understanding numbers in order to allow individuals to keep up with the ongoing changes in society. Understanding numbers was originally seen as part of literacy and was often described as quantitative or mathematical literacy. Quantitative literacy was also part of the first International Adult Literacy Survey (IALS). This survey was organized on behalf of the Organisation for Economic Co-operation and Development (OECD, 1997). The results showed that about one third of the adults in Western countries possessed a very low level of reading and quantitative literacy skills, and on this basis it was concluded that many adults may not be able to adjust ea-

sily to new technological developments. The need for lifelong learning was born. From then on more attention has been paid to what kind of mathematical knowledge and skills adults need to cope with in their lives. It soon appeared that school mathematics was not directly applicable to real-life situations. The difference between learning mathematics at school and doing mathematics in real-life situations became clear. Also, the way in which adults learn mathematics differs from the way in which students do it at school. To recognize these differences and to prevent math anxiety, which adults often feel with regard to mathematics, the word ‘numeracy’ came to be used in adult education in English-speaking countries, in particular in Australia and in the United States of America. To translate the term into other languages is often hardly possible because the concept of numeracy is not yet familiar in many countries. Alternative terms, such as ‘functional mathematics’ and ‘math for everyday life’, are used.

In the past ten years and with the focus on the future, the emphasis in adult literacy moved from knowledge and skills to underlying processes that are the basis for the development and processing of new information. In 2003, the Definition and Selections of Competencies project (DeSeCo) defined the broader notion of competency as “the ability to meet individual or social demands successfully, or to carry out an activity or task”. DeSeCo conceptualizes competencies as internal mental structures, which are the abilities, capacities or dispositions embedded in the individual:

“Each competence is built on a combination of interrelated cognitive and practical skills, knowledge (including tacit knowledge), motivation, value orientation, attitudes, emotions, and other social and behavioral components that together can be mobilised for effective action. Although cognitive skills and the knowledge base are critical elements, it is important not to restrict at-

tion to these components of a competence, but to include other aspects such as motivation and value orientation.” (Rychen & Salganic, 2003:8-9)

In the coming international comparative survey, the OECD Programme for the International Assessment of Adult Competencies, (PIAAC)⁴, starting in 2012, the emphasis is no longer on the traditional concept of literacy, but on the underlying competencies for acquiring and processing information. PIAAC aims to assess literacy skills of adults, including familiarity with information and communication technologies and the ability to manage information, construct new knowledge and communicate with others. PIAAC focuses on direct assessment of reading literacy which the previous national and international assessments have shown to be an essential foundation for individual success and on the development of other competencies that can be considered as sufficiently sustainable factors to be monitored over time. They include numeracy, ICT and problem solving. PIAAC identifies six underlying processes that reflect these competencies: accessing, managing, integrating, evaluating, constructing and communicating information (Schleicher, 2008).

Literacy and numeracy are not only the basis for the development of the individual, but also for the development of the society. The average level of education of individuals influences the technological and economical developments of a country. Schleicher (OECD, 2006) explains in *The Lisbon Council Policy Brief* why education is the key for Europe’s success. He indicates that “The most effective modern economies will be those that produce the most information and knowledge.” For this reason, countries must invest in higher and university education. “Faced with a rapidly changing world, Europe’s school systems will have to make considerable headway if they are to meet the demands of modern societies.”⁵

This means that people at low educational levels are at risk and vulnerable in their societal positions and mobility. They are understood as “having a high propensity to experience unemployment, poverty, ill-health, being a victim of crime, social isolation and related desiderata”⁶. The PISA study 2009 shows that this concerns about 15% of all European students aged 15-25 years.(Schleicher, 2006).

Numeracy competencies

Numeracy is seen in PIAAC as one of the sustainable components for measuring the development of individuals and the economical and technological position of individual countries in comparative international studies. Just like literacy there is also no universal definition for numeracy. In the Adult Literacy and Life skills survey⁷, a follow-up of the IALS survey, an overall description of numerate behavior was provided, which covers the concept of numeracy by describing competencies. It is applicable in every individual situation (Gal, Van Groenestijn, Manly, Schmitt & Tout, 2005).

Numerate behavior involves:

- *managing a situation or solving a problem in a real context* (everyday life, work, societal and further learning)
- *by responding* (identifying or locating, acting upon or communicating)
- *to information about mathematical ideas* (quantity & number, dimension & shape, pattern & relationships, data & chance, change)
- *that is presented in various ways* (objects & pictures, numbers & symbols, formulae, diagrams & maps, graphs, tables, texts)
- *and requires activation of a range of enabling knowledge, behaviors, and processes* (mathematical knowledge and understand-

Literacy and numeracy are the basis for the development of the individual and the society.

ding, mathematical problem-solving skills, literacy skills, beliefs and attitudes).

Numerate behavior can be observed in all situations in which adults have to deal with numbers. It is not always necessary to do computations. In many situations locating, identifying, interpreting and giving meaning to numbers will do. In other situations adults may have to do accurate computations, for example in professional situations or in order to keep control over their own monthly budget. Though people are not always aware of their daily mathematical activities, they deal with numbers in some way every day. Acting adequately in real-life situations requires that adults have acquired sufficient mathematical knowledge and skills, but, in addition, they must know what, when and how to use mathematics in practical situations. This means that they also had to develop problem solving skills, reading skills and reasoning skills to be able to communicate the mathematical issues they encounter, as well as a good feeling for numbers. Numerate behavior includes four main components:

First: knowledge and skills in four domains: numbers; proportions and proportional reasoning; measurement, shape and space, geometry; data processing.

Second: understanding real-life situations in which mathematical action is required. This may be shown by giving meaning to numbers, using mathematical language, communicating mathematical issues, understanding and using formulae, a good feeling for estimations and doing accurate computations when necessary, using tools for doing computations, such as a calculators or ICT, in an appropriate way.

Third: self-confidence in managing and solving mathematical problems and issues in real-life situations, in combination with reflection on their own actions.

Fourth: an open mind and attitude to new (mathematical) information.

These four components cannot be seen as separate competencies. It is the total that enables

people to act in a competent way in real-life situations in which mathematical action is required. Numerate behavior depends on the entity of these four components.

The fourth component is the basis for keeping up with new developments and processing new information that may require some adjustment of the first three components. This component also indicates that numeracy is a dynamic concept⁸. The content may evolve over the years, depending on new technological and societal developments. This requires adults to flexibly and continuously renew and adjust their own mathematical knowledge, skills, beliefs and attitudes. Lifelong learning is a precondition for this. As Schleicher describes in the Lisbon Council Policy Brief (2006: 16): “Success will go to those individuals and countries which are swift to adapt, slow to complain and open to change.”

LEARNING NUMERACY IN ADULT EDUCATION

Since the beginning of adult education it has been assumed that adults learn in a different way from children. The circumstances and environment in which adults and children learn differ. In compulsory school children have to learn a lot in regular school settings every day. The way in which they learn is often subjected to what they have to learn and depends on the way the teacher teaches. Learning situations for adults are often quite different. They live several lives simultaneously, as parents, citizens, workers, volunteers and learners. They learn a great deal in informal ways in the course of their life, on the shop floor, in leisure and pleasure. When they go back to school, they have a specific need to learn, e.g., they must have a diploma or do further training for a job. In the past decades studies showed the ways and conditions in which adults learn in practice (e.g. Greeno et al, 1999; Lave, 1988). Derived from these studies have been the se-

ven main points, described in “*A Gateway to Numeracy*” (Van Groenestijn, 2002: 184-187). These main points form the basis for learning numeracy in adult education in the project Mathematics in Action⁹ (Van Groenestijn & Lindenskov, 2007: 23–25).

- 1) *Adults are free to learn.* (Rogers, 1969). There is no compulsory education for adults.
- 2) *Learning happens in a functional situation.* (Resnick, 1987) There is a need for learning.
- 3) *Learning in practice is characterized by learning through authentic materials.* Whereas in school situations learning often takes place through textbooks, photos, schemes and with the help of artificial hands-on materials, in practice this can be done in the actual situation with authentic materials.
- 4) *Every learning situation is a socio-culturally determined situation.* Referring to Vygotsky (1978), Saxe (1991) states that social interactions are redirected by social and historical influences. These affect natural processes in cognitive development. In essence, learning is an *interactive and social act* in which everybody takes part. *Communication* including talking about problems which need to be solved and in what way, is an essential part of the learning process and the starting point of developing reasoning skills and problem solving strategies and skills.
- 5) *Learning in practice focuses on “shared cognition” rather than on “individual cognition”* (Resnick, 1987). Though of course there are also situations in which people function individually, in a work setting employees may often be complementary to one another, like a chief and a secretary, a nurse and a doctor, a car salesman and a technician. In many work settings people only have very specific tasks without having insight in the full production process of the product to be made, e.g. in the auto-

mobile industry. There are only a few people who need to have the overall overview of the entire production process. In other situations, e.g. in a garage, employees can help each other with problems that cannot be solved individually. In such situations people learn to ask questions, to discuss the problems they meet, to look jointly for solutions and to work cooperatively.

In school settings, on the other hand, learners are often expected to do their work individually and are assessed on their individual knowledge and skills¹⁰.

- 6) The way in which learning in practice takes place is often *via showing - imitating - participating and applying*. There is no need to create specific instructional settings. People spontaneously work cooperatively when the situation requires to do so, like in work and family settings. In school settings we have to create such “practical” learning situations, based on instructional constructs in order to learn to work cooperatively. (Resnick, 1987)
- 7) For learning in practice people construct or re-construct their own “*rules-of-thumb*” and informal “*rules and laws*” for managing actions, situations, materials and the environment in which they work.

The way in which adults process new information in real-life situations is often not through textbooks, as it is in school. Information in real life is embedded in sources like TV bulletins, newspapers, journals, texts, graphs, charts, tables, etc. Analyzing and understanding such information requires literacy and numeracy skills and notions of statistical concepts (Curry et al, 1996; Dossey, 1997; Gal, 2000). Adults are often supposed to acquire and process new information in their own informal ways, through “learning by doing” and through “learning by experiences”. However, when analyzing such processes, in general the

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following details in adults' actions can be observed (Van Groenestijn, 2002):

- read about, listen to or look at information
- give meaning to the information
- identify key points in the information
- reflect on *what is "new" to me?*
- communicate, discuss with others
- reflect on possible implications for personal life. *What does it mean to me?*
- reflect on possible implications for society or work.

A similar process takes place when adults have to manage or solve an actual problem in a real-life situation, for example when they are at work. In such situations adults may encounter new information they have to deal with and they may ask themselves questions and act as follows:

- Locate and analyze the situation
- Give meaning to the problem in the situation
- Identify the mathematical and other relevant information in the situation
- Activate pre-knowledge: what do I know about this problem? Have I met this before?
- If so, is it the same or a similar problem?
- If not, what do I recognize in this problem and what is new to me?
- Where can I find more information about how to deal with this problem?
- Plan and discuss possible steps to solve the problem
- Select a solution procedure
- Do computations or implement other mathematical processes, as required.
- Make judgments, where necessary
- Check possible consequences
- Make decisions and
- Reflect on the process.

Research into situation-bound learning shows that new information is always relevant for adults (see for example Hoyles & Noss (2000), Steen (1997)). It is meaningful, useful and applicable in situations they encounter in their own individual lives.

A disadvantage of this way of learning may be that it may lead to context-bound knowledge and skills. Adults may experience difficulties when they have to solve similar problems in different situations. It is not self-evident that adults are able to transfer the knowledge they acquired in one situation to a different similar situation. In order to develop flexibly applicable knowledge and skills it is necessary for adults in adult education to get familiar with mathematical activities in a variety of more general situations, in addition to developing the necessary knowledge and skills they need for their own individual purposes.

In order to create a sustainable basis for further learning and for better mobility possibilities in the labour market, numeracy in adult education must focus on broadening adults' horizons.

TEACHING NUMERACY IN ADULT EDUCATION

Teachers are used to teaching. In adult education this might be a didactical trap. Adults come back to school with individual purposes. They have often experienced problems in school in learning mathematics and may not have good memories of that. They only want to learn what they need to learn. Adult learners may be experts in their professional lives, but in school they depend on the teachers. To recognize the ways in which adults learn in real-life situations and to meet the individual purposes of learners, teachers must be professionals who know how to encourage adults to learn 'mathematics for everyday life' and are capable to facilitate learning. Adult learners and teachers are equal partners in learning.

The first condition is that learners are aware of the ways in which they learn best. Teachers must discuss the learning steps, as described in the previous section, with the learners. Learners must realize that learning numeracy is not only about learning percentages, fractions, measurements or budgeting. It involves more. The four components of numerate behavior must be discussed with the learners, and learning acti-

vities must be meaningful. Learning through contexts is the best way to work on developing numerate behavior. Practising actual mathematical subjects, such as calculating percentages, makes sense, but adults must realize that this is only ‘part of’ what they really need to learn.

The second condition is that learning must be meaningful. Adults’ own individual situations are the starting points for learning. If possible, mathematical subjects should be related to their individual situations. The subject “calculation of percentages”, for example, can be related to their work situations but also to situations in which customers deal with percents, or to societal activities like polls. Authentic materials are the ingredients of meaningful learning.

As a third condition it is required that adults get familiar with appropriate tools for doing computations in an easy way. Being familiar with a calculator is a must. In addition, it is necessary for adults to learn to work with spreadsheets, e.g. Excel, budgeting software or other job-related software programmes.

Finally, as the fourth condition, teachers should try to broaden their learners’ horizons by offering more general contexts, related, for instance, to societal situations like health, wellness, sports, budgeting in general, environment, education, in order to help them become competent citizens. Adults must learn how to communicate mathematically, give meaning to new information, make decisions.

When organizing learning in this way, teachers may apply the ‘six steps’ for processing new information. This can be done in authentic situations or in situations representing recognizable situations. The six steps come from the project ‘Mathematics in Action’ (MiA)¹¹ and are also described in the handbook of the European Numeracy Framework (ENF)¹².

1) Place the learner in a potential mathematical situation

Such a situation could be ‘sales’, for example. The teacher knows that the learners may enco-

unter a mathematical problem in the situation. The teacher organizes a ‘sales’ situation by, for example: – putting the learners into a real, authentic situation, e.g. in a department store or a street market

- asking them to tell a story about their experiences concerning sales
- showing something with a discount price (either the learners or the teachers) e.g. show a coat priced 150 euro with a label: 15% off

2) Identify problems in the situation

Focus or zoom in on mathematical problems, e.g. the learner says: “I don’t know how to calculate the new price. I just pay the amount at the cashier desk they ask me to pay”

3) Plan the problem solving procedure

The teacher challenges the learners to solve the problem: “*How do you think you can solve the problem?*” Learners may find all kinds of informal and formal problem solving procedures. The teacher’s task is to interact with the learners and try to discover what learners know and can do and what they don’t know or do wrong, e.g. the learner states that 10% reduction is always 10 euro off.

4) Do the problem solving

At this point the learning process can start, e.g. by discussions among learners (interaction). Try to connect this with the learner’s previous knowledge and good conceptions, e.g. the learner knows that 50% is a half. *How would you go on?*

5) Check the result

Can the learners explain why their answers or solutions are correct or not?

6) Review the process. What did the learner learn?

The learners discuss what they learned. *What is new to me? What does it mean for me in my personal life or in my work situation?*

These six steps can be applied to every real-life situation. They may help the teachers to create in school situations that closely resemble real life. When both the teachers and learners are aware of these six steps, then they get more and better involved in the learning process itself. It may help the learners to discover what they already know and what they really need and want to learn. It may also help the teachers to find out how they can support and coach their adult learners in such a way that adults feel independent and can organize their own learning processes. In this way the general premises of adult learning are recognized.

Going through this process requires qualified numeracy teachers; they must be good professionals, experts in learning and teaching in adult education, who know how to develop numeracy competencies and numerate behavior and are capable to facilitate learning for adult learners.

THE EUROPEAN NUMERACY FRAMEWORK (ENF)

From 2009 till October 2011 the Grundtvig project *In Balance*¹³ was conducted. It aimed to develop and establish a European Numeracy Framework (ENF) to ensure quality in adult numeracy education, based on the key principles of numeracy competence, as described in Section One, and four content domains and ways of adult learning. The ENF is aligned with the Common Quality Assurance Framework (CQAF), as developed for vocational education and training (VET) in Europe and tuned to the new European Quality Framework¹⁴. In doing so it offers a fine-grained coverage of the lowest parts of the EQF (Level 1 and 2), thus enhancing links among mathematics-related vocational qualification at all levels of attainment. The ENF is also aligned with UNESCO's ISCED levels 1 and 2 and bridges levels 2 and 3. These alignments enable the ENF to function as the first generation

baseline scale for determining the comparability of mathematics/numeracy related qualifications across the EU.

In summary, the ENF

- can be used in adult education in general and in courses for lower vocational educational training (VET),
- establishes standards for adult numeracy education in general and implies improving the quality of teaching numeracy in adult education and VET,
- facilitates better access to lifelong learning programmes, in particular those for disadvantaged people,
- offers possibilities for adults to improve their numeracy competencies for social inclusion,
- enhances accountability for the use of adult mathematics education resources,
- enhances adults' mobility in Europe,
- offers possibilities for professional development of teachers in adult education.

The ENF is also a means to draw more explicit attention to the need for good numeracy education in Europe. Though the importance of numeracy compared to literacy is equally recognized all over the world and is mentioned in many OECD documents as a sustainable factor to measure individual and societal development, in practice numeracy education is lagging behind literacy education. Learners in adult education must be convinced of the impact of numeracy in their personal and societal lives. In general, all adults must be aware of the need for lifelong learning. This also depends on the policy of governments and other stakeholders. But lifelong learning actually begins, as Schleicher (2006) states it in the Lisbon Council Policy Brief, already in primary school. Countries must invest in quality primary and secondary education. The reality is that people who have not completed upper secondary school are on average less than half as likely to be found in post-school education and training programmes in most European

countries. Particularly at risk are the 15–19-year-olds with incomplete secondary education or VET.

CONCLUSION

Education in schools cannot rely only on what can be learned from the past, it must prepare students for new developments and future challenges. Policy-makers and educators are to work on improvement of the quality of education in schools, focusing on lifelong learning and future developments. Numeracy is an essential part of lifelong learning. The underlying components of the competencies needed for processing new information, as described in PIAAC, are the starting points for adult numeracy. The goal in adult numeracy education is to further develop numeracy competencies in individuals and to focus on what adults really need in order to participate in the contemporary and future society.

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 - 2 The United Nations Educational, Scientific and Cultural Organization (UNESCO) was founded in November 1945. The UNESCO's mission is to contribute to the building of culture of peace, the eradication of poverty, sustainable development and intercultural dialogue through education, the sciences, culture, communication and information. (pdf retrieved from <http://unesdoc.unesco.org>)
 - 3 retrieved from <http://en.wikipedia.org/wiki/Literacy/>
 - 4 PIAAC is the third international comparative study of adult literacy of OECD, after IALS (1995 and 1996) and ALL (2002). It aims to assess underlying competencies for literacy in the today's information society.
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 - 7 The ALL survey was the follow up study of IALS. In this study quantitative literacy was replaced by numeracy.
 - 8 Van Groenestijn described numeracy as "a dynamic concept that encompasses mathematical content that may change over the years or may still be invented in the future, due to technological developments". Van Groenestijn, M. (2002). *a Gateway to Numeracy, A Study of Numeracy in Adult Basic Education*. Utrecht, Netherlands: CD Press.
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 - 10 Though students in school settings in recent years are more often expected to work together on problem-based and joint tasks, they are still assessed on what they can do individually. A student mostly passes or fails a test independent of the performances of other students. With the current changes in the adult education system, it should also be possible that students who work on joint tasks are assessed on cooperative learning aspects and study skills in addition to their individual competencies and their proficiencies in individual tasks.
 - 11 Van Groenestijn, M. & Lindenskov, L. (eds.) (2007). *Mathematics in Action – Commonalities across Differences. Handbook for Teachers in Adult Education*. Woerden: ALL Foundation, NL, pp. 31-33. Grundtvig-1 project: 116676 – CP – 1 – 2004 – 1 – DK – Grundtvig – G1 (2004-2007)
 - 12 The ENF is a result of the Grundtvig project *In Balance*. This project is the follow-up of the Grundtvig project *Mathematics in Action (the MiA project)* and was executed in the years 2009-2011.
 - 13 In this project six European countries created a European Numeracy Framework as a basis for embedding adult numeracy education in the formal European Quality Framework. The result of this project was a handbook for teachers in which the joint theory is developed and examples of this theory, the six steps, applied in the partner countries, are described (Van Groenestijn & Lindenskov, 2007).
 - 14 The European Qualification Framework from the European Commission replaces the ISCED standards. It offers the possibility to internationally compare national education systems.