# UNIVERSITY OF SZEGED FACULTY OF ARTS DOCTORAL SCHOOL OF EDUCATION INFORMATION AND COMMUNICATION TECHNOLOGIES IN EDUCATION

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## MEASURING ICT LITERACY AMONG GRADE 5-11 STUDENTS:

## CONFIDENCE IN ACCESSING INFORMATION

## PHD DISSERTATION

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#### Introduction

Our present-day society witnesses an accelerated technological development in all fields of life. The value of knowledge has changed, the importance of the ability to use knowledge to achieve certain purposes has been highlighted against other forms of knowledge. The notion of literacy has been reframed and elaborated (Csapó, 2008; Greenhow & Robelia, 2009; Griffin, McGaw, & Care, 2012; Koltay, 2010; Kondor, 2003; Molnár, 2011; OECD, 2010). The basic skills of reading, writing and arithmetic are no longer sufficient assets to maintain a conscious attitude towards studying, working or for the broader range of an individual's daily responsibilities as a citizen (Binkley et al., 2010; Griffin et al., 2012; UNESCO & Microsoft, 2011; NAGB, 2013). New concepts and content regularly emerge and need to be learned, skills, abilities and competencies are to be developed to succeed and progress in everyday life including as actors in the labour market or in the economy in general (Ainley, Fraillon, Gebhardt, & Schulz, 2012; Tongori & Pluhár, 2014). Computer-based work environments have raised the expectations of employers regarding the competencies of employees. Performance oriented employers and work places attach a high value to the individual's ability to solve problems effectively through efficient information search (Leu, Kinzer, Coiro, Castek, & Henry, 2017). The new concept of literacy involves those online search strategies without which there is no effective navigation in an Internet environment (Leu et al., 2017). Being digitally literate is unavoidable when the busy individuals of the 21st century society intend to arrange their banking, flight, theatre or hotel booking or do their shopping at a time chosen by themselves, contact close and distant friends, search or apply for a position, use one of the numerous online or computer applications while working, submitting a project or registering for a course at either stage of lifelong learning (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2015; Tongori & Molnár, 2018).

In our developed society millions of people use the internet both for communicating and as a source of information. The exponential growth of the worldwide web (Nelliyullathil, 2013) has brought about the necessity of handling the flow of information in a critical way (Metzger & Flanagin, 2013). The confident use of information and communication technology (ICT) is essential for responsible citizenship, decision making (Czirfusz, Habók, Lévai, & Papp-Danka, 2015) and efficient daily life management (Tongori, 2013b). But taking critical attitudes and approaches toward the information and knowledge that may be gained through such technologies is especially crucial (Metzger & Flanagin, 2013).

Technological development and the necessity of digital literacy has posed a challenge for education and has triggered novel ways of assessing and developing 21st century skills (Molnár, 2011). Assessment and developing of ICT literacy related skills and ability components have become major educational concerns (Educational Testing Service [ETS], 2002; Organisation for Economic Co-operation and Development [OECD], 2010; Oktatás és képzés, 2004; R. Tóth & Molnár, 2009; United Nations Educational, Scientific and Cultural Organization [UNESCO], 2008; UNESCO & Microsoft, 2011). A rapid improvement of technology-based assessment (Csapó, Molnár, & R. Tóth, 2008), computer game- (Pásztor, 2014) and digital storytelling-based (Karakoyun & Kuzu, 2013; Lanszki & Papp-Danka, 2017; Tongori, 2017) development could be witnessed. At the same time technology has advanced second and third generation educational assessment tools (Csapó, Ainley, Bennett, Latour, & Law, 2012; Molnár, Greiff, Wüstenberg, & Fischer, 2017). Among the multitude of computer-based assessment or development tools and tests, authentic assessment of ICT literacy (within the broader category of digital literacy) and its accessing information component applying simulation of original digital platforms has become possible. Simulation-type computer-based assessment (CBA) is an authentic means of ICT literacy performance assessment as Macklin (2007) suggested as early as 2007. Macklin's (2007) proposal has been confirmed by other researchers stipulating that ICT literacy could most authentically be measured by third generation assessment tools. This is because the actions taken to resolve tasks are closest to the operation of the construct in its natural environment (Fu, Zapata, & Mavronikolas, 2014). From the point of view of acquiring ICT literacy, technology and the computer itself have such a central role, that leaving them out of the performance assessment of the construct ICT literacy of students would be insensible (Bennet et al., 2007 as cited in Csapó et al., 2012, p. 147.).

### Research Problem

As it is claimed in paragraphs 3 and 4 of chapter 2.3.2. further on, in a national context, basic technological skills of lower primary pupils have been mapped (Molnár, Tongori, & Pluhár, 2015b), however, no performance assessment of ICT literacy (or its most fundamental access component) of higher grades applying a third-generation test has been carried out. It could be noted that the assessment instruments devised in an international context have not been applied (because of cultural, linguistic and curricular diversions) in our national context. However, performance assessment in an international context has concluded that ICT literacy

needs to be developed.

Assessment of digital literacy within an educational context, often referred to as ICT literacy (See chapter 1.3.1.), could be carried out from various perspectives considering the diversity of software and hardware tools, the multitude and variety of the contents communicated by mass media (including related ethical, social, legal and health issues) and how different roles technology plays in our everyday life (Molnár, Tongori, & Pluhár, 2015). As digital literacy works by applying many complex abilities organically linked, no research undertaking to detect the functioning of all components or dimensions of this construct uniformly has been known. Assessment usually aims to map a certain segment of digital literacy targeting a comparatively narrow age range of test takers, which is still characterised by complexity but could be divided into analysable components and may lead to interpretable results (Molnár et al., 2015b). Molnár et al.'s (2015b) research focuses on assessment of the basic technological skills of lower primary pupils. Other research also referred to within the same publication had a different scope of investigation within or related to the field of ICT literacy, for example, digital learning materials (Kárpáti, 2000), types and number of devices used (Tóth, Molnár & Csapó, 2011), or the research was aimed at a different target group such as educators' and administrators' ICT literacy (Hunya, 2011, 2013). There are examples of studying one component, for example, evaluating information (Metzger & Flanagin, 2013). Also, research has focussed on a narrower age range: grades 6 and 10 in case of ACARA (2012, 2015), grade 8 in case of NAEP TEL (NAGB, 2013) or ICILS (2014), 15-year-olds in case of the PISA Feasibility Study for ICT Literacy Assessment (OECD, 2003).

It could be noted that the assessment instruments devised in an international context (ACARA, 2012, 2015; The International Computer and Information Literacy Study [ICILS], 2014) have not been and might not be applied in our national context because of cultural, linguistic and curricular diversions as well as economic considerations. However, performance assessment in an international context has concluded that ICT literacy needs to be developed (ACARA, 2012, 2015). Consequently, within our national borders as well, the level of ICT literacy needs to be diagnosed by assessment.

This dissertation focuses on the assessment of ICT literacy – especially its information searching component – through simulated and imitated online platforms. The research aims at identifying developmental differences in the ICT literacy achievement of grades five to eleven

students in the light of international assessment of the kind, however, in a much wider age spectrum than that. To achieve high reliability and validity in the test development process, a single component was focused on. As a result, an innovative online assessment instrument for testing one component of ICT literacy will be dealt with.

The use of the term *student* in this dissertation is based on the concept provided in the online version of the prestigious Oxford Advanced Learner's Dictionary, where the definition "a person studying at a school, especially secondary school" is also given with *secondary school* defined as "a school for young people between the ages of 11 and 16 or 18" (Oxford Learner's Dictionaries, 2018), which covers the grade and age range involved in our research. Besides, research in an international context concerning the assessment of ICT literacy has also used the term *student* to refer to the test takers of the respective grades (ACARA, 2015; ICILS, 2014; NAGB, 2013)

Serious theoretical and practical issues were considered in selecting the research focus. The reasons for choosing only one specific component of ICT literacy for testing may be summarized as follows.

In terms of theoretical reasons, in the information society of the 21<sup>st</sup> century the most fundamental element of ICT literacy is to be confident in carrying out information finding activities. In our everyday learning, the what, where, how and when of our active lives – from finding directions to a location, what a journey will cost, or pharmacy hours and identifying details of a banking service – all depend on our confidence with all manners of internet search. Students are also expected to be confident in finding data about their school projects and details of their studies and daily routines. However, while confidence in information finding is considered a key element in ICT literacy, research indicates that even 'digital natives' - those who have regularly been exposed to digital environments from childhood - may be less confident than assumed despite the frequency of their ICT use (ACARA, 2012, 2015; The International Computer and Information Literacy Study [ICILS], 2014; Ainley, Fraillon, & Freeman, 2007). The research shows that this is because their frequent ICT use is often restricted to their preferential activities, especially their use of social networking sites (Tongori, 2013d). Others have exposed the myths about the knowledge and abilities of the so-called digital natives (van den Beemt, 2010) challenging the assumption that such a discrete group with elevated digital skills truly exists (Koutropoulos, 2011). Consequently, student performance in accessing information needs to be tested in order to better understand the process and character of their development, and lead to better instruction towards improving their ICT literacy.

As regards practical reasons for the research focus, even with the advantage of eDia, an online assessment tool (Molnár & Csapó, 2013; Molnár, Papp, Makay, & Ancsin, 2015), a feasible goal had to be set when devising an instrument with a high IT expertise need to minimise the human and technical resources involved, for the sake of cost-efficiency. In addition, to ensure that the component observed is measurable, it had to be reduced to its minimum complexity, as independent from the other components as possible. As a result, a component from the beginning of the information handling process (define, access, manage, integrate, evaluate, create and communicate) had to be chosen. In order to achieve the goal of measuring a single component, definition of the information need ('define' component) was not tested but given by the questions the test takers were expected to answer.

The reasons for choosing the age range may be regarded as both theoretical and practical. The theoretical background was provided by the international research focusing on students from grades five to ten, aged 11 to 15 or 16 (ACARA, 2012; ICILS, 2014 Lennon, Kirsch, von Davier, Wagner, & Yamamoto, 2003; National Assessment Governing Board [NAGB], 2013). Our aim was to involve a wide age spectrum as well. However, to eliminate the possible effects of low ability levels of reading and technology use on students' results, the lowest grades (one to four) of primary education concerned were excluded from the research. On the other hand, grades five to eight students, whose development in thinking skills had proven to be significant according to research into inductive reasoning (Molnár et al., 2013) and problem solving (Molnár, Greiff, Wüstenberg, & Fischer, 2017), were included. Regarding the practical aspects, the national educational context supports the idea of concentrating on students between grades five to ten or eleven. Information technology (IT) is taught up to grade 10 as a separate subject according to Hungarian Framework Curriculum 22/2016 (VIII. 25.) EMMI rendelet (Decree of the Ministry of Human Resources), 2016) and grade 11 is the lowest grade when students are allowed to take their high stakes Matura (school leaving examination, which is the equivalent of general certificate of secondary education) examination in the subject information technology (IT)<sup>1</sup>. Therefore, our research, which was carried out in a national public educational context, placed grades 5 to 11 in its focus.

A detailed discussion of the nature of ICT or digital literacy is addressed in the literature review of this dissertation. Here, a brief summary of what follows is presented. Although both terms have been explained in various ways – mainly relating digital literacy to a wider range of technologies beyond ICT literacy – because of the considerable overlap between them, these terms may be used interchangeably (Ainley, Schultz, & Fraillon, 2016).

#### The structure of the dissertation

The dissertation is divided into five major sections. Following the introduction, the second part presents a review of the literature on ICT literacy and its assessment. The evolution of the concept of ICT literacy is examined from the 1980s until today applying a diachronic approach. The research then considers the way the components of ICT literacy are integrated into the system of 21st century skills and present-day use of parallel terms to cover identical content is studied using a synchronic approach. Further, research into online information search, also regarded as a component of the whole structure of ICT literacy, is examined. Finally, a general summary model of ICT literacy is presented. To provide the core of our research project, assessment of ICT literacy and online information search is covered, first in an international, then in a national context.

The overall objectives and the overarching methodology of the entire assessment project are outlined in the third part of the dissertation. The aim is to provide a comprehensive picture of the four phases of the test development process, and a description of the main characteristics of the stages of the assessment. However, no detailed description of the aims, research questions, methods, results and discussion of each phase is given before the fourth part of the dissertation.

The four stages of the research project are presented in detail in the fourth part of the dissertation, maintaining a focus on test development. Following the detailed description of three pilot assessments, the specifics of a large-scale assessment (the last phase of the entire assessment project) are elaborated. First, in 4.1., a questionnaire-based pilot study on the self-reported confidence and frequency of grade 7 and 10 students' computer and internet use

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<sup>&</sup>lt;sup>1</sup> 36/2015. (III. 6.) Kormányrendelet (Government Decree), 2015; 100/1997. (VI. 13.) Kormányrendelet (Government Decree)

applying a questionnaire is introduced. Then, in 4.2., a pilot research applying a partly simulation-based, online performance assessment test measuring grades 5, 8 and 10 students' confidence in the most fundamental access component and related aspects of ICT literacy, is presented together with the results of the item analysis. The performance assessment test used in this second phase of the research is referred to as Confidence in Accessing Information Performance Test (CAIPT), while the self-reported questionnaire is referred to as Confidence in Accessing Information Questionnaire (CAIQ). Thirdly, in 4.3., a further pilot assessment is revealed. Besides confirming the reliability and validity of the newly developed test itself (based on the most authentic, simulation-based tasks of the previous, partly simulation-based test), gauging a wider spectrum of grades 5, 6, 8 and 10 students regarding their confidence and effectiveness of finding online information as a major component of ICT literacy, which was another focus of the research, is also presented in this chapter. Finally, a large-scale assessment of one component of ICT literacy, accessing online information effectively, among students of all grades from 6 to 11 is introduced.

In the fifth and final part of the dissertation, the summary of the four phases of the research project describing the evolution of an assessment instrument is presented. Then the overall limitations derived from sampling and a reduced focus (from ICT literacy assessment to one component of it) are concluded. Finally, the originality and significance of the research are highlighted.

#### 1. The Concept of ICT Literacy

Prior to introducing ICT literacy assessment, it is essential to categorise the construct to be measured. The field of literacies theory and research is characterised by conceptual diversity. However, re-conceptualisation of the term literacy typically involves a shift from print to digital literacy (Coiro, Knobel, Lankshear, & Leu, 2010).

The question whether ICT literacy and (digital) reading literacy could be separated from each other also needs considering. Although reading literacy and ICT literacy share the characteristic of being both means and end (Fraillon, Schultz, & Ainley, 2013), it is essential to distinguish reading literacy assessment, which is beyond, from ICT literacy assessment, which is within the scope of the investigation in the present dissertation. The answer to the question what the difference is between instruments testing digital reading literacy and the access dimension of ICT literacy could be given by the term focus. When digital reading skills are tested, the focus is on reading literacy, which necessarily involves navigation (following written instructions) on online surfaces. In the case of reading literacy assessment, the focus is on "understanding, using, evaluating, reflecting on and engaging with texts" (OECD, n. d., p. 8), whose type of medium could be printed or electronic (OECD, n. d.). When the confidence of accessing information is in focus, website search does involve reading literacy in a digital environment but as reading is a means only, the attention is on how well the test taker achieves in information searching tasks without exact instructions regarding what and where to read to find the information. Navigation is not restricted to navigation within a text but among texts and other sources of information including graphics, diagrams or images in menus or submenus of a website or websites without any limitations on the paths which could be taken, except for restrictions that are necessary to provide testing objectivity and uniformity.

The access component of ICT literacy is neither more nor less than digital reading literacy but they are closely interrelated. In case of an instrument assessing the confidence of digital information retrieval (i.e. the access component of ICT literacy) the paths the test taker chooses to follow are not exclusively comprised of verbal information to be decoded using the technique of reading but might include sources of other kind, for example, images or icons to click on. This will result in an extended notion of "reading". Another distinction that could be made is that, due to there being several paths (for example, on a website), the most efficient information seeker will have mastered a skill which enables them to find the shortest track and

reach the information in the most effective way. On the one hand, basic reading literacy, which ICT and media literacy are based on, is essential (UNESCO, 2008), because the online information is mostly, although not exclusively, presented using linguistic signs. On the other hand, however, using basic reading skills does not necessarily mean bearing the ability to create new knowledge built on the information found. Goal oriented digital reading and also accessing information can only take place when one is equipped with the ability to synthesize information found in isolated sources by finding meaningful connections and thus creating new knowledge (Coiro, 2015). Receptive tasks in computer- and information literacy- based assessments test students' skills and abilities in searching for and identifying several sources of information before deciding on the reliability and rightness of the information. Such student activities are carried out by means of reading, although not necessarily the kind of intensive text reading which digital reading items require (Fraillon et al., 2013).

Another example of an ICT literacy related area where it is a question of focus to decide on what is assessed could be a measurement of Problem Solving in Technology Rich Environments (PSTRE) in the Organisation for Economic Co-operation and Development (OECD) Programme for the International Assessment of Adult Competencies (PIAACC). The definition of PSTRE as "using digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks" (OECD, 2014, p. 9) bears the typical features of definitions of ICT literacy in terms of technological aspects, accessing, evaluating and communicating information (Ainley et al., 2016).

Various approaches and explanations of ICT literacy could be found in the related literature (Eurydice, 2002; Whyte & Overton, 2001; Koltay, 2010; Lennon et al., 2003; Molnár, 2011; Papert, 1993/ 1996; Tuparova & Tuparov, 2010). There is no uniform definition accepted by everyone, however, it is typical to find overlapping concepts. In line with the technological development, owing to the wider and wider range of info-communicational tools approaches, perspectives and requirements have changed. The differences between the definitions are partly due to technological development (Bawden, 2008), as well as to the changes that have taken place in terms of perspectives. It is a complex phenomenon that provides information transfer over borders and which is an essential tool for getting and being informed (UNESCO, 2002). While at the beginning — even within the group of ICT tools — only identifying the knowledge related to computers and programmes themselves (Masat, 1981) together with

measuring their use and frequency of use prevailed (see, for example, the Computer in Education Study (COMPED) administered between 1986 and 1992 or the Second Information Technology in Education Study (SITES) launched in 1997 (Molnár & Kárpáti, 2012), present day research witnesses a shift of emphasis towards procedural knowledge and application and not exclusively related to computers (Whyte & Overton, 2001; ETS, 2002; Katz & Macklin, 2007).

In the following section, the diverse terminology of the components of ICT literacy identified by the most prominent research centres and organizations will be discussed together with the reasons for such diversity and common points as well as existing models of ICT literacy. At first, gradual extension of the notion of ICT literacy will be traced by mapping the ever-expanding number of ICT literacy components. Research into online information search as another way of approaching the access component of ICT literacy will be reviewed as well. Next, integration of ICT literacy components into the system of the so called 21st century skills will be dealt with. Finally, a comprehensive model of ICT literacy will be created and interpreted.

## 1.1. Diachronic approach: The development of the term ICT literacy

In this part of the dissertation, a factual description of the evolution of a concept which was brought about by technological advancement and its consequences is given. As a result, contrasting the subsequent steps of development rather than criticising them is used as the governing idea of this part of the review. The author's critical approach is expressed by providing a synthesising model of the components and aspects (see Chapter 1.5.) based on the analysis of the preceding development of the concept of ICT literacy.

In the 1980s and early 1990s the term computer literacy was used, which referred to the basic knowledge of computers and certain level of proficiency in computer usage (Bawden, 2008; Figure 1). This kind of procedural knowledge was measured by the examinations leading to the European Computer Driving Licence (ECDL) initiated by Finnish experts and launched in Sweden in 1996. However, since 2001, when the tests consisted of 7 modules (1. Basic Concepts of Information technology, 2. Using the computer and Managing Files, 3. Word Processing, 4. Spreadsheets, 5. Databases/Filing Systems, 6. Presentation, 7. Information and Communication) (Whyte & Overton, 2001), ECDL tests have undergone considerable changes resulting in an additional range of modules, for example, Online Collaboration or ICT in Education (ECDL Foundation, 2012), classified into three levels (ECDL Foundation, 2018). However, at its first appearance, ECDL was aimed at mastering the mechanical use of certain

computer software. The Information and Communication module was restricted to executing such operations as writing emails or saving websites. At that time, it did not enhance collaboration and interaction using social networks, blogs and wikis, which it does today.

A huge step forward in the field of ICT literacy concepts was brought about in 1989 by the American Library Association (Figure 1) when announcing six steps of information handling which later, in 1999, formed the basis of the standards of information literacy competencies issued by the association as well (American Library Association, 2000), later updated by the Association of College and Research Libraries (2016). The original steps were declared as recognising the information need, determining the kind of information needed, accessing the needed information, evaluating the information and using it (Bawden, 2008). In 1999, recognition of the information need was deleted, and further specifications were made. The attribute *critical* was attached to evaluation, the competency of incorporating the information found into already existing knowledge was added as well as using the information for specific purposes and understanding the social, legal, ethical and economic issues related to information use (American Library Association, 2000). Using the term *information literacy*, which laid the emphasis on finding, managing and evaluating the information in a computerised environment became more and more frequent from the 1990s (Bawden, 2008).

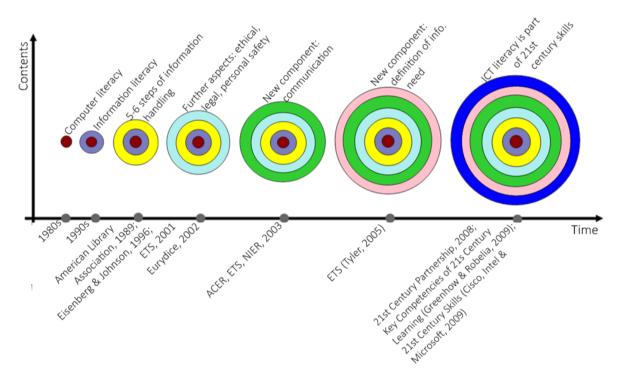


Figure 1: The extension of the components of ICT literacy in chronology and per contributors (not demonstrating the passing of time at accurate intervals; based on Tongori, 2012)

Papert (1993/ 1996) also postulated that the term computer literacy has become void and suggested the term technological fluency but emphasized that for a technologically fluent individual technology becomes a means of thinking and expression. By doing so, Papert (1993/ 1996) highlighted the relationship between applying technology and thinking skills and distanced himself from the approach stating that computer literacy was equal to mechanical application of a technological device.

In 2002 Lingard, Madison and Melara claim that the generally accepted and popularly used definition of computer literacy falls behind the technological development enabling the use of the world-wide web. According to the 1999 issue of Webster's II New College Dictionary, also referred to by these authors, computer literacy is an ability which enables one to use the computer and the software to accomplish practical tasks. Although this dictionary definition is about ability and use, it is still stuck with the computer itself without referring to all those abilities related to online information retrieval and processing.

By contrast, Eisenberg and Johnson (1996) had already identified the so called Big Six Skills – similarly to the American Library Association – in the field of computer skills necessary for information problem solving (Figure 1): (1) defining the task, (2) information seeking strategies, (3) localising and accessing information, (4) using the information, (5) synthesizing and (6) evaluating the information. Eisenberg and Johnson's (1996) approach is identical with that of Papert's (1993/ 1996) in one respect, that is they view information and communication technology skills from the perspective of thinking skills. Papert (1993/ 1996) regarded the application of technology and thinking skills inseparable.

The inseparability of technology and thinking skills is underpinned by the fact that having realised the importance of change regarding the concept of digital literacy, in 2001 the European E-Learning Summit envisaged devising such a digital literacy syllabus which would promote higher order digital literacy processes. Among them, developing social learning strategies, for example through collaboration between participants of online projects, is considered critical to our future collaborative decision-making processes at work. Thus, for long-term digital literacy improvement, and efficiency at work the following seven literacy components are of exceptionally high importance: (1) It is essential to realise the necessity of learning to learn, which is realising that depending on the medium used, various cognitive skills and learning strategies are needed. (2) It is crucial that the student should bear the ability to

cooperate with others and (3) apply the appropriate social norms in both real and virtual learning environments. (4) Students must be able to evaluate the reliability and quality of information on the internet, (5) must be aware of their own needs and (6) must be capable of deciding which browsers or surfaces might lead to the required result. (7) Students must also be aware of the need of lifelong learning and keeping all skills up-to-date (Whyte & Overton, 2001).

In terms of cognitive skills, basically the dimensions of skills formulated by Eisenberg and Johnson (1996) and the European E-Learning Summit (Whyte & Overton, 2001) appear in the re-wording of the International ICT Panel, a group of Australian, Brazilian, Canadian, French and United States experts, convened by the American Educational Testing Service (ETS) in 2001. The expert group of the panel committed themselves to the opinion that the concept of ICT literacy could not be defined primarily as a technical skill but critical cognitive skills are also involved. These cognitive skills include basic reading, writing and numeracy within general literacy, critical thinking and problem-solving. ICT literacy was defined as a continuum of skills and abilities, in which applying information and communication technologies ranges from technical actions used in everyday life to complex operations (ETS, 2002). In 2004, in a publication on the concept of ICT literacy, components of ICT literacy are called multiple ICT aspects, specific skills or are jointly referred to as ICT literacy using the common term (ETS, 2004). One of the main objectives of the panel was to elaborate a framework of reference, which is appropriate for measuring whether the individual has the ICT competencies, which are the necessary conditions for functioning successfully in the knowledge society. The panel formed the following definition: "ICT literacy is using digital technology, communications tools and/or networks to access, manage, integrate, evaluate and create information in order to function in a knowledge society" (ETS, 2002, p. 2).

The five components (Figure 1) of this definition are comparable to most of the *six big skills* by Eisenberg and Johnson (Eisenberg & Johnson, 1996). Eisenberg and Johnson's (1996) seeking strategies and access components could be identified with the category *access* by ETS. The term *use* could be identified with the category *manage*, the term *synthesize* with *integrate* and the component *evaluate* is referred to in an identical way in both concepts of ICT literacy. The difference lies in the term *create*, which is not part of the six big skills and the component *define*, which was non-existent among the components of ICT literacy according to ETS (ETS,

2002) at that time.

ICT-s became such a focal point of interest in the context of education and economic growth, that the document Key Competencies by Eurydice (2002) emphasizes the usefulness of ICT knowledge over subject knowledge by making a statement that "subject knowledge is rendered obsolete" as info-communication technology facilitates the rapid access to and transfer of factual knowledge (Eurydice, 2002, p. 11). Concern about social justice, equality of opportunities and the requirement that key competences comply with ethical, economic and cultural values is also raised (Eurydice, 2002). Over a decade later, based on the same concept of obsolescence of pre-scribed curriculum knowledge, popular education researcher Sugata Mitra (2013) introduced his findings and two years later published his handbook (Mitra, 2015) on how effectively self-organized learning environments (S.O.L.E.) challenged only by questions could work using computers with access to the internet. The major role of thinking skills (which are fundamental ICT literacy elements (ETS, 2002) as knowledge acquisition and application skills as opposed to the minor role of specific academic knowledge in problem solving situations is supported by further research (Molnár, Greiff, & Csapó, 2013; Molnár et al., 2017).

Three organizations, the Australian Council for Educational Research (ACER), the Japanese National Institute for Educational Policy Research (NIER) and the American Educational Testing Service (ETS) – mostly financed by the Organisation for Economic Cooperation and Development (OECD) – did a research together in 2003. Its aim was to gather data about the information literacy of 15-year-olds and assess the feasibility of an ICT literacy performance test for the Programme for International Student Assessment (PISA). The major concerns raised by the researchers regarded several aspects of the development and the delivery of the ICT literacy test. The ICT Expert Panel suggested simulated applications instead of existing software applications to prevent any disadvantage which might derive from not knowing the specific functions of a given application and to provide a performance scoring platform. The research questions were related to the time and technical apparatus needed for development, possible technological issues, usability and the kind of information to be gained. Further questions emerged related to translation and adaptation of content and layout as the Expert Panel wanted to avoid putting any of the students of an international community at disadvantage. Task difficulty and time-on-task were also to be investigated. The committee of experts created the theoretical framework by forming an even more extensive (than earlier ones), overall definition of the construct in question, which included *interest* and *attitudes* as well as the component *communicate* (Figure 1). Their definition: "ICT literacy is the interest, attitude and ability of individuals to appropriately use digital technology and communication tools to access, manage, integrate, and evaluate information, construct new knowledge and communicate with others in order to participate effectively in society (Lennon et al., 2003, p. 8)." Subsequently, the communication component of the definition by ACER, NIER and ETS (Lennon et al., 2003) is named by other authors (ETS, 2006; Whyte & Overton, 2001; Katz & Macklin, 2007; Tyler, 2005).

In the USA, an innovative, simulation-based assessment instrument was devised as a result of the joint efforts of seven higher education institutions and the ETS in 2003 in order to measure the ICT proficiency and literacy of students entering and leaving universities to transition to the world of work. The research results showed that the cognitive skills of the individual (thinking, problem-solving and learning) played a much bigger role in one's navigation in a technological environment than knowledge of any software or hardware platform (Tyler, 2005). This finding makes educators conclude that developing ICT literacy should not primarily be approached from a technological but rather from a cognitive aspect. Our goal is not simply to educate software users but individuals who function confidently in problem-solving tasks in our information society. In today's technologically rich working environment such employees are needed, who with the help of their cognitive skills can analyse and evaluate what they have learnt to form their own opinion based on the information accessed (Tyler, 2005). The component define (defining the information searching task), which was not present in the definition by ETS in 2002 but was included in the one by Eisenberg and Johnson, is incorporated in the ICT literacy models provided by ETS later on by Tyler (2005) and Katz and Macklin (2007) (Figure 1; define, access, manage, evaluate, integrate, create and communicate). The extended definition also involves the requirement made by the European E-Learning Summit, which states that the individual has to be able to apply the rules of social behaviour or in other words he or she has to be able to communicate when collaborating with others (ETS, 2006; Whyte & Overton, 2001; Katz & Macklin, 2007; Tyler, 2005).

The same ICT literacy components compose the model used in the ICT literacy assessment launched by the Australian Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) within the National Assessment Programme (NAP). "ICT literacy

is defined as: the ability of individuals to use ICT appropriately to access, manage, integrate and evaluate information, develop new understandings and communicate with others in order to participate effectively in society" (Ainley, Fraillon, & Freeman, 2007, p. VII.).

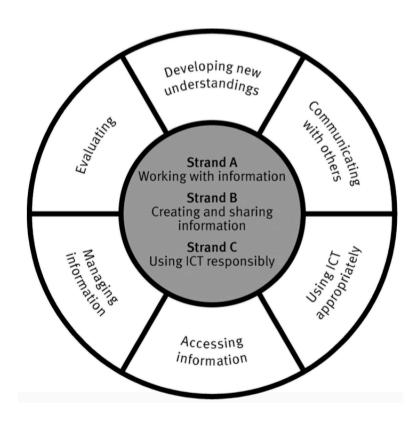


Figure 2: The ICT literacy domain (based on MCEETYA, 2008, p. 4)

## 1.2. The integration of the components of ICT literacy into the system of 21<sup>st</sup> century skills

Eight key competencies were identified by the European Commission: 1. Communication in the mother tongue; 2. Communication in the foreign languages; 3. Mathematical competence and basic competences in science and technology; 4. Digital competence; 5. Learning to learn; 6. Interpersonal, intercultural and social competences and civic competence; 7. Entrepreneurship and 8. Cultural expression (Commission of the European Countries, 2005). Studying the requirements of the Hungarian secondary school leaving Matura Examination in terms of the digital competences defined by the European Commission, it could be stated that both in the field of subject-related and general competencies the Matura Examination requirements in connection with information society comply with the components

of ICT literacy. Two prominent examples could be "the student should be able to access and process information and extend his or her knowledge using up-to-date tools" and "the student should be familiar with the ethical a legal aspects of information technology" (Informatika. I. Részletes érettségi vizsgakövetelmények, 2017, p. 1). Apart from this, naming such competences as Interpersonal, intercultural and social competences and civic competence, Entrepreneurship, Cultural expression, Basic competences in technology, the programme launched by the European Commission bears characteristics which point into the direction of the knowledge domain later defined as 21<sup>st</sup> century skills (Figure 1).

Using the (digital) technologies inevitable for learning and working efficiently and categorising and defining the 21<sup>st</sup> century skills necessary for technology use is in the foreground of several projects, for example, the Assessment and Teaching of 21<sup>st</sup> Century Skills (ATC21), UNESCO or the National Assessment of Educational Progress (NAEP) (Binkley et al., 2012; Griffin et al., 2012; UNESCO & Microsoft, 2011; NAGB, 2013). Although in 2004 the amendments to the Scottish Curriculum proposed four capacities as aims (successful learners, confident individuals, responsible citizens and effective contributors), the abilities and skills within the capacities cover the literacy and competence dimensions discussed so far, including creative, critical thinking and problem-solving, social skills and attitudes (Scottish Executive, 2006).

Greenhow and Robelia (2009, p. 1131) contrast two ways of knowledge acquisition: the conventional *academic*, print-based, old communication emphasized and assessed in school and the unconventional *non-academic*, communicative, new literacies, which are developed on social network sites. They claim that in our notions of learning and literacies a shift is witnessed because of the strong influence of communicative and creative social practices on them. Citing 21<sup>st</sup> Century Partnership (2008) and Coiro et al. (2010), the authors, Greenhow and Robelia (2009) postulate that in a culture that is so heavily dependent on participation and the Internet, for students to become engaged in this culture, it is not sufficient to have a solid understanding of conventional print-based literacies, but there is a substantial need for other literacies, namely 21<sup>st</sup> century skills (Partnership for 21<sup>st</sup> Century Skills, 2008) and the digital literacies of online reading, writing and communication.

Ten major literacy domains are grouped into four categories in the model developed by the Assessment and Teaching of 21<sup>st</sup> Century Skills (ATC21S) project created by Cisco, Intel and

Microsoft and launched at the 2009 London Learning and Technology World Forum: (A) Ways of thinking [1. Creativity and innovation; 2. Critical thinking, problem solving, decision making; 3. Learning to learn, metacognition], (B) Ways of working [4. Communication; 5. Collaboration (teamwork)], (C) Tools for working [6. Information literacy; 7. ICT literacy] and (D) Living in the world [8. Citizenship – local and global; 9. Life and career; 10. Personal & social responsibility – including cultural awareness and competence]. These categories also summarise those skills and abilities already dealt with among ICT literacy skills and abilities, without which the 21<sup>st</sup> century individual is not prepared to function efficiently in learning, thinking, working and citizenship. Within their framework, the ATC21S categorize information and ICT literacy as the means of work, clearly regarding such skills as essential for employees in the 21<sup>st</sup> century (Binkley et al., 2012).

Similarly, employability, marketability and citizenship consciousness are in the focus of the goals of the American organisation called 21st Century Partnership. The establishment of the organization displays a perfect fusion of the world of business, educational administration and political decision making. Besides critical thinking and the ability to make decisions, multi-disciplinary complex, problem-solving, creative, entrepreneurial thinking, communication and collaboration, innovative application of information, knowledge and opportunities together with responsibility in financial, health and civic issues are also part of the system of skills and abilities they find essential. ICT literacy in this model is reckoned to belong to the information, media and technology skills, which, together with the other two sets of skills, learning and innovation skills and life and career skills, is based on the set of score 21st century subjects: English, reading or language arts, World languages, Arts, Mathematics, Economics, Science, Geography, History and Government and Civics (Partnership for 21st Century Skills, 2008; see Figure 3). A typically common feature of the models describing 21<sup>st</sup> century skills up to this point is that they consider ICT literacy a distinct group of skills or abilities separated from other skills domains such as thinking, social and communication skills.

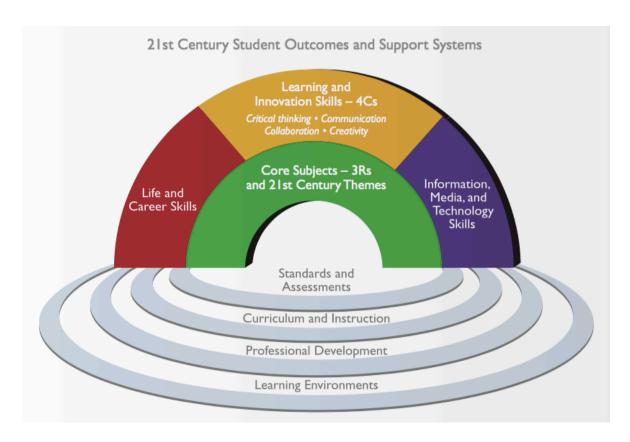


Figure 3: The model of 21<sup>st</sup> century learning by Partnership for 21<sup>st</sup> Century Skills (Partnership for 21st Century Skills, 2008, p. 13)

ICT skills and media literacy are built upon thinking and basic literacy skills in the model provided by UNESCO (2008) (Figure 4). ICT skills and media literacy are regarded as certain basic technological knowledge (digital technology use, use of communication tools and networks, sifting and analysing media messages, and other ICT/media skills) which serve as foundation for information literacy, the domain identical with the ICT literacy domain as identified by the American ETS or the Australian ACER (Ainley et al., 2007; Tyler, 2005; Catts & Lau, 2008).

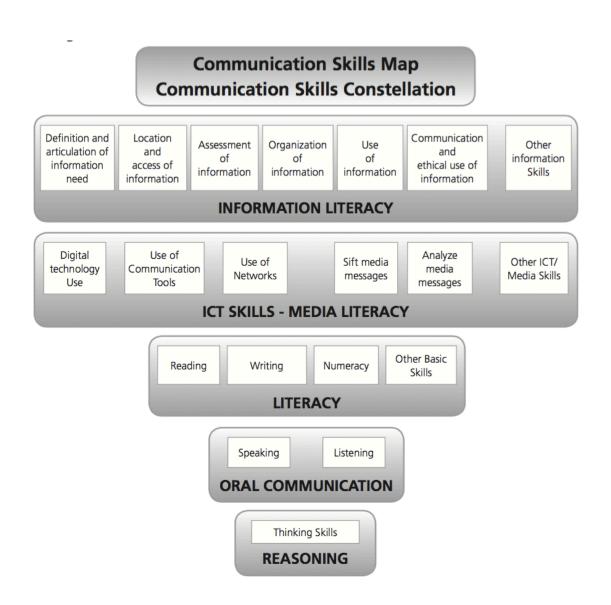


Figure 4: Communication Skills Map by UNESCO (Catts & Lau, 2008, p. 18)

The assessment areas of Technology and Engineering Literacy (Figure 5) devised for the 2014 National Assessment of Educational Progress (NAEP) by the American National Assessment Governing Board (NAGB) are also based on a similar theoretical framework (NAGB, 2013). Its focal point is inherently employability. ICT literacy is embedded in a framework of 21st century skills in this model, too. Components of ICT literacy include thinking skills (construction of ideas, investigation of problems), accessing (information research), managing (use of digital tools), evaluating (acknowledgement of ideas and information, selection of digital tools), creating (construction of ideas and solutions) and communicating (exchange ideas and solutions) information (see Figure 5).

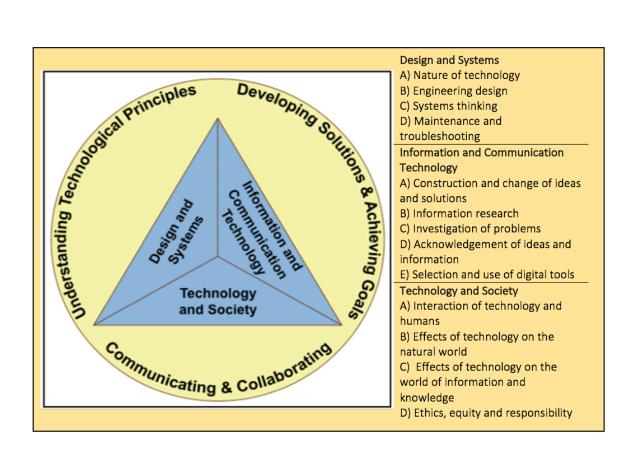


Figure 5
Major Assessment Areas and Practices of Technology and Engineering Literacy (based on NAGB, 2013, p. XII and p. 1-7)

## 1.3. Synchronic approach: Present-day application of parallel terms to cover identical content

The domain of ICT or digital literacy in its complexity involves a huge variety of conceptual approaches. Frameworks of ICT literacy are often based on such terms as competency (UNESCO & Microsoft, 2011). Blurred boundaries between terms such as "digital and ICT literacy" as "an important competence" (Ainley et al., 2016, p. 2) are not uncommon. Definitions highlighting the necessity of applicable knowledge, key or new competences (Kárpáti, 2011) and literacy are terms often used in the related literature (Binkley et al., 2010; Griffin et al., 2012; Molnár, 2011; Kárpáti, 2011) as parallel terms covering identical content. In this passage the ways how huge, present day organizations — carrying out national and international assessments of the ICT literacy related fields — define the same set of abilities and skills is summarized.

Following the initiative of UNESCO aiming at reforms in education, the ICT Competency Framework for Teachers (ICT CFT) project was launched, which emphasizes the use of information and communication tools and the relationship between education and economic

growth. In the document, UNESCO ICT Competency Framework for Teachers (UNESCO & Microsoft, 2011) the development of teachers' and students' knowledge related to ICT use is conceived of as a progress in three stages: (1) technology literacy, (2) knowledge deepening and (3) knowledge creation. In terms of ICT, on stage one, teachers' and students' use of basic tools (e.g. a Word document), on stage two, teachers' and students' use of complex tools (e.g. spreadsheets, videos, simulations) and on stage three, pervasive tools used by the students (e.g. the Internet, graphic applications) are required (UNESCO & Microsoft, 2011).

The expressions applicable knowledge, competence or literacy are often used as synonyms in several kinds of conception of ICT literacy (Binkley et al., 2010; Catts & Lau, 2008; Commission of the European Countries, 2005; Greenhow & Robelia, 2009; Griffin et al., 2012; Implementation of "Education and training 2010" (2004); NAGB, 2013; Partnership for 21<sup>st</sup> Century Skills, 2008; UNESCO & Microsoft, 2011). Digital literacy is also considered as a key competence by Molnár (2011). Kárpáti (n. d.) refers to non-subject-related, new competences as inter- or transdisciplinary abilities, which are built on the traditional cultural abilities of reading, writing and numeracy. Such new competences are the abilities to function in the world of media, which together with the abilities of digital creation and learning are rated as elements of the domain of digital competence. Integration of the components of ICT literacy into 21st century skills and abilities is described in parallel (Kárpáti, 2011).

The Hungarian national documents regulating the required contents of instruction are no exception. The term informatics (equivalent of information technology) is used as one of the ten literacies in the National Core Curriculum<sup>2</sup>. The same document identifies eight key competencies, one of which is digital competence; a group of knowledge, skills, abilities and attitudes involving the ICTs of the information society and confident, critical and ethical use of contents made accessible by them in the fields of social life, work, communication and free time. It is based on identifying, retrieving, evaluating, storing, creating, presenting and sharing information, creating and sharing digital content and collaborative communication through the internet. It also emphasizes the responsible information search, creativity, interactive media use and innovation. The document accumulates the components of ICT literacy enlisting the

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<sup>2 110/2012. (</sup>VI. 4.) (Government Decree ont he issue, introduction and implementation of the National Core Curriculum) regi.ofi.hu/download.php?docID=5846

elements of the information handling steps, cognitive, social, technological and responsibility related aspects which could be found in models of ICT literacy in an international context discussed so far, suggesting an up-to-date approach. What the document does not explicitly verbalize is that the activities of information handling are based on thinking skills and such basic literacy as reading, writing and numeracy. What makes the reader doubtful is that the digital competences described there could only be fulfilled if information literacy was incorporated in each subject and field of literacy together with extra-curricular school activities, however this is not the case. The National Core Curriculum despite describing 6 areas of development in Informatics, which — in theory — appears to be up-to-date, on the other hand, claims that realization of the developmental goals (only) 'builds on' the knowledge gained in IT lessons. With only one 45-minute lesson a week (64 lessons for two years of grades 9-10), developing the six areas (*Using Information Technology Devices, Knowledge for Software Users, Problem-solving using Devices and Methods of Information Technology, Info-communication* (within it: *Media informatics*), *Information Society* and *Library Use*) is impossible.

The general requirements are literally the same in the Framework Curricula for grades 5-8<sup>3</sup> and 9-12<sup>4</sup> (usually only up to grade 10) referring to general requirements to be achieved "by the end of the process". However, the goals are impossible achieve. The Framework Curriculum for grades 7-8 includes such utterances as "While programming, students are forced to read and understand the manuals of software as well as error messages in English. This develops their foreign language communication." In general, grade 7 students' foreign language competences are not sufficient – and not planned for comprehending the technical language of manuals. Also, their programming skills are not usually based on reading manuals in grades 5-8.

The aims of the IEA International Computer and Information Literacy Study (ICILS) were to investigate how young people develop their computer and information literacy to be better

<sup>&</sup>lt;sup>3</sup> 51/2012. (XII. 21.) EMMI rendelet 2. melléklet. (Decree of the Ministry of Human Resources, Appendix 2) Retrieved from http://kerettanterv.ofi.hu/02\_melleklet\_5-8/index\_alt\_isk\_felso.html

<sup>&</sup>lt;sup>4</sup> 51/2012. (XII. 21.) EMMI rendelet 3. melléklet. (Decree of the Ministry of Human Resources, Appendix 3) Retrieved from http://kerettanterv.ofi.hu/03\_melleklet\_9-12/index 4 gimn.html

able to represent themselves in and contribute to our digital age. The target group of the assessment was grade 8 students in (public) education. The assessment was planned to be computer-based and focusing on computer use. To reach their aim, the following definition was formed: computer and information literacy is "an individual's ability to use computers to investigate, create and communicate in order to participate effectively at home, at school, in the workplace and in society" (Fraillon, Schulz, & Ainley, 2013, p. 18). Although the authors explicitly restrict the construct assessed to computer literacy, the broader contexts of ICT literacy, digital competence or digital literacy implicitly present, cannot be excluded (Fraillon, Schulz, & Ainley, 2013). The Association of College and Research Libraries (2016), in its updated document, Framework for Information Literacy for Higher Education, gives a broader definition of information literacy than in the previous document (American Library Association, 2000) emphasizing the critical approach to the information searched and relating the information seeking activities to learning processes:

"Information literacy is the set of integrated abilities encompassing the reflective discovery of information, the understanding of how information is produced and valued, and the use of information in creating new knowledge and participating ethically in communities of learning" (Association of College and Research Libraries, 2016, p. 3)

Considering our technology- and computer-based society, where information handling from searching and finding to creating and communicating will be executed using computer technology, it makes the boundaries between information literacy and ICT or digital literacy less distinct.

In Martin's definition (Martin, 2006a, p. 19) digital literacy is described as "the awareness, attitude and ability of individuals to appropriately use digital tools and facilities to identify, access, manage, integrate, evaluate, analyse and synthesize digital resources, construct new knowledge, create media expressions and communicate with others in the context of specific life situations in order to enable constructive social action; and to reflect upon this process". However, UNESCO's ICT and media literacy (Catts & Lau, 2008) or OECD PISA Feasibility Study's (Lennon et al., 2003) ICT literacy have been defined with the use of identical terms.

As it has been seen, ICT literacy is such a complex domain that there is a huge variety of

conceptual approaches. Assessments of the related skills have a few of the components in their focus at a time, sometimes using different terms to identify the same set of abilities. The term problem solving in technology rich environments was aimed at measuring adult competencies in integrating information found through using digital technology, networks and communication tools in the OECD Programme for the International Assessment of Adult Competencies (PIAACC) (OECD, 2014). Whether they are referred to as competencies, problem solving skills or certain parts of ICT literacy, the components of finding and integrating information, the cognitive (thinking skills), technological (digital tools) and social aspects (communication) of ICT literacy are present.

#### 1.3.1. The digital literacy domain

Among the many attempts (Ainley et al., 2016; Bawden, 2008; Koltay, 2011; Martin, 2006b) to summarise the concept of the structure of digital technology-based media and ICT literacies, Figure 6 visually demonstrates the relationship between the elements of the literacy domain the overall term of which could be digital literacy (Molnár, Tongori, & Pluhár, 2015b). It is noted by Martin (2006b) that digital literacy is broader, and by Ainley, et al., (2016) that it is related to a wider range of technologies than ICT literacy.

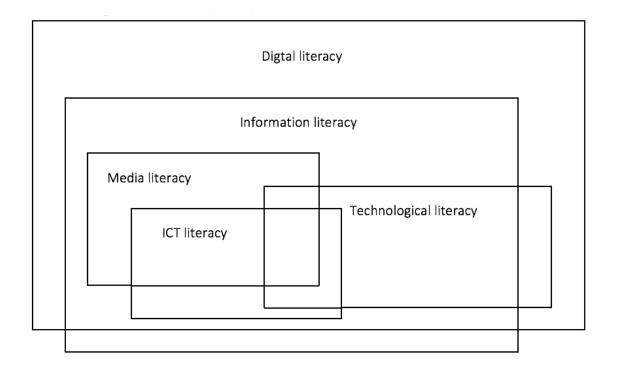


Figure 6: The structure of digital literacy (based on Molnár et al., 2015b, p. 299)

Information literacy is placed within the broader category of digital literacy, however, as Molnár et al. (2015b) claim, the term digital literacy is often used as a parallel expression in the technical literature. Media literacy (a special case of information literacy) and technological literacy are subcategories within information literacy with the remark that the latter does not exclusively belong to the category of information literacy. Finally, the term *ICT literacy* having intersections with the three sets, information, media and technological literacy (within digital literacy) is often used in educational contexts.

## 1.3.1.1. Information literacy

Information literacy is a set of intellectual capacities. These capacities are perceived as realizing the information need and the abilities of finding, comprehending, evaluating and using the information, which ability involves basic hardware and software use (technological literacy) as well (Bundy, 2004). Information literacy models are rooted in the computer literacy models of the 1980s and were gradually extended until they were considered as identical with digital literacy from the 1990s. However, as information literacy models (often referred to as models of ICT literacy) focus mainly on the information and its handling (defining the information need, accessing, managing, integrating, evaluating, creating and sharing the information) (ACARA, 2012; Katz & Macklin, 2007; Law, Lee, & Yuan, 2009; European Parliament and the Council, 2006, 2004; NAGB, 2013; UNESCO, 2008; UNESCO & Microsoft, 2011; Tongori, 2012), they cannot be identified with, only considered to be part of digital literacy (Molnár et al., 2015b).

Complexity of the model is demonstrated by the fact that some of the components themselves (e.g. integrating or evaluating information) presuppose the existence of certain developmental level of complex thinking abilities, for example, critical thinking and problem solving. When assessed, individuals with high information literacy level will quickly and efficiently capture the essence of the use of the hardware or software regardless of the technological tool, effectively find relevant data and handle and evaluate information critically (Molnár et al., 2015b).

Despite first appearing to be incongruous in the setting of digital, information and ICT literacy described above, for the sake of a wider perspective, it is worth mentioning that some researchers have approached information literacy from a different aspect and introduced new concepts within the domain such as the hierarchy of Generic, Situated, Transformative and Expressive windows in the order of increasing complexity (Bruce et al., 2017). Taking a closer

look reveals the connections between their system and the one constituted by the author of and detailed in this dissertation. According to their interpretation of information literacy the generic level window is where the information is "codified and tangible" (Bruce et al., 2017, p. 7), which could be identified as the innermost intersection of media, ICT and technological literacies in the structural model provided by Molnár et al. (2015b, Figure 6) as in most cases technology is used to codify information. In this respect, Bruce et al.'s generic window could also be related to the technological aspect of ICT literacy as described by Tongori (2012, Figure 7). The next level, the situated window (Bruce et al., 2017) could be identified with all the components of ICT literacy (Tongori, 2012, Figure 7), as involvement in authentic information handling takes place in each ICT component. Also, the socio-cultural orientation of Bruce et al.'s (2017) interpretation of information literacy could be detected in the social and responsibility-related aspects of ICT literacy as defined by Tongori (2012). On Bruce et al.'s (2017) next level, the transformative window is defined. With its critical approach to knowledge creation, connections could easily be made between the transformative window (Bruce et al., 2017), the evaluate, create and communicate components and the cognitive aspect (including critical thinking) of Tongori's (2012) dynamic model of ICT literacy (Figure 7). The most dissimilar but still not contrasting element of Bruce et al.'s (2017) expressive window (on the same level as the transformative one) emphasizes the information creator's and respondent's subjective, aesthetic and emotional aspect while the individuals express themselves when creating their "digital identities" Bruce et al., 2017, p. 7). Having the act of creation allows assigning this window to the create component of the ICT literacy model set up by Tongori (2012).

# 1.3.1.2. Media literacy

Although the lack of uniform terminology is also characteristic of media literacy, in general, it could be described as the system of those skills, abilities and knowledge, which is essential for understanding how data that can be retrieved from mass media are formed, what forms of media these data can be published in, and how such information could be stored, forwarded and presented (Koltay, 2009). Duncan's (2006 cited by Koltay, 2011, p. 213) concern for education is reflected in his definition when postulating that media literacy "is concerned with developing an informed and critical understanding of the nature of the mass media, the techniques used by them, and the impact of these techniques". Media literacy is distinguished

from information literacy by the fact that the former focuses on understanding the information as an outcome, whereas the latter focuses on information processing (Christ & Potter, 1998; Catts & Lau, 2008; Fraillon et al., 2013; Livingstone, van Couvering, & Thumim, 2008).

In addition, numerous other definitions of media literacy describe the circle of knowledge and skills which are necessary for understanding and critical handling of content and information from media and using such information in communication (Herzog, 2012; Babad, Peer, & Hobbs, 2012; Herzog & Racskó, 2013; Hobbs, 2011). Media literacy also includes understanding the influence media contents have on the audience and the reasons behind the effects together with the issues of ethical use. The basic abilities of creating media contents, for example, programmes, pictures or websites presented by any communications (movie, video, photo, musical recording, computer game) or mass media (television, radio, printed press, internet etc.) tools are also part of the definition of media literacy (Buckingham, 2005) regardless of the genre, length or purpose (Hartai, 2002). The main characteristics of a conscious media consumer as opposed to the unconscious and ignorant consumer are that the first one is aware of the rate of his or her own media use, the choice of programmes and media providers is also conscious, and he or she is capable of critically making their own informed opinion of media texts (Herzog & Racskó, 2013).

#### 1.3.1.3. ICT literacy and its relation to computational thinking

ICT literacy in the model demonstrated by Figure 6 is the group of knowledge, skills and abilities essential for effective and productive technology use for learning and instruction. From among higher order thinking abilities critical thinking, problem solving and computational thinking could be regarded as abilities closely connected to ICT literacy. Computational thinking is considered an indispensable element of activating ICT literacy when the learner is given an active role as a designer and builder during the process of computer aided learning (Molnár et al., 2015b). Recent years have witnessed a growing interest in computational thinking and its relation to ICT or digital literacy (Barr, Harrison, & Conery, 2011). Since its introduction as a core asset to develop learners' understanding of computer programming through the programming language LOGO (Papert, 1980), there have been revived expectations of its helping learners "to better understand the bases of digital information systems and enable them to become creators of knowledge" (Ainley et al., 2016, p. 5). Computational thinking is also referred to as a style of thinking applied during processes of developing algorithms. It is

also associated with specifying, denoting and investigating problems (Ainley et al., 2016).

As it has been seen, the digital literacy domain itself is built upon complex cognitive abilities. Also, its complexity is reflected by the terminological diversity identifying and describing its elements and their relations. In this chapter, an attempt was made to clarify the main concepts related to ICT literacy, whose assessment is in the focus of the research introduced in this paper.

## 1.4. Research into information search also regarded as a component of ICT literacy

Another way of approaching ICT literacy and its accessing information component in particular is from the aspect of research into online information search. The fields typically researched in the literature in terms of the theoretical foundation of online information seeking are information searching behaviour (Navarro-Prieto, Scaife & Rogers, 1999; Wilson, 1997), information seeking or searching strategies (Choi, Koo, Choi & Auh, 2008; Henry, 2005; Navarro-Prieto et al., 1999), information search as a new literacy (Leu et al., 2017) based on reading literacy embedded in a technological setting (Henry, 2006), identifying the goal of information search (Leu et al., 2017), and the relationship between critical thinking, critical reading and the evaluation of the credibility of information (Henry, 2006; Metzger & Flanagin, 2013; Nelliyullathil, 2013). All these studies demonstrate that research into information seeking is closely related to the definition of information need, accessing information and evaluation of information components as well as the cognitive and technological aspects of ICT literacy as detailed in chapter 1.5 of this dissertation.

In this chapter, the research into the theoretical models of information search will be reviewed based on the literature. The aim of this chapter is to provide further foundations offered by the literature from a different perspective for the research project carried out and described in detail in chapter 4. At first, theoretical models in an international, then in a national context are introduced.

Information searching — although not restricted to online search — is identified as a strategic exploration activity in the Framework for Information Literacy for Higher Education by the Association of College and Research Libraries (2016). The association emphasizes a new concept of information literacy, which involves metaliteracy, an encompassing set of abilities, which enables students to use and create information effectively while collaborating with others. These abilities include metacognition, or "critical self-reflection" (Association of College

and Research Libraries, 2016, p. 3) in the first place to facilitate confident and independent information use in an environment where constant evaluation of information sources along non-linear paths is needed.

From the point of view of information search, Wilson's (1997, 1999) studies could be regarded as the foundation of the general model of information seeking behaviour. His flow diagrams demonstrate how the information seeking activities derived from the information need are processed by the individual, who is determined by their environment, social role and personality hindered by obstacles also rooted in the environment, the social role and the individual's personality. Wilson (1999) also differentiates three subsets related to accessing information with information behaviour as the broadest category covering a general field of search. Within it, information-searching behaviour, which involves the methods used to find and access the sources of information. The narrowest subset is information-seeking behaviour, which is concerned with the actual interactions between the individual user of the information and the computerised information systems.

According to the theoretical model by Navarro-Prieto, Scaife & Rogers (1999), the focus is not on the information searching behaviour but on the interrelationship between user, task and web-based information. They claim that prior knowledge of the user assists them in how to approach a task and what search strategies to use, which are appropriate for the specific information seeking situation.

In his study based on information searching strategies, Henry (2005) defines five functions of new literacy (defining the search question, finding the source of the information, evaluating the usefulness of the information, synthesizing the information to give answers to the question and communicating the answers with others), which are basically identical with the seven components of ICT literacy as defined by Tongori (2012, 2013b) detailed in chapter 1.5 of this dissertation: define, access, manage, integrate, evaluate, create and communicate.

Another aspect of studying information search is from the point of view of defining reading literacy embedded in a technological environment as a new literacy, whose central component is accessing information (Henry, 2006). Henry (2006) refers to the 2002 report of Educational Testing Service (ETS, 2002), which identifies accessing information as a critical component. As the first step of information search, defining the goal of information search is named (Leu et al., 2017). Critical thinking and evaluating the information, which are

indispensable for knowing one's way round the information found, also have a prominent role in research into information search (Henry, 2006). It could be summarised, that the most critical components (defining, accessing, critically evaluating) of information search – as a new literacy comprised of reading literacy embedded in a technological setting – are identical with those of ICT literacy from the beginning of the information processing procedure. However, as creating and communicating are not inherent in information search, Henry's (2006) new literacy and ICT literacy do not share these components.

From among research focusing on information search in a national context, the publications of Karácsony (2002) and Virágos (2001) describe the development of library catalogue systems through three generations from the digitalised versions of paper-based catalogue cards through key word search to today's online public access catalogue. Both publications warn that a vast number of key word searches are ineffective, call attention to the possible reasons and suggest directions to set to become more user-friendly.

Examining information search has yet another field that is investigating how artificial intelligence could be incorporated into the processes of information search and use. These processes from identifying the information need and the search list, through the relevance of the information found, to the actual information retrieval are dealt with in detail by Mészáros (2015).

# 1.5. A general summary model and definition of ICT literacy underlying the test development in the four phases of research

As ICT literacy is characterised by terminological diversity and no uniformly accepted terminology or definition exists, the same concepts are sometimes defined using different terms. However, this dissertation intends to use the term ICT literacy.

ICT literacy domain characteristically has an ever-extending number of components. Meanwhile, definitions put an emphasis on certain elements leaving others unstressed. What there is in common with the models in the related literature is that dating back to the 1990s already (Papert, 1993/ 1996), thinking skills, critical thinking and problem solving in particular, have had a major role. Halpern's definition identifies critical thinking as an ability used for solving problems, calculating probability, making decisions and similar operations based on causality. During the procedures, critical thinkers are aware of their own thinking and learning, are able to control it and reflect upon the possible outcome of their own decision (Halpern,

1998). Such operations are needed when applying the components of ICT literacy in a digital technology environment. Garrison, Anderson and Archer (2001) view critical thinking as a group of abilities, skills and inclinations, which lead to deep understanding by allowing of domain-specific, critical enquiry. This is the group of thinking skills the application of ICT literacy components (defining our information need, selecting the paths to access the information, managing and storing it, evaluating it, integrating it into the system of already existing information, creating new information and communicating it) are based on.

From among social skills and competences, collaboration and communication skills also occupy a prominent place among the elements ICT literacy. In 2001, the European E-Learning Summit strongly suggested that preference of social learning strategies is imperative due to future employee needs (Whyte & Overton, 2001). The definition provided by the OECD PISA Feasibility Study (Lennon et al., 2003) also designates communication with others (Figure 1) as a necessary condition for functioning in society (Lennon et al., 2003) and in all further models of ICT literacy both communication and collaboration are included.

Responsible use of information [concerning ethical and legal issues, as well, also raised by Livingstone (2014), although mainly related to media literacy] has also been built into the framework of ICT literacy as a major aspect (Ainley et al., 2007; Griffin et al., 2012; Katz, 2005; Catts & Lau, 2008) (Figure 1). The role of ethical information use has grown in our digital environment where data could be searched for, retrieved, downloaded and transformed within seconds, as anonymity or ignorance cannot be an excuse to violate others' rights. Ainley et al. (2007) regard health related aspects as ones belonging to the circle of responsible use of information technology. One of the tasks in their test developed to assess ICT literacy is about the interrelationship between neck problems and computer and monitor use. Personal safety issues including becoming a victim of online harassment are also associated with responsible use of information and are in connection with technological literacy, cognitive and social competences. The more proficient users are technologically, the less they are exposed to unwanted messages because they are able to decide which strategies and what restrictions imposed on the circle of their online friends will avoid the negative experience of cyberbullying (Aoyama, Barnard-Brak, & Talbert, 2011).

Synthesizing the models introduced so far in this paper, such a model of ICT literacy has been set up in which four (technological, cognitive, social and responsibility-related) aspects of

the seven components (define, access, manage, integrate, evaluate, create and communicate) are demonstrated. Technological literacy, cognitive skills, social competences and the application of legal and ethical competences together with health and personal safety precautions comprise ICT literacy, which manifest themselves in seven action-type components (Figure 7).

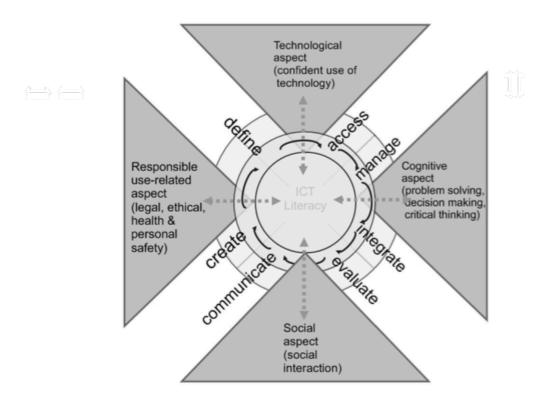


Figure 7
The dynamic model of ICT Literacy with the seven components and four aspects (Tongori, 2012, 2013b)

All seven components of ICT literacy could have numerous points of connection with the four main aspects. The four aspects could be positioned in a way that they should partly overlap. By moving them along the arrows in Figure 7, the aspects and components could be arranged in various ways to overlap, which is to demonstrate the dynamic relationship between the components of ICT literacy. The aspects and the components (latter shown in Figure 7 on a disk that could be turned around) could have intersections. The possible intersections and points of connection between the components and aspects will be dealt with below (Tongori, 2012, 2013b).

The link between technological literacy and cognitive skills (critical thinking and problem solving) is recognized in the seven components of ICT literacy as defined by Tyler (2005). The

connection between these areas is apparent in all activities during which defining the information need (define), collecting relevant information based on a sequence of decision making processes (access), grouping the information in order to store it in an organized way (manage), conceptualising and reconceptualising information by and with the goal of comparing, summarising and synthesizing pieces of information (integrate) take place (Catts & Lau, 2008; Garrison et al., 2001; Halpern, 1998; Tyler, 2005). Furthermore, the intersection of technological literacy and critical thinking could be illustrated by the process of weighing up to what extent the information present will meet the needs of a given task (evaluate) (Catts & Lau, 2008; Tyler, 2005). The interconnection between problem solving – as an active and productive process where insight and restructuring patterns play an important role (Molnár, 2010) – and technological literacy is shown by information adaptation and application meaning knowledge transfer, and processes of creating and recreating (create) (Catts & Lau, 2008; Tyler, 2005) in an ICT environment. Sharing and communicating the information in a way appropriate for the context and the target audience (communicate), selecting the right medium and using the communication tool all are all presumed to depend on both cognitive skills and technological literacy (NAGB, 2013; Tyler, 2005).

The component *communicate* has both cognitive and social aspects. It could be found in the intersection of cognitive skills (critical thinking and problem solving) and social competences. In case communication takes place in a technological setting, it is conceived of as a component found in the intersection of technological literacy, cognitive skills and social competences.

The component *evaluate* could be placed in the intersection of the technological, cognitive and responsible use related aspects. It is justified by the fact that evaluation takes place in a technological environment needing the abilities of decision making also related to the legal and ethical issues of downloading, using and sharing information in a reliable and accountable way.

Tyler's (2005) seven components of ICT literacy could be interpreted as a construct in the common intersection of the four main aspects (technological, communicative, social and responsible use related ones). The seven components are embedded into the environment of info-communication technology, not simply technology. However, ICT use is a dynamic activity and therefore, it cannot be demonstrated by providing a static model. The components and

aspects are supposed to dynamically interact with one other during information handling activities.

In summary, ICT literacy is defined as a construct which involves the confident use of info-communicational tools and networks during which the individual defines his or her information need, accesses, manages, integrates and evaluates the information, creates and shares with others information through communication in order to participate efficiently in society, while being aware of the technological, cognitive, social and responsibility-determined (legal, ethical, health and personal safety) aspects of ICT activity (Tongori, 2013b; see Figure 1).

Nowadays ICT literacy, which pays a key role in our lives, is not any more barely referred to as knowledge and application of computers, digital mobile devices and basic software in the literature but as a conception which involves technological literacy, cognitive abilities, social, legal, ethical and other competencies related to responsibility and safety. The dimensions of ICT literacy (its components and aspects) are more and more embedded in the ever more complex system of 21<sup>st</sup> century skills. In this complex system, in addition to the basic literacy skills of reading and writing, mathematical, geographical, historical, science, first language and world language, healthy lifestyle, entrepreneurship and citizenship competencies are also included and are vital for employment and thriving in the developed world of the 21<sup>st</sup> century (Partnership for 21<sup>st</sup> Century Skills, 2008). The skills and abilities which are necessary for everyday life and career together with those ones which are in connection with information and media, learning and innovation, ICT literacy and 21<sup>st</sup> century skills are closely interrelated.

Since the millennium, it has been undisputed that it is not only beneficial but highly recommended that information and communication technology devices should be involved at all levels and in all fields of education whether it is higher education (ETS, 2002; Kárpáti, 2004) or public education (Ainley et al., 2007; ETS, 2002; Fehér, 1999; Kárpáti, 2004; Molnár, 2011; OECD, 2005) which is concerned. All the more so, because in addition to the fact that ICT literacy and the related cognitive abilities are not simply essential for prospering in the world of work, knowledge creation and economic growth (Partnership for 21<sup>st</sup> Century Skills, 2008; UNESCO & Microsoft, 2011) but a whole new generation has grown up whose most natural environment is the use of info-communication technology. Besides its different circle of interests and habits, this net generation, digital natives, Y or even Z generation are also characterized by changed abilities (visual, special orientation, inductive, discovery-based

learning, multitasking) owing to – among other factors – computer games (Oblinger & Oblinger, 2005; Prensky, 2001; Tari, 2010, 2011; Molnár, 2010, 2011). However, the frequent use of computers or the internet does not necessarily result in a proficient level of application in terms of all dimensions of ICT literacy (Ainley et al., 2007; Law et al., 2009; Katz & Macklin, 2007). Therefore, identifying the dimensions of ICT literacy and measuring students' achievement in these dimensions might provide us with a better insight into which fields need intervention in order for education to have the most positive effect on students' development in ICT literacy.

# 1.6. How the ICT literacy model set up served the purpose of the research on test development

Having seen the phenomenon, that is students' inability to act efficiently in certain fields of our technology-rich environment, the underlying reasons had to be found. Reviewing the ICT literacy related literature has helped to collect, compare, contrast and synthesize the existing models of the construct in question into one model clarifying the structure of the components and aspects as well as their relation to one other (see Figure 7). As a starting point, the whole construct was explored to get the full picture. Moving on, when development of the assessment instruments commenced, the research had to be given a focus so that attention should be paid to an analysable number of components at a time. This focus was also to serve internal consistency and feasibility as well as cost effectiveness (see the chapter *Research problem*).

Besides the core assets of basic literacy such as reading and numeracy, in the first phase of the research, where an online self-reported questionnaire was devised, confidence in the *define*, *access* and (critically) *evaluate* components as well as the technological and responsibility related aspects of ICT literacy were in focus. These components from among the seven components of ICT literacy – from the beginning of the information handling process – are regarded as the most critical elements of (research into) information search embedded in a technological setting, which is also conceived as a new literacy (Henry, 2006). The fact that both research on ICT literacy and information search had declared these components central ones, implied that the development of an assessment instrument should be launched with a focus on them. However, the self-reported questionnaire also included questions about frequency and duration of besides attitudes towards online activities as well as demographical questions.

Responsibility related and technological aspects as well as the define and evaluate

components were also present in the second phase of the research, where a shift towards performance assessment through an online, partly simulation-based test was initiated. However, at this stage the research focus was reduced and the items were centred mostly around accessing information (see chapter 3.1.). To improve and maintain internal consistency, from the third phase on, assessment of students' confidence in accessing information was mapped.

To ensure that testing confidence in accessing information excludes other related abilities or components as much as possible, definition of the information need (*define* component) was not tested but given by the questions the test takers were expected to answer. Evaluation of the information in terms of the cognitive processes of decision making about the appropriacy or usefulness of the information could not be excluded, as such thinking abilities cannot be excluded from reading comprehension either. However, the other aspect of evaluation, that is judging the credibility of the information was not involved, as the virtual websites were provided as credible ones. No managing, integrating, creating or communication was needed to complete the tasks.

In the second phase, to exclude the hindering effect of possible reading difficulties, the instructions and scenarios were also audio recorded for the students to listen to if they wished by clicking on a loudspeaker icon. And to ensure that no memory test was taken, the scenarios could be re-displayed by clicking on a button. (In further phases, there were no long scenarios and the test takers could move forward and backwards in the test and navigate freely on the virtual websites, consequently these measures were not needed.)

Reviewing the literature did not disclose any previous work on adapting a third generation, simulation-based online performance assessment test on purely the access component of ICT literacy of such a wide span of grades as grade 6 to 11 students, either in a Hungarian national or in an international public educational context. Focusing on merely one of the components of ICT literacy made it possible to have a deeper insight into it. As a result, the relevance and unique character of the assessment instrument which is based on the synthesized ICT literacy model (Figure 7) and which is introduced in chapter 4, is given. Selecting other components of the ICT literacy model might shape the course of further research, which is beyond the scope of the present one.

#### 2. ICT literacy assessment in an educational context

In the following sections, from 2.1 to 2.3., an attempt to categorize ICT literacy assessment from various perspectives is made. At first, grouping is made by the medium, then by the stage of education and finally by the scope of investigation of the assessment.

# 2.1. The medium of ICT literacy assessment

Examples of both paper-based and computer-based assessment of ICT literacy could be found, as it is also demonstrated in chapters 2.2. and 2.3. of this dissertation. However, technological development has produced such advantages of computer-based testing, that paper-based assessment has been being superseded by measurement using computers as its medium in most fields of ability related performance testing including ICT literacy as well. Molnár et al. (2015b) claim, that there are three types of assessment in terms of ICT literacy and related areas referred to as first-, second- and third-generation ones. First-generation assessment is characterized by online questionnaires exploiting certain advantages of digitalization of paper-based kind of measurement such as instant feedback, fast, effective and cost-effective data collection, for example eLEMÉR researches (Hunya, 2015) aimed at examining how the use of information technology devices contributes to the development of schools in Hungary. Students' individual performance has also been gauged by ability and skills tests which, apart from including some multimedia elements, apply mostly static items, for instance, the assessment executed by Tongori (2014b). Such measurement is referred to as second-generation as opposed to paper-based ability assessment task sheets, for example, the ones devised by Dancsó (2009), whereas the ones applying simulation and a dynamically changing testing environment are labelled as third-generation assessment (Csapó, et al., 2012; Molnár, et al., 2017). According to the present day internationally accepted view, nearly two decades after the millennium, the relevant setting for authentic information literacy assessment should be technology-based (or even gaming technology-based), where items are presented in a simulated online environment (Fu, Zapata, & Mavronikolas, 2014) and contextual information is logged and analysed online (Csapó, Lőrincz, & Molnár, 2012). Current trends in the assessment of ICT literacy and related domains also suggest that further development of the research in this field will favour assessment instruments focusing on collaborative online activities (Greiff, Holt, & Funke, 2013; Tongori & Molnár, 2018).

#### 2.2. The context of ICT literacy assessment according to the stages of education

The initiative in elaborating systems of authentic assessment instruments of such high-order skills as ICT literacy or complex problem solving has been in the focus of research since the last decade (Fu, Zapata, & Mavronikolas, 2014). From among the three commonly known stages of education, that is primary, secondary and tertiary (postsecondary or higher) education, due to the indispensability of ICT literacy considering the 21<sup>st</sup>-century information-based labour market demand, the required educational level to prepare students for life as employees, has shifted from higher (Katz & Macklin, 2007) to secondary education (Bangser, 2008).

Although a pilot assessment initiated by OECD was administered as early as in 2003 (Lennon et al., 2003) to map the feasibility of a PISA ICT literacy test among 15-year-olds it was not until 2007, that large scale, authentic assessment of ICT literacy was launched by ETS on university level involving students in higher education (Katz & Macklin, 2007). Later, when technological advancement further enhanced the necessity of ICT literacy education and its assessment on secondary levels, all over in highly developed countries as well as by international associations such as the International Association for the Evaluation of Educational Achievement (ICILS, 2014), research projects, for example, in Australia, first in 2005 (ACARA, 2016), Hong Kong (Law et al., 2009) and the USA (NAGB, 2013) were launched. These researches are also dealt with in chapter 2.3.1. from another perspective of ICT literacy assessment, that is the measurement in an international context.

### 2.3. Context of ICT literacy assessment according to the scope of investigation

#### 2.3.1. International context

In this part of the dissertation the term international context is meant to identify contexts apart from research carried out in Hungary. Although some of the assessments described here were executed within the national borders of a respective country, they are distinguished from the measurements with a solely Hungarian reference. On the other hand, research done in Hungary is referred to as national context.

### 2.3.1.1. The international context of assessing ICT literacy

Our information-dependent society and knowledge-based economy needs competent individuals with new literacies (Leu et al., 2017) to function efficiently as work force, citizens and life-long learners (Commission of the European Countries, 2005). As a result, cross-national investigations have been focusing on the assessment of those abilities and skills that are needed for such efficiency (ACARA, 2015; Fraillon, Schulz, Gebhardt, & Ainley, 2015; ICILS, 2014; Katz & Macklin, 2007; NAGB, 2013).

Different ways and means of assessing ICT were analysed in detail by Molnár et al. (2015b) and Tongori (2013a). Partly based on the meta-analysis of ICT related assessment carried out by Molnár and Kárpáti (2012), Molnár et al. (2015b) found that until the millennium, the medium of educational research into ICT literacy was mainly paper-based questionnaires. In terms of international assessment, the first major examinations were conducted between 1986 and 1992 (First Information Technology/Computer in Education Study – COMPED) and in 1999 (Second Information Technology in Education Study – SITES) (Molnár & Kárpáti, 2012). In the 1990s, the International Association for the Evaluation of Educational Achievement (IEA) organized multiple projects (Learning ICT, Learning with ICT and Learning Through ICT) to examine the effects of ICTs on schools. Another one of the earliest researches called Information and Communication Technology and the Quality of Learning was conducted between 1999 and 2004, coordinated by the educational research centre of OECD, the Centre for Educational Research and Innovation (CERI), involving 25 countries, focusing on the evaluation and application of educational software using case studies and surveys of 17-yearold students (Molnár & Kárpáti, 2012). Another major research named Safer Internet was conducted in 25 European Union member states at the turn of the years 2005 and 2006. Its aim was to map children's internet usage habits, with a focus on safety issues regarding harmful website content in particular (Molnár & Kárpáti, 2012). Furthermore, as the use of computers was declared as important background variable in terms of results in other fields, the 2003 OECD PISA assessment (OECD, 2003) included a questionnaire on habits of and attitudes towards using computers, the results of which revealed that almost every 15-year-old student in OECD countries had had some computer-related experience. The Third International Mathematics and Science Study (TIMSS) also used ICT as a background variable (Molnár & Kárpáti, 2012).

The abovementioned researches were significant at their time, before computer-based assessment and better school infrastructure offered such new opportunities that could pave the way for novel measurement tools to test digital literacy. Switching from the old medium of assessment to the new one – that is conversion from paper-based testing to computer-based data collection – is in progress in a number of ability and skills areas. Regarding the educational setting, besides students' – both in secondary and higher educational settings –, teachers' ICT or digital literacy and competence have been assessed using computerised data collection methods and even recent research with ICT literacy in its focus might still stick to digital versions of self-reported questionnaires (Al Khateeb, 2017; Tadesse, Campbell, & Gillies, 2018). However, in case of ICT literacy, rapid reaction to the advancement of technology was urged by its inherent characteristics, and the necessity of valid and authentic assessment based on such assessment instruments and environments which facilitate measurement of actual ICT performance.

The largest organizations carrying out assessment including the American Educational Testing Service (ETS) conducting educational assessment in higher education (Katz & Macklin, 2007), the National Assessment Governing Board (NAGB, 2013) responsible for nationally representative assessment of subject areas in secondary education in the United states called National Assessment of Educational Progress (NAEP), the former Australian Ministerial Council of Education, Employment, Training and Youth Affairs (MCEETYA) (Australian Curriculum, 2012) [now Ministerial Council for Education, Early Childhood Development and Youth Affairs, Australia (MCEECDYA)] responsible for the National Assessment Program (NAP) in primary and secondary education overseen by the Australian Curriculum, Assessment and Reporting Authority (ACARA; ACARA, 2012), the Japanese National Institute for Educational Policy Research (NIER; Lennon et al., 2003), the Centre for Information in Education (CITE) of the University of Hong Kong (Law et al., 2009) and the International Association for the Evaluation of Educational Achievement (Fraillon et al., 2015) developed novel assessment tools to gauge students' ICT literacy performance by using simulation software delivered digitally to administer large scale assessment [with the exception of The Feasibility Study (Lennon et al., 2003), which was a pilot assessment]. The 2014 assessment by ACARA introduced new elements. Students were administered four large tasks using purpose-built software, two of which were new modules incorporating tablet or animation software use and/or collaboration

(Fraillon et al., 2015). Also, the Technology and Engineering Literacy assessment administered within the framework of the National Assessment of Educational Progress by the National Assessment Governing Board has Information and Communication Technology as one of the three interconnected areas measured (NAGB, 2013) through online, interactive, scenario-based tasks. Besides, a small scale CBA ICT literacy assessment conducted by the Russian Education Aid for Development programme (READ) of the World Bank was administered to compare results of grade 9 students in Tatarstan, Russia and Thailand (Zelman, Shmis, Avdeeva, Vasiliev, & Froumin, 2011; see Tables 1 and 2). In addition, small scale pilot studies were carried out in terms of learning through digital networks as well led by the Assessment and Teaching of Twenty-first Century Skills (ATC21S) project (Griffin et al., 2012).

While the OECD feasibility (pilot) study – as planned to be part of the PISA assessment – took its sample from among 15-year-olds from Australia, Japan and the United States, ACARA carried out – and still carries out every three years – a large-scale assessment of the ICT literacy of grade 6 and 10 Australian students (Fraillon et al., 2015). Students at higher levels of proficiency are expected to be able to perform higher order actions where they research and also transfer their existing ICT knowledge to create and then communicate new information. Examples of modules and their themes in the test are creating an art show web site, adding new levels to a game, setting up a crowd-funding page for their band (in higher level large tasks) and identifying whether an advertisement was created by a person or a computer (in higher level stand-alone tasks). An example from lower level stand-alone tasks requires students to activate the map of a sports picnic from within an invitation template. The two-hour time allotment included the filling in of the online questionnaire.

CITE tested (n=2622) grade 5 (primary school) and grade 8 (secondary school) Hong Kong students' "information literacy competence" (Law et al., 2009, p. 150) through mathematics, technical literacy and Chinese language (grade 5) and science, technical literacy and language (grade 8) based scenarios across all the seven "dimensions" (Law et al., 2009, p. 150) of information literacy (see Table 1) following authentic, daily life scenarios appropriate for the curriculum, subject and grade. The themes (scenarios) comprised, for instance, a day trip to an ocean park, decorating a photo frame, endangered species, ecosystems, while the tasks related to the information literacy dimensions were for example, managing information (to assess the manage dimension), finding out about ticket prices and calculating the amount

(to assess the access dimension), deciding on keywords to search for information (to assess the define dimension).

NAEP TEL is another example of large scale national assessments (of grades 4, 8 and 12, according to the preliminary plans) involving ICT literacy as one of its three areas. A 50-minute test time was planned to include one 25-minute long scenario – composed of multiple choice, short answer and long answer tasks –, an approximately 12-minute short scenario – multiple choice and short answer tasks – and a 12-13-minute section of discrete, non-scenario items. According to the plans, students were to be administered different combinations of the long and short scenarios and the set of discrete items. However, in the actual assessment only grade 8 students were involved (n=21,500) in a 60-minute test in two individual, 30-minute sections each of which included one long task and a combination of short tasks and discrete questions or just sets of discrete questions (The Nations Card, n. d.). A background questionnaire also belonged to the test (NAGB, 2013) (see Table 1).

ICILS is an international comparative study assessing students' computer and information literacy together with the ICT learning environment in schools first administered in 2013 to (n=60,000) grade 8 students in 21 countries (see Table 1). The test consisted of four 30-minute modules of questions and tasks. Each student is administered two randomly allocated modules followed by a 30-minute student background questionnaire. The test has a linear structure composed of tasks based on realistic themes such as after school exercise, a band competition, breathing and a school trip. As in NAEP TEL, a module includes small discrete tasks and a large task. The total number of tasks and questions was 62.

The American ETS focuses on higher-level education, assessing the ICT literacy of American university students. The assessment of the READ program (n=495) was devised based on the ETS test. In terms of procedures, ETS (Katz & Macklin, 2007) and the assessment of the READ programme (Zelman et al., 2011), which shows a number of common features with the ETS test regarding both theoretical foundations and execution, required students to complete timed tasks after a 30-minute background questionnaire on demographical and academic achievement related questions using the computers of the respective institutions. The time allotment of the ETS test was 120 minutes. During the READ assessment students solved tasks in all Components of ICT literacy, while ETS examined the individual students' performance in only two ICT literacy components as preceding measurements showed high (r=0.85)

correlations across the results of the seven components. Applying the right anchoring techniques, students were administered various test forms including different component pairs with the same number of students per campus completing the tasks. Students results in raw points were plotted on a common scale. Students were asked to reflect on their experience regarding the test in an online post-test questionnaire – in case of the ETS assessment – or in focus group discussions – in case of the READ programme.

In addition, confirming the validity of the instrument was among the aims of both the ETS (Katz & Macklin, 2007) and READ (Zelman et al., 2011) assessments. Both support construct validity by confirming convergent and discriminant validity. Both researches in this respect are based on the correlations between the results in the ICT literacy performance assessment test and the responses to the self-reported questionnaire in three fields: confidence in ICT activities, frequencies of ICT literacy related activities and general academic achievements. Both researches claim that the fact that all areas measured in the self-reported questionnaire – except for frequencies of ICT literacy activities – show significant correlations with the results in the ICT literacy performance assessment support the convergent validity of the test. On the other hand, the low negative correlations ("r=-.01", Zelman et al., 2011, p. 9) between the frequencies of ICT literacy activities and the ICT literacy test indicate that there is no close relationship between them. As a result, discriminant validity of the measurement is confirmed. Reliability coefficients were high in case of both researches: Cronbach's  $\alpha$ =0.85 (pre-test by ETS including all components) (Katz & Macklin, 2007) and  $\alpha$ =0.9 (READ) (Zelman et al., 2011).

Table 1: Comparison of the CBA ICT literacy performance assessment instruments regarding samples and time (cf. Tongori, 2013b, p. 606)

ICT literacy performance assessment instruments	Sample	Age/Grade	Time allotted
OECD PISA Feasibility (ACER/NIER/ETS)	n=34 <sup>1</sup> n=55 <sup>2</sup> n=29 <sup>3</sup>	Secondary school students aged 15	165 min.
ETS	n=4048	College students	150 min.
ACARA <sup>4</sup> / MCEETYA	n=5710 n=5313	Grade 6 Grade 10	120 min.
ACARA 2014	n=5622 n=4940	Grade 6 Grade 10	120 min.
CITE	n=1320 n=1302	Grade 5 Grade 8	135 min.
READ	n=395 <sup>5</sup> n=100 <sup>6</sup>	Grade 9	No data
IEA ICILS	n≈60.000 <sup>7</sup>	Grade 8	60 min.
NAEP TEL <sup>8</sup>	n≈21.500	Grade 8 <sup>9</sup>	50 min. <sup>9</sup>

<sup>&</sup>lt;sup>1</sup> Australia ACER (Australian Council for Educational Research)

<sup>&</sup>lt;sup>2</sup>·Japan NIER

<sup>&</sup>lt;sup>3</sup> U.S. ETS

<sup>&</sup>lt;sup>4</sup> Australian Curriculum, Assessment and Reporting Authority

<sup>&</sup>lt;sup>5</sup> Tatarstan, Russia

<sup>&</sup>lt;sup>6</sup> Thailand

<sup>&</sup>lt;sup>7</sup>21 countries: Australia, the City of Buenos Aires (Argentina), Chile, Croatia, the Czech Republic, Denmark, Germany, Hong Kong SAR, the Republic of Korea, Lithuania, the Netherlands, Norway (Grade 9). Newfoundland and Labrador (Canada), Ontario (Canada), Poland, the Russian Federation, the Slovak Republic, Slovenia, Switzerland, Thailand and Turkey. Three of these participants represented education systems within their countries—the City of Buenos Aires (Argentina), Newfoundland and Labrador (Canada), Ontario (Canada)

<sup>&</sup>lt;sup>8</sup> USA National Assessment of Educational Progress, Technology and Engineering Literacy

<sup>&</sup>lt;sup>9</sup> Planned: grades 4, 8 and 12 in 50 minutes + background questionnaire (NAGB, 2013); Actual assessment: grade 8 in 60 minutes + background questionnaire (The Nation's Card, n. d.)

Table 2: Comparison of the CBA ICT literacy performance assessment instruments regarding types of software and tasks (cf. Tongori, 2013b, p. 606)

ICT literacy performance assessment instruments	Simulation (Purpose- built large tasks*)	Authentic	Multiple Choice and Open Ended Tasks	Working with tablets, animation and collaboration	Additional demographic & Self- Assessment Questionnaire
OECD PISA Feasibility (ACER/NIER/ETS)					
ETS					
ACARA <sup>1</sup> / MCEETYA					
ACARA 2014	*				
CITE			No data		No data
READ					
IEA ICILS					
NAEP TEL					

<sup>&</sup>lt;sup>1</sup> Australian Curriculum. Assessment and Reporting Authority

What all these assessments have in common, except for the ones conducted by ETS testing university students, is that their samples are drawn from the population of grades 5 or 6 to 10 or up to the age of 15 or 16. All of them were computer simulation-based tests with purpose-built large and short tasks. All of them collected data by administering an additional demographic & Self-Assessment Questionnaire.

Common features can not only be found in how the tests are structured. Another important aspect of the assessments – in terms of focus for future test development purposes – could be found in the analysis regarding students' results. Detecting significant change in the development of students' ICT literacy between grades 6 to 10 (ACARA, 2015) is a major finding

which might help a test developer in setting research goals, formulating research questions and hypotheses regarding developmental characteristics of ICT literacy. Also, significant difference between the performance of girls and boys could be seen in favour of girls (ACARA, 2015; ICILS, 2014; NAGB, 2013).

# 2.3.1.2. The international context of assessing information search

Research into information search is another perspective from which examining ICT literacy (especially the define, access and evaluate components) could be viewed. In chapter 1.4. of this dissertation, the literature on the theoretical background to information search as well as to ICT literacy have been reviewed. In this chapter, the literature on assessment of information search in an international context is viewed.

In terms of assessment of information research, Raquel Navarro-Prieto, Mike Scaife and Yvonne Rogers (1999) conducted their investigations based on observation, interviews and questionnaires regarding web search, focussing on the interrelationship between information seeker, searching task and information on the web, involving 23 volunteering university students. They assumed that 'users' proficiency, their cognitive strategies, the type of search task and the display of information are interrelated. According to their results, the type of search task (fact finding or discovery of information) had a greater impact on proficient than on least proficient participants, which led to the conclusion that prior knowledge of web search is needed to enable the participant to differentiate between search tasks. Also, prior knowledge and proficiency helped the participants decide on how to start the search task and choose the appropriate search strategy for the given situation (Navarro-Prieto et al., 1999).

Henry (2005) puts information search strategies in the centre of his research as well. In his qualitative pilot research based on observation and interviews, he collected data from seven teachers of an American country elementary school seeking an answer to which abilities and strategies are necessary for a successful information search on the internet and how the participants learned online information search. In his study, Henry's (2005) identification of the part (information search strategies) was developed from the definition of the whole (new literacy). Covering an identical content with the seven components of ICT literacy defined by Tongori (2012; see in Chapter 1.5) only having a different number of categories, Henry defines five functions of new literacy, with successful information search as the one having the central role. The results showed that reading comprehension was a major literacy component,

supporting information localisation, which involved different reading techniques and critical reading. What also played a significant role in finding the information successfully was higher order thinking skills, which form an intersection with critical reading. The major factors in learning information search proved to be self-training, trying and the combination of these (Henry, 2005).

Another relationship investigated was the one between information search strategies and cognitive closure. As a result of their research, the Korean researchers, Choi, Koo, Choi and Auh (2008) found that cognitive closure (the desire to have certainty over uncertainty in terms of an answer) made the individual grasp the first possible answer in a given topic and ignore further aspects. In addition, once a decision had been made or a conclusion drawn, the individual stuck to it.

Several studies were centred around evaluating the information searched and found (Metzger & Flanagin, 2013; Nelliyullathil, 2013). The evaluate component (See Chapter 4) — evaluating the credibility or the usefulness of the information — is connected to our overall research on ICT literacy. Leu et al. (2017) identify the ability of evaluating information as a fundamental element of new literacy among other ICT literacy components. Metzger and Flanagin (2013) postulate that online information consumers often rely on favourable visual display or the ease of navigability instead of content or sources when making their decisions on credibility, which decisions might often prove to be rash and premature. Nelliyullathil (2013) conducted a research involving 68 master course university students to investigate whether instructions on web use helped the development of better evaluation competencies regarding the credibility of information. According to his results, those who had been trained in web use had a significant advantage in evaluating credibility of information over those who had not.

A related field of research is that of the examination of viewing behaviour using artificial intelligence. Although not with an educational purpose, Qi Guo and Yang Song (2016) carried out a large-scale research into certain factors of accessing information. They were seeking answers to which variables influence the reading of the information offered in the browser. They investigated factors from the ranking in the browser through the characteristics of the information on the display of the mobile device to the technological specifications of the touchscreen. Their results showed that more viewings were given to information that was at the beginning of the list offered. Furthermore, according to their results, regardless of the

relevance of the information, screens including visual stimuli had a higher frequency of viewing. Screens of a bigger size measured in pixels were also more frequently viewed.

Alongside easy visibility, other factors of easy access to information also play a role in the individuals' choice of methods to be used. For example, familiarity with or easy usability of the information source are also favoured by users (see Brindesi, Monopoli, & Kapidakis, 2013).

Research incorporating the examination of eye-movement also contributes to revealing the ways of information search. As reported by Nielsen (1997), decisions whether a web page is worth reading or not are made by a fast, F-shape scanning movement of the eyes. This scanning movement starts from the top left corner of the web page horizontally. Together with the supplementation of Nielen's (1997) research by Pernice (2017), the results of eye-movement research are valuable sources of web page design and devising a measurement instrument simulating websites.

#### 2.3.2. Hungarian national context

Since the millennium, there have been numerous researches into ICT literacy related fields in educational contexts, for example, digital learning materials (Kárpáti, 2000) or attitudes of educators towards using ICT (Fehér, 2009; Lakatosné Török & Kárpáti, 2009; Szili, 2014). Measurements involving students in Hungary have mostly relied on paper-based questionnaires or task sheets, collecting information about students' IT knowledge in a static and indirect way (Dancsó, 2009; Hanczár, 2006; Blénessy, 2007). Further, recent research applying self-assessment questionnaires was conducted by Hungarian researcher Gábor Kiss, whose studies based on a partly national, partly international context were published on ICT literacy and attitudes of university students (Kiss, 2017; Kiss & Csiba, 2017). Besides, a few small-scale pilot assessments testing the applicability of mlearning (Abonyi-Tóth & Turcsányi-Szabó, 2015) or virtual reality (Ollé, 2012) in education have gauged at least obliquely one or another aspect of students' ICT literacy.

In their meta-analysis of major post-millennium Hungarian and international empirical researches with Hungarian relevance directed at ICT literacy-related issues, Molnár and Kárpáti (2012) provide a detailed summary of the nature and objective of research directly focusing on ICT. They postulate that the vast majority of these examinations were paper and pencil (PP) questionnaires focusing on such aspects as frequency of or access to ICT use, teachers' or students' ideas about their own ICT competences or attitudes or had ICT as a background

variable (Molnár & Kárpáti, 2012). They draw attention to the fact that even over a decade after the millennium, research in a national context aimed at the field of literacy in question, still bears the characteristics of international research at around the year 2000 in terms of focus. This delay of national research could be detected in focusing on provision of equipment for ICT within the field of infrastructural issues, besides typically using questionnaires (Molnár & Kárpáti, 2012). However, the significance of these researches lies in the fact that comparison with the results of earlier research helps to form a view of the effectiveness of infrastructural educational development strategies and the tendencies of the changes of the areas investigated (see the studies by Hunya, 2015; Tóth, Molnár, & Csapó, 2011; Molnár & Pásztor-Kovács, 2015).

Moving on towards the assessment of abilities applied by pupils and students while using technology in their everyday learning activities could be a further step taken in the direction of international assessment trends. A measurement of this kind carried out among lower primary pupils by Molnár et al. (2015b) was aimed at mapping pupils' basic technological skills such as using the keyboard and the mouse. Contrary to the results of international research in higher grades (ACARA, 2015; ICILS, 2014; NAGB, 2013), in this research there was no significant difference between the results of boys and girls.

In national context, there has been no performance assessment of ICT literacy applying a third generation, online test. In this respect, the research described in this dissertation is unique. It has been proven that valid and reliable measurement of the most fundamental, access component of the ICT literacy construct vital from the perspective of lifelong, individual learning is possible in a wide age spectrum using the assessment instrument devised.

It could be concluded that to create a meaningful instrument to assess ICT literacy performance of grades 5 to 11 students, it is essential that it should be suitable for the nature of the construct assessed. Consequently, based on the literature reviewed, an appropriate ICT literacy assessment instrument is technology-based. Another fundamental feature is that it should be based on authentic or simulation software to provide the test-takers with tasks that require similar responses from them as real-life problems. Also, an appropriate assessment tool (technology) is needed for recording the test-takers' results. In chapter 3 of this dissertation the four phases of a research project with increasing levels of appropriacy for the requirements are introduced starting from simply being technology-based to being fully simulation-based.

#### 3. Assessing grade 5 to 11 students' ICT literacy

# 3.1. Introducing the four phases of a research project

Having reviewed the relevant literature (Tongori, 2012, 2013a, 2013b, 2013c; Tongori & Molnár, 2018), a stepwise research of measuring the ICT literacy of grades 5 to 12 students in public educational settings was planned. The whole research project had four different phases, with the goal of evolving step by step towards a large-scale performance assessment test of ICT literacy. Each phase had its specific aims, methods and results. The methodology of the whole research is outlined in chapter 3.5. Overarching research design and methodology. Detailed description is given in separate chapters. The aim of this chapter is to provide a general outline of the common features regarding aims, research questions and hypotheses, and to introduce the planned and executed processes and major changes during the whole research project.

During the process of the research, its scope was gradually reduced from the wider aspects of ICT literacy (including other components and aspects) to the most essential component of ICT or digital literacy, which is accessing information (Henry, 2005). Without being able to find specific information efficiently in a digital environment, 21<sup>st</sup> century students leaving public education and either entering tertiary education or the labour market would be exposed to not being found eligible for the challenges of everyday work and life. Besides its indispensability in our information society, the measurability of the one component chosen within a comparatively restricted time span and resources in a Hungarian context was also taken into consideration. Another reduction in the scope of our investigation was made in terms of grades 5 to 12 in focus. Such a grade range would have covered the upper primary (grades 5-8) and all secondary levels (grades 9-12) of the Hungarian educational system preparing students for further education. However, the original grade range from grades five to 12 students finally had to be reduced to grades 6 to 11 due to constraints of the accidental (as opposed to random) sampling method used, which was convenience sampling based on availability (Etikan, Musa, & Alkassim, 2016).

The sampling method chosen had both advantages and disadvantages. During test development several rounds of small, pilot assessments were carried out with an extended number of grades. As all the aspects of representativeness are rarely given at the same time,

our research was not an exception. The large-scale assessment in the last phase of our research was administered as part of a large-scale, overall assessment of thinking abilities with all the background variables provided. As a result, the effects of those background variables on the construct might be analysed. One of the limitations was that the schools participated on a voluntary basis, which might have resulted in their leaving out their lowest achieving students from the test. Further research is needed to reveal whether it was the case. However, the considerably large sample size, the national coverage and large number of participating schools together with the outstandingly high reliability coefficient of the test supports the generalisability of the results.

The entire research project was aimed at developing and applying an assessment instrument to measure those abilities of grade 5 to 11 students which are necessary for being confident in finding information in a digital environment. The research project consisted of four major phases embodied in three pilot assessments leading to one final large scale assessment. Each phase and the related steps of test development will be outlined in the following paragraphs and will be described in detail in chapters 4.1. to 4.4.

The focus of the research is measuring students' confidence in accessing information', a major component of ICT literacy. However, to avoid constant repetition of the term, throughout the dissertation it is also referred to as efficiency in accessing information. Efficiency is considered as the reflection and/or manifestation of confidence. Consequently, it is often used as a synonym based on the notion that if one is confident in searching for and finding information online, then he or she is meant to be able to access information efficiently, which is reflected in his or her result. Similarly, accessing information, information search and browsing are used as synonyms in this paper. Also, the term successful activation of students' abilities in ICT literacy (or the access component of it) is used as an alternative to refer to confident or efficient information search.

In the first phase of the research project an online self-assessment questionnaire was devised and administered with the binary aim to map grade 7 and 10 students' computer-related confidence, use and attitudes on the one hand, and to test the reliability of the questionnaire on the other hand (Tongori, 2013d) to facilitate further use. Our aims were to collect data regarding students' computer and internet use involving the technological aspects as well as their confidence in interpreting online and offline information. Furthermore, data

collection concerning the frequency of the students' computer and internet use in addition to their technology-related habits and attitudes alongside with different variables of their socioeconomic background and gender was also intended.

In the second phase of the research project a partly simulation-based online pilot performance assessment test was devised and administered focussing on collecting data about grade 5, 8 and 10 students' performance in information searching tasks and technology use (Tongori, 2014a, 2014b). The assessment was followed by analysing the items of the test to estimate item parameters (Tongori, 2016a).

In the third phase of the research project, based on the analysis of the items in the previous test and following the international trends in ICT literacy test development, a small-scale third generation, fully simulation-based online pilot performance assessment test was devised. In the process of test developing those items of the previous test were adapted whose item parameters and web-based nature suggested that they would appropriately measure such a major aspect of ICT literacy as accessing information in a digital environment (Tongori, 2016b). On the one hand, the pilot assessment was aimed at comparing the reliability of the assessment instrument with that of the earlier, second and first generation tests. On the other hand, data was collected regarding grade 5, 8 and 10 students' online information searching activities and their results were compared.

Finally, in the last phase of the research project, a large scale, third generation, simulation-based online performance assessment test involving over ten thousand grade 5-11 students was devised and administered with multiple aims. One of the aims of the test was to demonstrate that it is possible to develop such a reliable, simulation-based assessment instrument to be used in a wide age spectrum in public education settings which could be efficiently applied to give instant feedback to educators on the level of their students' vital, 21<sup>st</sup> century skills and ability to confidently and efficiently access information in a computer-based environment, which would typify the access component of ICT literacy. Furthermore, we analysed how the data fitted our theoretical model, how the difficulty levels of the items fitted the ability levels of the sample and how the efficiency of accessing information varied from grade 6 to grade 11, and what differences could be found between the two genders (Tongori & Molnár, 2018).

#### 3.2. Overall aims

Through the whole research project, all the four phases were intended to serve the final double purpose of devising a measurement instrument on the one hand and collecting and analysing data both regarding the instrument and the test-takers on the other. The goal in terms of the measurement instrument was to create an authentic (A1), reliable and valid (A2), simulation-based, third generation instrument which would measure the access component of ICT literacy within the grade range of 5 to 11. The emphasis was put on examining the confidence of using computers and the internet to find information efficiently in order to be able to further manage, integrate, evaluate create and communicate it. Although ICT literacy involves all the seven components and different aspects, which are to be further examined, during these initial four phases the emphasis was placed on the most fundamental component, accessing information. Task difficulty and appropriacy (A4) as well as time allotment (A3) and feasibility of tasks within the test were main concerns. Besides the performance test, a reliable background questionnaire (A4) was to be devised and tested, the function of which was to collect data about the technology-related habits and attitudes of students together with certain socio-economic variables. Regarding student achievement, data was gathered from grade 5 to 11 students in public educational settings to test their abilities to find online information efficiently using computers as well as to investigate gender- (A5) and grade-based differences (A6) to gain an insight into the developmental trends of students' abilities which are mobilized to find information online.

#### 3.3. Overall research questions

Although each phase of the research project had their own focus in terms of research questions based on the progress that had been made up to that point in terms of test development, an attempt could be made to summarize overall research questions related to the overall aims. It was to be investigated whether it is possible to devise an authentic, that is computer-based, interactive, third generation and performance-based assessment instrument in the Hungarian national setting to gauge grade 5 to 11 students' ICT literacy (Q1). The questions, whether the assessment instrument could be reliable and valid were also raised (Q2). It was also in the focus of the research whether the tasks developed were feasible and appropriate for the age range and genders of the students, also considering the public educational setting with its time constraints (Q3). The question whether a reliable background questionnaire (to discover the socio-economical background-, practice- and attitude-related

variables and their possible relations to students' achievement in the performance assessment test) was possible to adjust (Q4) was also sought for. In terms of student performance testing, the questions whether there were differences and what kind between the practices and attitudes (for example, frequency of and emotions influencing the use of technology), and the actual performance of the two genders (Q5) and the various grades (Q6) in their efficiency to access information online were also put forward. What developmental characteristics could be detected in how confidently the students activate their abilities to access online information effectively (Q7), by analysing the data of the cross-sectional research, was also to be investigated.

#### 3.4. Overall hypotheses

Based on the related literature describing assessment of the components of ICT literacy (ACARA, 2015; Fraillon, et al., 2015; ICILS, 2014; Katz & Macklin, 2007; Law et al., 2009; Lennon et al., 2003; NAGB, 2013) it was hypothesized that it is possible to *create* a *valid* and *reliable* measurement instrument in a *national* setting,—throughout the phases of the research project—(H2) which also meets the requirement of an *authentic* (Katz & Macklin, 2007), *third generation* (Csapó, Ainley, Bennett, Latour, & Law, 2012; Molnár, Greiff, Wüstenberg, & Fischer, 2017) assessment tool (H1) to gauge the ICT literacy or at least the *most fundamental* (Henry, 2005) *component of ICT literacy* of a *wide age range* of grade 5 to 11 students with appropriate and feasible tasks for the grades (ACARA, 2015; ICILS, 2014; NAGB, 2013). It was assumed, that it is possible to create an instrument which could be adjusted to the *45-minute* time frame (H3) typically given in public education settings as other assessments of a similar nature managed to measure more than one component of ICT literacy in a similar time frame during 50 (NAGB, 2013) or 60 (ICILS, 2014) minutes.

It is to be noted that these hypotheses did not simply refer to devising a test and a questionnaire. Based on the literature referred to, all the requirements expected here together and marked by *italics* were novelty in test development, as far as the author knows, with no real precedents in a national context. Thus, they were intended to qualify as overall hypotheses. Revisiting these overall hypotheses was not planned to happen. Their aim was to emphasize their relation to the relevant literature besides providing an outline of the overall expectations. However, at the end of the dissertation the very specific hypotheses of each phase – in which the overall ones are rooted – are revisited and verified.

Furthermore, it was also speculated that a reliable questionnaire – based on national examples (Balázsi et al., 2017) – to collect data about background variables, could also be developed through the four phases (H4). Based on the international literature, regarding the differences between the performance of the two genders in how successfully they activated their abilities in ICT literacy, it was assumed that there would be significant differences between the performance of the genders (H5) in favour of the girls as significantly higher levels of achievement for females were detected in Grades 6 and 10 in Australia (ACARA, 2012), with two exceptions in all countries in the IEA assessment (ICILS, 2014), and in the ICT content area of NAEP TEL (The Nation's Report Card, n. d.) (H5). It was also presumed that there should be a development of the abilities of activating the necessary skills to effectively perform in ICT literacy tasks, resulting in higher achievement levels of higher grades (ACARA, 2015) (H6).

# 3.5. Overarching research design and methodology

Focusing on the common goal throughout the whole research project, which is the measurement of certain components and aspects of ICT literacy – the access component, in particular –, each of the four phases of the research project was built upon the earlier one, considering the implications. As one phase was the successor of the previous one – there were major alterations made to the instruments in the process of development. To emphasize the process of test development, an outline of the alterations and advancements in the main features is given in this chapter. However, as each phase of the research project had their own methods, they are discussed in detail in chapters 4.1 to 4.4.

#### 3.5.1. An outline of the samples

Regarding the general outline of the samples (See Table 3) – the further details of which are provided in the relevant chapters describing each phase –, the first three piloting phases in the years 2013-2016 were small-scale, pilot assessments with samples of  $N_1$ =65,  $N_2$ =106 and  $N_3$ =94 to prepare the fourth, final phase in 2016, which was a large scale one testing a sample of  $N_4$ =10,064 students. As the overall aim was to gauge the ICT literacy component *access* of grades 5-11 students in public education, the subjects of the measurements of all phases fell within this grade range with a growing number and wider span of grades involved from stage to stage (phase 1: grades 7 and 10; phase 2: grades 5, 8 and 10; phase 3: grades 5, 6, 8 and 10; phase 4: grades 6, 7, 8, 9, 10 and 11) to get information from a larger array of age groups of students from assessment to assessment. Regarding the proportion of the genders, except for

the first phase, where the boys were considerably overrepresented (61%) — despite convenience sampling — an attempt was made so that the overall representation of the genders should be more balanced in the further phases. With boys amounting to between 46-52% of the samples (phase 2: 46%; phase 3: 52% and phase 4: 47.6%), this attempt could be regarded as successful.

Table 3: The main features of the samples and the types of instruments newly devised and further improved in the four phases of the research project on online assessment of the access component of students' ICT literacy

Research Phase	Year of Data Collection	Grade	N	Boys	Type of Instrument Introduced
1	2013	7 10	65	61%	Pilot questionnaire
2	2014	5 8 10	106	46%	2 <sup>nd</sup> generation pilot performance assessment test
3	2016	5 6 8 10	103	52%	3 <sup>rd</sup> generation pilot performance assessment test
4	2016	6 7 8 9 10 11	10064	47.6%	3 <sup>rd</sup> generation large scale performance assessment test
	2013-2016 Altogether	5-11	10338	_	_

#### 3.5.2. Overall Instruments and design

Throughout the development of the assessment instruments to map students' confidence in the access component of ICT literacy, from the online self-reported questionnaire in the first phase in 2013, through the first attempt at a (second-generation) performance assessment test of the second phase in 2014, research moved into the direction of an authentic, simulation-based, interactive, third generation performance assessment test, which was first achieved in the third, then perfected in the fourth phase of the research in 2016 (See Table 4). The research started from the perspective of a self-reported questionnaire to collect data mainly about how students view their confidence related to and their frequency of use of

ICT together with background variables. From this conventional method, the research was planned to move into the direction of a more authentic, performance assessment so that in further stages students' self-reported responses could be compared with the results of their actual performance. While the questionnaire was delivered, the meticulous work of the test development with a high expertise need could be started. It was seen as another advantage of administering the questionnaire first, that the tests of the second to fourth phases could all include the questionnaire which had proved to be reliable beside the performance assessment test. In phase 2 correlations between students' responses to the questions and performance assessment tasks were detected, while in phases 2 and 4 background variables were analysed.

As the large-scale ICT literacy assessment test was preceded by pilot assessments, whose primary focus was test development, the structures of the three performance assessment tests reflect the conscious alterations for improvement. The test of the second phase included elements of other aspects (responsibility related or technological) and components (define, evaluate) more overtly than the subsequent tests, while the focal point was the access component in phase two as well. In phase 2, the test comprised scenario-based, open-ended and multiple-choice tasks (See Table 4) using stative, imitated websites with little interactivity (except for the last four simulated website tasks). Instead, it also included items which were designed, for example, to test purely use of technology aspects such as how to print out a page by clicking on an icon, or to test how students evaluate the usefulness of given sources.

For the sake of uniformity and consistency within test, this design was amended in the third phase and only dichotomous, closed-ended, multiple choice items were devised (See Table 4) using the simulated websites of the last four tasks of the test of phase 2. The new design was also to allow the most authentic, simulation-type display. After analysing the functioning and the time need of the items in phase 3, a selection process commenced. The number of items was reduced to have the best functioning items most appropriate for assessing the access component of students' ICT literacy.

Table 4: The main features of the instruments used for data collection in the four phases of the research

Research Phase	Online Assessment instrument	Rate of Authenticity	Number of Items	Item Type
1	Self-reported Questionnaire	-	47	
2	Pilot Performance Assessment test	Partly Simulation-based	16	Scenario-based, Open- and Closed-ended Items *
-	Self-reported Questionnaire	-	59	
3 -	Pilot Performance Assessment test	Completely Simulation-based	45	Uniform, Closed- ended Items Related to 4 Virtual Websites
	Self-reported Questionnaire	-	59	
4 _	Performance Assessment test	Completely Simulation-based	44	Uniform, Closed- ended Items Related to 4 Virtual Websites
	Self-reported Questionnaire	_	54	

Note: \* Additional audio instructions

#### 3.5.3. Common procedures

Regarding the overall procedures — emphasizing that the specific procedures are described in detail at each phase —, in all four phases the instruments used were planned to be delivered online by providing the students with an access code. The intention was to have an as authentic means as possible, which would be appropriate for performance assessment in the field of ICT literacy. The intended delivery method was successfully executed.

All the instruments across all phases were linear and all the students participating were delivered the same questions and tasks. The linear structure was decided on because with the expertise need mentioned in the passage *Research Problem*, it made item and test development more feasible than creating a whole item bank, which would have been required if adaptive testing had been planned. The parallel development of eDia (Molnár et al., 2015a) online platform offered the opportunity to deliver the tests of three consecutive phases

through it by using the computer facilities of the schools involved. This way data collection was also executed online via the eDia platform.

Regarding analyses, functions of Classical Test Theory were used across all phases. To gain more information over the consecutive phases of testing, further and more advanced statistical methods were applied. Descriptive and mathematical (Mann-Whitney Test, ANOVA) statistics were use in phases one and two. Besides descriptive and mathematical statistics, in the third and fourth phases Item Response Theory and Confirmatory Factor Analysis based on structural equations were used to test one- or the two-dimensional model fit (See Table 5).

# 3.5.4. An outline of major results regarding reliability and validity throughout test development

As the results of each measurement in each phase are detailed in chapter 4 describing the stages of the development of an ICT literacy assessment instrument gauging the access component of ICT literacy, only the most prominent results indicating development are outlined in this passage. Since one of the main overall objectives was to achieve validity and reliability of the assessment instrument devised, results regarding these two goodness indicators are of high importance. Due to deliberate actions to raise internal consistency a gradual improvement could be detected in the reliability measures (See Table 5) of both the background questionnaire (phase 1: Cronbach's  $\alpha$ =.85; from phase 2 on: Cronbach's  $\alpha$ =.91) and the performance assessment test (phase 2, from Cronbach's  $\alpha$ =.68 to Cronbach's  $\alpha$ =.74 by selecting 16 items from the 24); with new items in phase 3: from Cronbach's  $\alpha$ =.89 to Cronbach's  $\alpha$ =.92 by selection of 44 items from 61; phase 4: Cronbach's  $\alpha$ =.90).

Table 5: Goodness of the assessment instruments and the statistical methods used in the four phases

Research Phase	Statistical Methods Used	Online Assessment instrument	Number of Items Selected	Reliability	Model Fit
1	Functions of CTT	Q	4	Cronbach's α=.85	-
Functions of CTT	Functions of	PA	16	Cronbach's α=.74	-
	CTT	Q	59	Cronbach's α=.91	-
3	Functions of	PA	45	Cronbach's α=.92	[RMSEA .028 CFI: .970; TLI: .969] <sup>1</sup>
	CTT, IRT, SEM	Q	59	Cronbach's α=.91	-
4	Functions of CTT, IRT, SEM	PA	44	Cronbach's α=.90	[RMSEA .036 CFI: .942; TLI: .939] <sup>2</sup>
		Q	54	Cronbach's α=.91	_

Note: 1 one-dimensional model, 2 two-dimensional model, CTT: Classical Test Theory, IRT: Item Response Theory, SEM: Structural Equation Modelling; Q: Questionnaire, PA: Performance Assessment; RMSEA: Root Mean Square Error of Approximation, CFI: Comparative Fit Index, TLI: Tucker Lewis Index.

Regarding validity, the tasks of the test were devised based on the theoretical framework which was elaborated beforehand. During the early phases of piloting already — although no expert panel was summoned — the process of the test development was aided by a group of people with various competencies or expertise, such as psychometrics, pedagogy, information technology and educational research. Consultations were held regularly or irregularly, as the nature of a field made it necessary (See Acknowledgements). In the third phase of the research, statistical procedures of Structural Equational Modelling (SEM) were used to justify the model fit. In the third phase, a one-dimensional model was hypothesized and the data had a good model fit. In the fourth phase, a further step was taken towards detecting the dimensionality of the construct assessed. The possibility of a hypothetical two-dimensional model was tested as well, where the two-dimensional model had a better fit than the one-dimensional one (See detailed in chapter 4.4).

# 4. The phases of the development of an ICT Literacy Assessment Instrument 4.1. The first phase: Online self-reported questionnaire

In our economy determined by knowledge and innovation, digitally literate labour force capable of proficient handling of information is needed (Tongori, 2013d). As in advanced robot technology where the robot-human interaction could be enhanced by exaggerated robot motion influencing human attention (Gielniak & Thomaz, 2012), a novel digital learning environment is vital to improve students' engagement and efficiency in accessing, processing, and creating knowledge and information. The desire to develop digital literacy and the means of education is closely related to educational assessment (Molnár & Kárpáti, 2012), which might be executed by applying simulation-based tests alongside self-reported questionnaires focusing on the same construct (Ainley et al., 2012).

In the first phase of the pilot research, parallel to the first steps of online ICT test development, an online questionnaire was devised to gather information about how individuals of the target population of grade 7-10 students assess their confidence in and frequency of ICT use and their socio-economic background. The research was carried out in May 2013 (Tongori, 2013d).

#### 4.1.1. Aims

The aim of the pilot research was to map the self-reported confidence of grades 7 and 10 students' ICT literacy, computer and internet use and compare the subsamples along certain background variables. As the pilot research was a first step towards designing an instrument to test grade 5-12 students' ICT literacy online, the primary aim of it was to collect data online on such students' self-reported confidence in computer and internet use (A1) as well as on their confidence in interpreting online and offline information (A2) whose grades fall within the target grade range. Data on the frequency of the students' computer and internet use (A3) in addition to their technology-related habits and attitudes (A4) alongside with different variables of their socio-economic background and gender (A5) was also to be collected. As the overall purpose of the entire research project including all four phases was to work towards the development of a reliable test and background questionnaire, devising a reliable self-assessment questionnaire (A6) was also focussed on.

#### 4.1.2. Research questions

Based on the aims specified, our research questions were how confident grades 7 and

10 students regarded themselves in their use of computers and the internet (Q1); how confident they reported themselves to be in interpreting online visual and audial as opposed to printed information (Q2); how frequently students used computers and the internet and for what purposes (Q3); what computer and internet-based habits they had and what their attitudes were towards the target technology (Q4). We were also interested in how their socioeconomic background and gender effected their confidence in, habits related to, and attitudes towards computer- and internet-based activities (Q5). As regards our overall objective, which was test development, a focal question we formed was how reliable our self-reported questionnaire would be (Q6).

#### 4.1.3. Hypotheses

Based on the literature on students' duration of time spent on and frequency of visiting social network sites (Moeller & Nagy, 2013; Adeshope & Ogan-Charles, 2015) we assumed that most of the students would report themselves as totally confident in using them. On the same theoretical basis, we also assumed that activity on social network sites would be reported as the most frequently pursued one of all computer and internet related activities in both grades (H1). We expected that the number of students' totally confident in interpreting online visual (Rayner, 2009) and audial information in general, as opposed to printed information (H2) would be higher. A typical characteristic of visual search is that viewers are able to process more information around their fixation point than while reading (Rayner, 2009).

In terms of how frequently and for what purposes students used computers and the internet, our expectation was that in general, the most frequent activity by grade 7 students would be playing computer games or online games, while 10th-graders were expected to report online socialising activities and school-related information seeking (Moeller & Nagy, 2013) or computer-based activities as their most frequently pursued ones (H3). Statistics have shown that the younger the students are, the more probable it is for them to play computer or digital games. In the United Kingdom, for example, 88% of 12-15-year-olds play games on a games console, 78% of 16-19-year-olds and only 37% of the 16-49-year-old citizens play computer games (Williamson, 2009).

We assumed that girls would report themselves more confident in digital reading and typing related activities, whereas boys were assumed to report more confidence in using technology for games based on research by Gentile (2009) (H4). Lower grade students and girls

in general were expected to have less positive attitudes towards using the computer or the internet and have more fears for the negative consequences of computer or internet use Gentile (2009) (H5). Our questionnaire, which was devised partly based on existing questionnaires widely used (OECD, 2008; Balázsi et al., 2012) was expected to have a measure based on which it could be regarded as reliable (H6).

#### 4.1.4. Methods

#### 4.1.4.1. The sample

The sample (n=65) consisted of fifteen  $7^{th}$  graders (one of whom was a girl) from a six-form and fifty  $10^{th}$  graders (26 of whom were boys) of a four-form capital city secondary school (Tongori, 2013d; See Table 6).

Table 6: Sample distribution of the online self-reported questionnaire by gender and grades (number of people)

		Gender		
		Boys	Girls	Altogether
Grade	7	14	1	15
	10	26	24	50
Altogether		40	25	65

## 4.1.4.2. Instrument and design

## Instrument

The assessment instrument was an online questionnaire including 47 closed-ended questions (including gender and grade). The questionnaire consisted of four main sections: (1) confidence in using technology (keyboard and mouse); (2) confidence in interpreting and using various kinds of information on the internet (the access dimension of ICT literacy); (3) frequency of computer and internet use and (4) habits related to and attitudes towards online activities and socio-economic background (for example the number of books owned by family) (see Appendix 1). To make it more imaginable for students what a certain number of books means, instead of simply asking them about the numbers as in the international OECD PISA assessment (OECD, 2009), we followed the example of a national assessment (Balázsi et al., 2012), where next to the number of books, shelves of books or book cases were also given. Thus, students could relate the abstract idea of the number of books they have at home to images of everyday objects in their homes.

## Design

The online questionnaire covered the four main sections described in the Instrument passage, which were all related to confidence in the accessing information component of ICT literacy. All students in both grades 7 and 10 completed the same set of questions (see Appendix 1) marking their answers mostly on a Likert scale. After the first three questions on gender, grade and class, in the first section, from questions 4 to 7, students answered questions on how confident (not at all, a little, fairly or entirely) they felt during certain computer actions regarding technology use (for example, using the keyboard or the mouse). In the second section, from 8 to 17, questions about digital reading (for example, finding information in texts, images, diagrams, menus or charts), understanding audial information and accessing information in dynamically changing, interactive environments like mailing systems, databases and social network sites) were answered by students. In the third section, from questions 18-33, students were asked to assess the frequency (never, monthly or less frequently, weekly or fortnightly, several times a week or more frequently) of their computer and internet-related activities (for example, searching for information for school assignments or for free time activities, using the word processor or presentation software for school assignments, activities on social network sites, chatting, mailing, watching, downloading or uploading films and videos, online file sharing activities, reading or posting on forums and blogs). In the most diverse fourth and last section, students were asked to report on aspects of their lives, habits, attitudes and experiences which might influence how effectively they retrieve information online. This section included questions on their socio-economic status, for example, who they lived with, whether they had access to a computer and internet at home, the number of books their family had at home and their financial background compared to fellow students. Student were also asked about their attitudes towards and experiences with using the internet, for example, if they were pleased with their possibility to access the internet, how pleasurable they found using it, the number of hours a week spent online (which is a frequency issue closely related to attitudes), to what extent they had any fears or negative experiences related to the internet.

#### 4.1.4.3. Procedures

Completion of the questionnaire was performed online by providing students with an access code. Students were allowed to access the questionnaire at a favourable time for them within a given time span of two weeks with the restriction that they were required to accomplish answering all the questions at one sitting within 45 minutes.

#### 4.1.5. Results and discussion

# *4.1.5.1. Descriptive statistics*

Reliability statistics for the first three sections of the questionnaire (Cronbach's  $\alpha$ =.87) proved to be higher than that of the whole questionnaire together with the fourth section (Cronbach's  $\alpha$ =.85). The lower reliability measures could have been caused by the high diversity of questions in the last section, which resulted in lower consistency.

Regarding frequencies, the results are presented in different sections depending on what the questions referred to. Due to the fact that alongside this online measurement another one assessing students' confidence in basic technological actions (Tongori & Pluhár, 2014), the detailed introduction of which is beyond the scope of this dissertation, was also in progress, the questionnaire included questions regarding confidence in basic technological actions such as typing characters, words and text, mouse clicking and dragging objects using the mouse.

First, students were asked about their confidence in using such peripherals as the keyboard and the mouse – which represented the technological aspect of ICT literacy (Figure 9). The vast majority of students (84.6%) reported themselves totally confident in using a mouse, the majority (63.1%) considered themselves totally confident in using a keyboard for typing characters or words but only slightly over half of them (52.3%) marked themselves as totally confident in using the keyboard for typing texts or games. The reasons for their confident use of the mouse cursor could be due to their extensive use of it during their everyday digital manipulations both at and outside school. The fact that about two thirds of them felt confident in using the keyboard for typing words could be explained by their using search terms in leisure time information searching activities or short (word-length) messages on social network sites, which are frequently pursued activities (see results related to their most frequent computer and internet use) reported by them. The reason why only about half of them found themselves confident in using the keyboard for games or typing texts might lie in their less frequent gaming activities (see results related to their most frequent computer and internet use), as well as in

the fact that keyboards are less frequently used for games since game consoles and joysticks have become widespread in the digital game world. Besides, typing longer texts is not among their most frequent activities according to their answers to questions about school tasks and forum writing activities (see results related to their most frequent computer and internet use). Less frequently pursued activities may result in lower levels of confidence reported by the students.

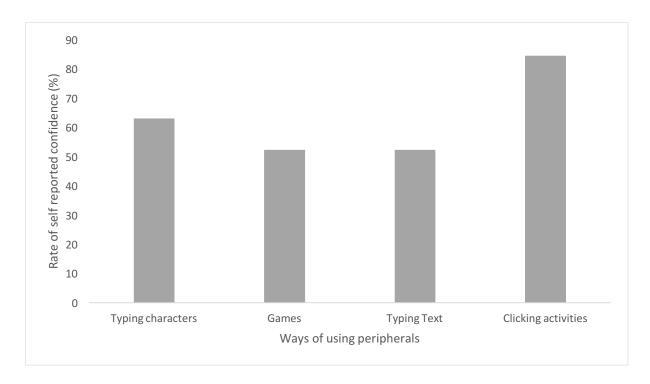


Figure 9: Confidence of activities with respect to the peripherals used (Tongori, 2013d)

In terms of data related to confidence in interpreting and using various kinds of information on the internet (the access dimension of ICT literacy, see Figure 8), the highest rates of students totally confident in finding information were self-reported in terms of navigating on social network sites. Almost 80% (76.9) of the students reported themselves as totally confident in navigating on social network sites. Thus, the first part of our hypothesis (H1) regarding students' confident use of social network sites appears to be confirmed. This was only preceded by reading texts from the monitor: the vast majority (78.5%) of students reported themselves to be totally confident in reading texts on the computer screen. However, as it is not necessarily an online activity and it could be interpreted rather as simply digital reading than finding information, it was omitted from the set of answers related to interpreting

and using online information. Equal rates of students felt totally confident in finding information in the following three pairs of areas: mailing systems and data bases (63.1%), decoding audial information and finding information in online texts (56.9%) or navigating online menus or online tables (52.3%). The students in general did not report themselves as confident in decoding information represented by printed or audial texts; only around 55% (56.9 %) of the students considered themselves totally confident in both areas. Thus, our hypothesis (H2) regarding the higher numbers of students totally confident in decoding audial or visual imagery information than in paper-based printed information was confirmed. In addition, more students felt totally confident in finding information in visual stimuli (images online) than in audial sources: 60% of them felt totally confident in the previous one. Only slightly over half (52.3 %) of the students reported themselves as totally confident in finding information in charts and roll-down menus. Only less than half of the students appeared to report total confidence in finding information in online diagrams (44.6%). With only around 45% of students reporting themselves as totally confident, the students in the survey in general appeared the least confident in decoding information represented by diagrams.

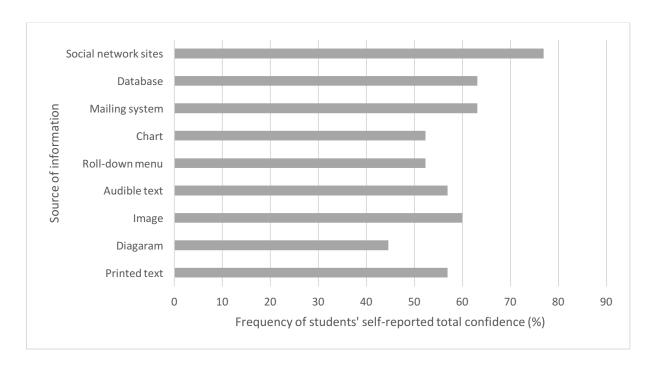


Figure 8: Frequency of students' self-reported total confidence in terms of different sources of online data (Tongori, 2013d)

Another aspect of the questionnaire was to map students' online activities in terms of the frequency of pursuing them for different purposes (Figure 10). Visiting social network sites was reported as the most frequently pursued online activity. Nearly 70% of students admitted visiting social network sites several times per week, which confirmed the second part of our second hypothesis (H2) regarding the most frequent online pastime. The proportion of students in this assessment visiting social network sites is similar to the 2011 results of a survey carried out in the United States, where 80% of teenagers used some kind of social media including Twitter – not typically preferred by teens in Hungary – and Facebook (Madden et al., 2013). It was followed by searching for information in their leisure time and then chatting and emailing. Nearly two thirds (61.5%) of the students reported searching for information on the internet several times per week. 60% of students reported chatting online several times a week and 35.4% of them used emailing several times a week. It could be said that on average, 47.7% of students reported spending several times a week communicating online. Online file sharing activities (up-, and downloading and sharing images, videos, music and films) several times a week were preferred by about 30% of the students on average (with 56.9% of them downloading music, films and videos; 21.5% of them uploading images and videos; also 21.5% sharing files on the internet; and 18.5% up- and downloading files into and from internet storage spaces). Games were in the fifth place in the frequency scale of online activities (with 24.6% of the students reporting playing online games several times a week). Computer use (3.1%) and internet use (33.8%) for school related tasks marked as Homework (see Figure 10) was reported as the sixth most frequent reason for online presence (with less than 20% – 18.7% - of students on average pursuing such activities several times a week). A similar percentage of students reported reading forums several times per week, while visiting blogs was reported as a scarcely performed activity by the students of grades 7 and 10. However, about twice as many students reported reading (15.4%) as posting (7.7%) blogs several times a week.

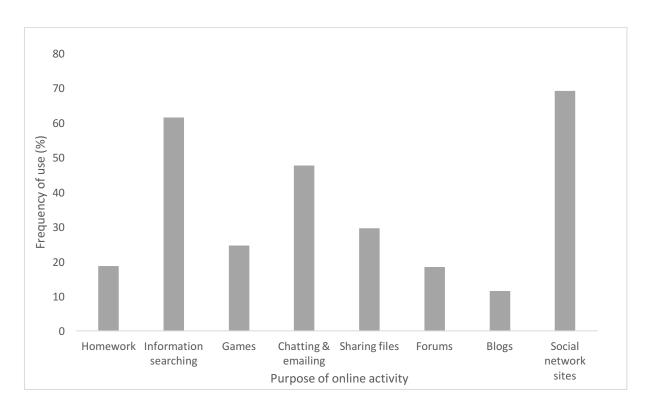


Figure 10: Frequency of students' online activities for different purposes (Tongori, 2013d)

The hours spent online are closely related to the frequency of online activities. With 36.9% of the students spending 2-3 hours daily – which is about 14-21 hours weekly on average -41.5% reporting spending 6-10 hours and 21.5% of them reporting spending 1-5 hours weekly online, the students in this assessment could be regarded as frequent internet users.

Regarding computer use at school, over half of the students stated that they used them only in IT and no other class and that they did not use the school computers after class. The reason could be the unfavourable infrastructure, the lack of teaching staff to supervise extra student activity at school or the favoured access to computers at home, which might have prevented these students from using the computers at school other times than in the IT lessons. This last supposition is supported by the responses students gave about their access to computers at home. All of them stated that they had at least one computer at home. Nearly 80% of them (78.5%) reported having two computers and 6.2% of them reported having three or more computers in the household. These data together with the fact that all of them reported living with their parents and or grandparents suggested a stable socio-economical background, which was also supported by the data that over a third of the students (35.4%) reported a better than average, and almost two thirds of them (60%) an average financial status.

Students were asked about the number of books in their household. By 'at home' the books owned by the family was meant, which background variable is used, for example, in the National Assessment of Basic Competencies (National ABC) or in the ICILS assessment (Fraillon et al., 2013) as a possible indicator of the educational background of the parents or in other words, home literacy. The qualifications of parents might be more exact variables. Our decision fell on the number of books (expressed in the number of bookshelves) because we suspected that especially lower grade students would have a better knowledge of the number of bookshelves at home, the mental images of which they could recall than of the level of qualification of their parents, which they might not know.

The largest number of students, over a third of them (35.4%) reported having 500-1000 books (2-10 shelves of books) in their household, and over another third (32.3%) reported having over 1000 books (3 book cases). Over a quarter of them (26.2%) reported having 100-500 books (1-10 shelves of books). Only a very small proportion of students reported having less than 100 books at home (1-2 shelves). With nearly 70% of the students having between or over 500-1000 books, it could be concluded that the educational background of the families of these students is high, which must have influenced the abilities of the students. The results of the analysis of the national assessment of reading and mathematical competencies of the same year (2013) showed that students of about the same grades (6, 8 and 10) – compared with our assessment of grades 7 and 10 – having 3 or more book cases of books were among the highest achievers [around 1600-1700 ability points in both competencies on a scale of achievements between about 1250 and 1800 ability points (Balázsi et al., 2014)].

Affective factors such as students' attitudes towards their access to the internet or using computers were also investigated with the following results. The majority (56.9%) of students reported themselves as totally pleased with their access to the internet. It supports the idea that not only is their infrastructural background satisfactory but they also have positive attitudes towards it. Also, the majority (52.3%) of students reported themselves to use the computer with total pleasure. These factors might contribute to their success regarding online activities as affective factors like attitudes directly influence academic achievements (Józsa & Fejes, 2012). On the other hand, however, a vast number of students reported having sometimes or rarely ("not really") fears of the negative consequences of computer or internet use, which might have a negative effect on their successful online activities. Similarly, with

35.4% admitting "a few times" and 36.9% rarely ("not really"), and 12.3% admitting "many times", nearly 85% of the students reported having had negative experience while using the internet. Only 15.4% reported never having had negative experiences using the internet. These results might explain their fears of the negative consequences of computer or internet use. An even stronger predictor of fears could be failure to use the computer or the internet. The proportions reporting failure were as in fears of negative consequences or having had negative experiences. 32.3% reported having had failure a few times, and 38.5% rarely ("not really"). About a tenth of them (10.8%) admitted failure many times. However, over 18% of them never had failure using the computer or the internet.

Students were asked to rate the computer use of their family in terms of frequency. According to 35.4% of the students' responses, their fathers were the most frequent computer users followed by themselves: 33.8% of students reported themselves as the most frequent computer user. Over a fifth of the students reported their siblings, and only 9% of them rated their mothers as the most frequent computer user.

# 4.1.5.2. Comparing the results of grades 7 and 10 in terms of self-reported confidence and frequency of online activities

Grade 7 and 10 students' self-reported confidence was compared in twelve areas: typing longer texts or words, using the keyboard for games, using the mouse for clicking and scrolling, reading texts from the monitor, interpreting diagrams or images, understanding audible texts, finding the relevant information in roll-down menus, interpreting charts and data bases, navigating within and finding the information on social network sites (see Table 7). Distinction at different rates appeared to be detected in each confidence area in favour of the higher-grade students (between Z= -.04 and -1.89). However, comparison of self-reported confidence of the two grades showed no significant differences except for in students' confidence in typing longer texts. Students in both grades felt confident about each of the online activities enlisted, except for typing texts, where applying the Mann-Whitney test, the tenth graders' confidence proved to be significantly higher than that of the seventh graders' (Z=-1.89; p< .05) (Table 7). This difference could be explained the by the longer exposure to routine computer-based activities (either on social network sites or for school assignments) of the higher-grade students resulting in a higher level of proficiency in or being accustomed to typing.

Table 7: Differences between grades 7 and 10 in terms of confidence

Question	Mea	n rank	Grade in		Mann-Whitney test	
	Grade 7	Grade 10	favour	Z	р	
Typing longer [MGy1] texts	25.7	35.2	10	-1.89	.05	
Typing words	27.7	34.6	-	-1.47	n. s.	
Keyboard for Games	3.53	3.20	-	-1.30	n. s.	
Clicking and scrolling	3.87	3.78	-	32	n. s.	
Reading texts	3.33	3.54	-	04	n. s.	
Interpreting diagrams	3.33	3.32	-	08	n. s.	
Interpreting images	3.47	3.50	-	43	n. s.	
Comprehending audible texts	3.53	3.46	-	61	n. s.	
Roll-down menus	3.33	3.48	-	73	n. s.	
Interpreting charts	3.60	3.38	-	-1.18	n. s.	
Interpreting databases	3.40	3.50	-	41	n. s.	
Navigating on social network sites	3.53	3.74	-	-1.14	n. s.	

As regards frequency of online activities, the tenth graders appeared to be significantly more active online in all but one activity, while the 7<sup>th</sup> graders proved to be significantly more frequent users of the computer for games than the tenth graders (Table 8).

Table 8: Differences between grades 7 and 10 in terms of frequency of online activities

Question	Mear	Mean Rank			Mann-Whitney test	
	Grade 7	Grade 10	favour	Z	р	
Using computer for games	42.6	30.13	7	-2.31	.05	
Social networking	19.80	36.96	10	- 3.79	.01	
Watching films online	16.43	37.9	10	-4.09	.01	
Chatting on the internet	23.17	35.9	10	-2.62	.01	
Downloading files	25.27	35.32	10	-2.01	.05	
Up/downloading images	30.63	33.71	10	-1.96	.05	
Reading blogs	24.03	35.7	10	-2.22	.05	

Examining the differences between genders revealed significant differences between the boys and the girls. In four from five areas of frequency (social networking, watching films online, chatting on the internet and reading blogs) the girls proved to be significantly more active and more frequent users of the internet. Boys reported themselves to be more frequent online game users (Table 9). Although the results cannot be generalized, this latter result is in line with research (Gentile, 2009) according to which boys between the ages of 8-18 are not only more frequent computer gamers, but they spend longer time per week playing games, are less willing to reduce their time spent playing games, and the prevalence of their addiction to games is four times greater than that of girls'. Such a tendency to pathological gaming calls our attention to the responsibility related aspects of ICT literacy, and among them mental health issues respectively, which educators have to be aware of. On the other hand, the girls' frequency of online activities seemed to reflect their typical advantage in fields of social skills and competences (Pečjak et al., 2009) demonstrated by social networking, and such social

4.1.5.3. Comparing the results of the two genders in five areas of frequency of online activities

interest activities as blog reading or watching films online.

Table 9: Frequency of online activities and confidence of basic technology use by gender

0	Mea	n rank	Gender in	7	
Question	Boys Girls		favour	Z	
Using computer/internet for games	40.35	21.24	Boys	-4.11 **	
Social networking	29.10	39.24	Girls	-2.59**	
Watching films online	28.71	39.86	Girls	2.45*	
Chatting on the internet	28.94	39.50	Girls	-2.5*	
Reading blogs	27.53	41.76	Girls	-3.14**	
Confidence in using the keyboard for typing longer texts	29.21	39.06	Girls	-2.29**	

Note. \*\* p<.01; \* p<.05

Although basic technology use is not the focal aspect of this paper as it was stated earlier, referring to another research on assessing students' confidence in basic technological actions running at the same time (Tongori & Pluhár, 2014), the questionnaire included items regarding confidence in basic technological actions such as typing characters, words and text, mouse clicking and dragging objects using the mouse. (At that point of research using the questionnaire with lower grade students and comparing the results of the technology test and the questionnaire were planned.) As this section is intended to compare reported gender differences, it is necessary to state that significant divergence was found between the two genders in terms of the confidence of using the keyboard for longer texts. Girls proved to be more confident (see Table 9).

# 4.1.5.4. Relationship between finding and interpreting information and the number of books at home

As regards relationship between finding and interpreting information and the number of books at home, significant correlations were detected between the number of books and typing words and text, reading the screen, finding information in a text, diagram or images on the web, comprehending audible text, finding information in web menus, charts and mailing systems (see Table 10). The significant correlations between these information access-related activities and the number of books at home [which represents the educational background of the household (parents) and through them a steady socio-economic or socio-cultural

background] supports the notion that the number of books at home is in close connection with students' achievements in text-based and reading related activities (Balázsi et al., 2017).

Table 10: Correlations between finding and interpreting information and the number of books at home

Ways and sources of finding and interpreting information	Spearman Correlation
Typing words	.49**
Typing text	.35**
Reading online	.33**
Finding information in online texts	.26 *
Web diagram	.45**
Web image	.27*
Web audible text	.30 **
Web menu	.30 **
Web chart	.36**
Web mailing system	.47**

Note. \*\* p<.01; \* p<.05

# 4.1.6. Limitations on the first pilot study about students' self-reported confidence in computer and internet use

Limitations on the interpretation of the results of the pilot research need to be imposed. One of the limitations is due to sampling measures. The relatively low number of subjects (N=65) prevents the researcher from generalizing the results and also effects reliability measures. Another limitation calling for caution before generalizing the results to assumptions about the entire population of  $7^{th}$ - and  $10^{th}$ -graders is the lack of representativeness as the test results originate from data collected by convenience sampling based on availability (Etikan, Musa, & Alkassim, 2016). Further limitations derive from the fact that the data collected was based on students' self-reported confidence, which is the students' retrospective evaluation of their confidence in information search-related activities rather than their confidence itself.

# 4.1.7. Conclusion and further research opportunities

Summarising the findings and the limitations in our case could set the goals for further research regarding sampling or the assessment instruments to be devised and used. Also, even with the limitations on the interpretation of the results, the pilot research could trigger additional investigation into the trends in existing higher or lower levels of confidence in computer- and internet-based activities. Besides, with further research, it might have

implications for educators on which areas of effective information handling should be improved. Firstly, to facilitate less limited interpretations, involving a larger number of students increasing the sample size would be desirable. The 7<sup>th</sup>- and 10<sup>th</sup>-graders involved in the research referred to themselves in general as confident in finding information on social network sites and decoding visual stimuli, which could be because of their (self-reported) most frequently pursued online activity. It could be – and in the subsequent phases of the research project it was – the object of further research to test students' actual performance of accessing information effectively on such sites or other websites as research has shown that frequent activities do not always result in effective searching methods and achievements (Ainley et al., 2007; Law et al., 2009; Katz & Macklin, 2007). In terms of background variables and gender differences, the significant correlations found in this research could be further examined on a larger scale. The relationships between the socio-cultural status represented by the number of books at home and the confidence of digital reading of text, images, diagrams and charts could be further investigated. Research could progress towards considering the reasons behind girls' higher levels of (self-reported) confidence in typing words and texts and the possible correlations with the frequency of girls' such online activities as social networking, chatting on the internet and reading blogs. Regarding the internal consistency of the questionnaire, it could be concluded, that a more consistent design, especially in terms of the desired lower diversity of question themes in the last section could increase the reliability if the assessment instrument. As regards the implications for educators, in case a further, large-scale, performance assessment confirms the results of this research, instruction should also focus on the areas students are least confident in: decoding information both in printed and audible sources, finding information in charts, roll-down menus and diagrams, which are related to both information search and reading literacy, which ICT literacy is based on.

The information gained from this first phase of the research had implications, which oriented us in the second phase of the research. Although the relatively small sample size prevented us from generalising the results, we were left with these pilot results to guide us. Most of the data suggested that the students were frequent and confident internet and computer users (with 80% of them spending 6-21 hours weekly online) nearly 80% of them having two computers at home, almost 85% of them totally confident in using the mouse and almost 80% of them being totally confident in reading texts from the monitor). This confirmed

our assumption that students were prepared to feel comfortable in an online testing environment. Their confidence in using the mouse allowed us to involve a large number of clicking activities and to provide check boxes and radio buttons for their responses in the test. Their attraction to social network sites (shown by the data that almost 80% of them felt totally confident in navigating on such sites) suggested that designs and topics that appeal to them will attract their attention. One of the scenarios of a task in the second phase semi-authentic, second generation, partly simulation-based performance assessment test referred to a message from a social network site, which the students might be familiar with. With almost 80% of them reporting total confidence in reading texts from the monitor and around 60 % of them reporting totally confident in finding information in online texts and data bases we were positive about using them in the test and we were also interested in what their actual performance will be like compared with their self-reported responses. The lower their reported confidence was in a field, the more urge we felt to involve it in the test, for example, information search in data bases and online texts (around 60% of them having total confidence reported), navigating in online menus and tables (around 50% of them having total confidence) or finding information in diagrams (45%). In chapter 4.2. the detailed description of the second phase is built upon the implications of the first phase.

## 4.2. The second phase: A partly simulation-based, online performance assessment test

In the second phase of the research, a step towards an ICT literacy assessment test development was taken. A partly simulation-based online performance test was devised (Tongori, 2014b). It was the next step in the test development process following an online questionnaire. By using a performance assessment test, direct information could be gained about students' activated abilities in the field of ICT literacy, as opposed to questionnaires, whose data collection is executed indirectly, by asking students about what they think about their ICT literacy. Consequently, our aim was to move the research into the direction of devising an online performance assessment test. As the final goal of the whole research project was to create an authentic, third generation, simulation-based test to assess (at least one component of) students' ICT literacy, pilot tests were to be assembled to test their operation and reliability.

It is necessary to clarify what distinction was made between imitated and simulated online surfaces. Simulated online surfaces in the pilot test delivered through eDia online assessment platform could be classified as second generation digital tests in terms of sharing a few common characteristics with them, for example, having more than one source of media (audio and visual tools), interaction with the assessment instrument causing different results by clicking and instant feedback on students' results (Csapó et al., 2012; Molnár et al., 2017). On the other hand, the appearance of the simulated websites was of a static kind rather than a dynamic one, resembling screenshots of websites combined with a series of action buttons rather than having real website looks and having a seriously restricted number of paths the test takers could take. However, in the process of ICT literacy test development in a national context, having simulated websites and tools in a computer-based, online environment was a necessary, major improvement. This progress was based on earlier researches applying self-reported questionnaires (Hanczár, 2006; Blénessy, 2007), and paper-based testing (Dancsó, 2009), which characterised the assessment of ICT related domains at around the millennium.

In the course of test development, within the same pilot assessment, four novel kinds of tasks were also piloted. Their novelty consisted in their being simulation-based, which meant that the students were directed to purpose built websites exiting the test instrument to simulate real life search activities. Then the test takers were redirected to the assessment instrument to register the results of their findings based on previous instruction.

#### 4.2.1. Aims

The aim was to investigate how students perform in the access component of ICT literacy and how confident their online technology use was. In addition, the items of the assessment instrument were also to be tested (Tongori, 2016a) in terms of difficulty and time allotment and the assessment instrument itself was to be put to test regarding reliability. As time-on-task is a controversial issue in the field of research of educational assessment focusing on item difficulty and individual ability, there is no uniform identification of it, however increasing ability levels result in shorter time spent on task (Goldhammer et al., 2014). Consequently, we were interested in how task difficulty is related to the completion time and how time-on-task effect influences the achievements of different grades with supposedly different ability levels. The aim was also to find out about the characteristics (e.g. discrimination) of the items bearing in mind the further goal of test development.

### 4.2.2. Research questions

- 1. What is the number of items which could be applied to successfully test students' confidence in the access component of ICT literacy to match the 45- minute time allotment of a regular lesson in the Hungarian educational setting?
- 2. What is the order of task difficulty in the light of student achievement and time spent completing the tasks?
- 3. Is there a relationship between successful task completion and the time spent completing it?
- 4. Does the set of tasks compose a reliable and valid assessment instrument to gauge grades 5 to 10 students' ICT literacy performance in the access dimension and how could internal consistency be improved?
- 5. What differences exist between grades, and between male and female students' achievements within the grades in the access dimension of students' ICT literacy?
- 6. How well do the items discriminate between the students? Are there any items whose value of discrimination justifies its deletion from the test?
- 7. To what extent do the item difficulties cover the range of abilities of the students? Are there too easy or too difficult items that should be omitted from the test?
  - 8. What is the model fit like? How well does the empirical model fit the theoretical one?

## 4.2.3. Hypotheses

H1: Based on the order of information handling processes (Bawden, 2008), we expected that task difficulty reflected by task mean scores would be at least 70 per cent identical with the sequence of tasks in the test administered. H2: We expected that there was a relationship between successful task completion – which is related to ability levels and task difficulty – and the time spent completing it (Goldhammer et al., 2014) across all grades and genders. H3: We expected that students' performance in the access dimension of ICT literacy could be tested in 45 minutes applying the set of tasks in the pilot test administered across all grades and genders, as research into different components of ICT literacy tested at a time has proved to be feasible in 50 minutes in case of the NAEP TEL test (The Nation's Report Card, n.d.) and 60 minutes in case of the IEA ICILS test (Fraillon et al., 2013). However, an advantage of the higher graders over the lower graders was also expected in terms of speed and achievement (Fraillon et al., 2015). H4: We expected that the set of tasks would compose a reliable and valid assessment instrument to gauge the (tested) students' ICT literacy performance in the access dimension. It was presumed that reliability measures could be affected by the sample size. It was assumed that the requirements of convergent and discriminant validity (to achieve construct validity) could be tested by analysing correlations between responses to those parts of the selfassessment questionnaire and the performance test which were expected to be related (Sommerville, Smith, & Macklin, 2008; Katz & Macklin, 2007). In our case, the responses to those questions in the Confidence in Accessing Information Questionnaire (CAIQ) which asked about students' confidence in reading, digital reading, navigating in online menus, tables, diagrams and texts were all expected to be strongly related to the responses to the items testing the efficient mobilizing of abilities related to these activities in the Confidence in Accessing Information Performance Test (CAIPT). At the same time, frequency of certain online activities was not expected to be related with successful information search (Katz & Macklin, 2007). H5: We expected that in the access component of students' ICT literacy there would be significant differences between the genders and we expected differences across grades (ACARA, 2015). H6: It was hypothesized that the items would discriminate. H7: the task difficulty was expected to cover most of the ability range of the students. H8: A high model fit was presumed with similar MNSQ values across selected items. As the MNSQ value of an item provides information about how similar the discrimination value of the given item is to that of the other items', similar MNSQ values – around 1, but in case of smaller samples (n=200) within the range 0.8 to 1.2. – would result in a good model fit (Molnár, 2013).

#### 4.2.4. Methods

## 4.2.4.1. The sample

The pilot assessment was administered in four different state primary and secondary schools in a major city in Hungary from May to June 2014. The sample of the study consisted of grades 5, 8 and 10 students. The two genders were not represented in the same proportion. Boys were underrepresented in the entire sample. Observing the cohorts, in grade 5 boys were underrepresented, in grade 8 the representation of the two genders was reasonably balanced, while in grade 10 boys were overrepresented. The questionnaire was completed by all but one grade 10 students. The final sample contained data from (N=107) grade 5 (n=57), 8 (n=40) and 10 (n=10) students for the test and data from (N=106) students for the questionnaire. In the final analysis, data from only those students were involved who participated in both measurements (see Table 11). In three cases the gender of the student was not given. As a result, those students were excluded from analyses where the gender as a variant was investigated.

Table 11: Parameters of the sample of the pilot partly simulation-based, online ICT literacy research

Grade	N	N (%)	Number of boys	Rate of boys	Number of unknown gender students	Rate of unknown gender students
5	57	53.77	24	42.1	1	1.75
8	40	37.73	19	47.5	1	2.5
10	9	24.52	6	66.66	1	11.11
Total	106	100.0	49	46.23	3	2.83

Data collection was first followed by an analysis of the data regarding the students' achievements (Tongori, 2014b) and then by an analysis of the items based on the students' achievements using Generalised Item Response Modelling Software in March, 2015 (Tongori, 2016a).

## 4.2.4.2. Instruments and design

#### Instruments

During the test the students were asked to complete scenario-based open-ended and multiple-choice tasks both in the imitated and in the simulated task-set. The 14 tasks (originally 24 items) ranged from simple multiple choice — on imitated online surfaces — to complex, simulated website search tasks all of which were delivered through eDia online platform (Molnár et al., 2015a). The tasks were intentionally varied in terms of complexity, and action-type needed (see detailed in the *Design* section).

The questionnaire included 47 questions. After the first three questions on gender, grade and class, in questions 4-17, students were asked to rate their confidence in using computer-technology. In questions 4-7, students were asked to rate their confidence in carrying out technological actions, for example using the mouse, and the keyboard for typing characters, words or longer texts. The focus of this section was on the technological aspect of ICT literacy. The next set of questions in this section asked the students to rate their confidence in finding information in various sources by reading online. In this set of questions the focus was on the different sources of information, for instance, texts, diagrams, images, audio text, roll-down menus, web sites, data bases, mailing systems and social network sites. The next section (from question 18 to 33 and 43 included questions about the frequency of students' computer use for different purposes such as school assignment, leisure, entertainment, or keeping in touch with friends. Questions 34-39 and 43 were centred around students' socioeconomic status. The last set of questions (40-47) was about affective factors related to computer and internet use, for example, whether the student liked using a computer.

The time allotment for both the performance assessment test and the questionnaire was 45 minutes each. Consequently, two school class sessions were needed to complete both sections of the assessment. The main specifications of the instruments and design are presented in Table 12.

Table 12: The main specifications of the material and design of the pilot partly simulation-based, online ICT literacy assessment

Delivered in eDia online platform (Molnár et al., 2015a)					
Perform	ance Test	Questionnaire			
Linear and so	cenario-based	Linear			
Tasks 1-10	Tasks 11-14	Questions 1-47			
Items 1-13	Items 14-24				
Simple multiple choice	Complex	Manthulilant and			
Imitated online surfaces	Simulated website search	Mostly Likert-scale			
45 m	45 minutes				

### Design

The test used for the study was a linear one and covered confidence in the accessing information component of ICT literacy. All students in all grades 5, 8 and 10 completed the same set of tasks. The test could be divided into two types of tasks. From task 1 to task 10 students were faced with imitated online surfaces on the screen represented by screen shots embedded in the 'slides' or 'screens' of the assessment tool eDia online platform (Molnár et al., 2015a) Figure 11 demonstrates the second 'screen' of an imitated online surface type of task. According to the rubric (scenario) given on the previous web page, students intend to advertise programmes organized by their school in the online version of the local paper. After having clicked on the menu Advertisement (Hirdetés), students were directed to this imitated web page, where they were instructed to decide on what to do and give their answer by clicking on the check box next to their choice (Tongori, 2014b).



Figure 11. A sample task from among the imitated online surface ones in the ICT literacy test of the second phase of the research project [Instructions: On the previous screen you could read: "The student government would like to promote the gala event – where each class presents a short performance, – in the local paper." By clicking on the Advertisement button, you were directed to this page. Navigate on the site, choose the most appropriate step(s) to take from the ones below by clicking in the check box(es), then click on the Next (Tovább) button. Task to do: a) Write an email to ernst.petra@partlap.hu; b) data and the text of the advertisement can be submitted online; c) you can post the advertisement by phone using the given phone number; d) advertisements can be posted in person at the given address of the editorial office.]

From tasks 11 to 14 (items 13 to 24) after reading (and listening to) the scenario and the instruction, by clicking on the Next (Tovább) button, students exited the assessment tool to search simulated websites for information as response to tasks. Then they could record their responses when re-entering the assessment platform by clicking on the Back to the task (Vissza

a feladathoz) button in the top menu on the screen.

To illustrate the operation of the simulated part of the test, in Figures 12 and 13 the screenshots of task 13 are given. In figure 13 the answer 'screen' of an open-ended task after a simulated web search (Figure 12) can be seen. The student is required to type the overall price of a Saturday aqua park experience (involving the retired grandparents, the student and the student's cousin of the same age) into the box in the response space in the message to Grandma.

Both the imitated and the simulated sets of tasks involved different types of operations representing various components and aspects of ICT literacy. From the items which represented the technological aspect of ICT literacy – from simple recognition and clicking on the right button (see Appendix 2/ task 3 kivetites) to actual typing (see Appendix 2/ task 4 keresoszogepel), and through the items where the cognitive (see Appendix 2/task 8 hajzsele) or the responsibility-related aspect (see Appendix 2/ task 7 wiki) of ICT literacy was in focus – with critical thinking and decision-making involved – to the most complex, simulated web site search items (see Appendix 2/ tasks 11 szarnyasrepuloruha1-2), students faced a variety of aspects. Test-takers also encountered a few of the ICT literacy components from the beginning of the information handling process, most closely linked with online information search. The focus of each item was on the access component, however, they could be related to defining the information need (see Appendix 2/ task 7 wiki) or evaluating the usefulness of information (see Appendix 2/ task 5 netajandek1). The assumption was that the tasks focusing simply on a technological aspect of ICT literacy, for example, how to print a document – and only requiring the student to recognize which button to click on, such as task 3 (see Appendix 2/ task 3 kivetites), are simpler, consequently are at the lower end of the difficulty scale. When cognitive aspects like critical thinking and decision making processes were involved, for instance, in tasks 6 or 8 (see Appendix 2/task 8 hajzsele), the tasks were assumed to be more difficult than the previous category. The presumably most difficult tasks were the ones that included several steps to be made and clicks to be executed before finding the information searched for. These tasks – tasks 11 to 14 (see Appendix 2/ task szarnyasrepuloruha1-2) involved technological (use of navigational devices) and cognitive (critical thinking, decision making) aspects of ICT literacy. They could also incorporate evaluating the usefulness (but not the credibility) of the information, which is partly related to another, the evaluate component of ICT literacy.

To support students with possible reading difficulties, and exclude testing reading comprehension instead of the accessing information component of ICT literacy, all instructions had been recorded and the students could listen to or stop them unlimited times by clicking on a button in the top right corner of the screen in the eDia platform on the scenario and the answer screen (see figure 13) but not on the simulated website outside the test platform. All instructions in the test (the assessment instrument) were given and students responses were recorded within the assessment tool, eDia online platform. In case of simulated websites, when students exited the platform of the assessment tool, a reminder button (Emlékeztető) was provided on the home page of each simulated website, clicking on which revealed the scenario and the instruction (see Figure 12). This way no memory test but pure confidence in the accessing information component of ICT literacy test was administered. Besides, to avoid the pressure of mental arithmetic, and distraction from ICT activities, students were allowed to use paper, pencil and a calculator for taking notes or doing calculations.

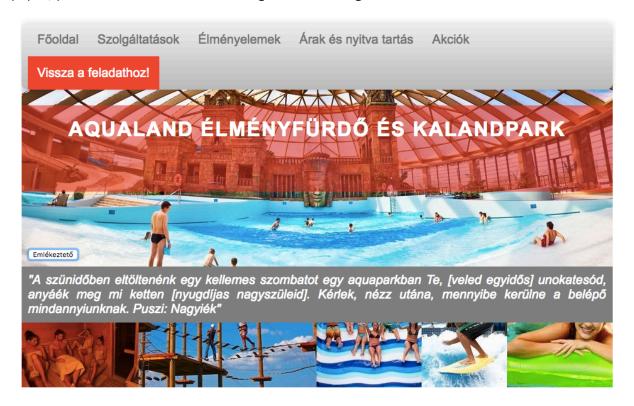


Figure 12: A sample simulated website task

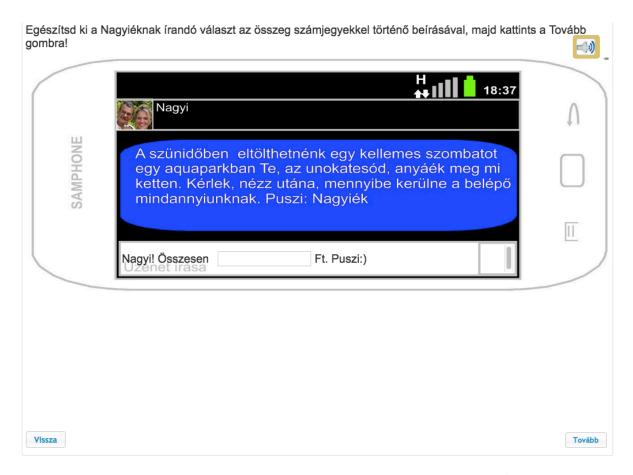


Figure 13: The answer 'screen' of a sample simulated website task. (Instructions: It would be nice to spend a splendid Saturday in an aqua park, you, your cousin, mom and dad and the two of us. Please find out about the price of the entrance fee for all of us. Kisses,

Grandma & Grandpa

### 4.2.4.3. Procedures and Scoring

Test completion was divided into two sessions with each lasting between 25 to 45 minutes. In Session 1, students in all three grades worked on the Confidence in Accessing Information Performance Test (CAIPT). In Session 2, students completed the Confidence in Accessing Information Questionnaire (CAIQ) and background questionnaire on demographical data. The schools were allowed to vary between classes the order of the sessions and the lengths of the breaks separating the sessions.

The tests were administered in specially equipped computer rooms using the eDia online platform (Molnár & Csapó, 2013; Molnár et al., 2015a). In the CAIPT test full credit was given for each correct answer, whereas no credit was given if the answer was incorrect. Altogether 20 points were given in 14 tasks, as four tasks included more than one item.

Consequently, they scored more than one point. The tasks – rather than the items – were handled as separate units as they were related to a certain theme or virtual website. In terms of analysis, descriptive and mathematical statistics (ANOVA) were used to analyse the data.

Furthermore, to execute item analysis, item-total correlations statistics using SPSS software and the item analysis results of ConQuest Generalised Item Response Modelling Software were applied. The analysis of the items was carried out in three steps. The first step was to look at the reliability measures using item-total correlations statistics to increase the consistency of the test. The second step was using Generalised Item Response Modelling Software to see how well each item behaved. The following steps were taken: (1) estimating item parameters in terms of difficulty and discrimination; (2) visualizing the mean squared indices in a plot by means of item characteristic curves to demonstrate fitness between the data and the model; (3) drawing an item-person map to illustrate the distribution of the students' achievement and plotting the items to indicate their difficulty level; (4) getting expected a posteriori/plausible value (EAP/PV) reliability coefficient: .76; and (5) getting the Weighted Likelihood Estimate (WLE). The third step was to draw conclusions from the findings. Too difficult or too easy items, the ones that did not discriminate students or the ones that behaved wrongly, had to be deleted. The average WLE measure helped to filter out those items in which the average ability parameter of the students giving the right response was only slightly higher than that of students giving the wrong answer. This phenomenon is a typical example of an item behaving inexplicably (see Appendix 7/ Tables 20-21).

In terms of item characteristic curves, which are related to the discrimination value of the items, it is known that the expected value of Weighted MNSQ measures is around 1. Measures below 1 result in a steeper empirical curve than the theoretical (expected) curve, whereas measures higher than 1 result in a flatter curve indicating a lower discrimination value than that of the empirical curve (Molnár, 2013; See Figures 22 to 36 in Appendix 5). To visualize how well an item can differentiate between students whose abilities are on a higher ability level from the ones whose ability level is lower than item location, item characteristic curves are made. A flatter slope at the middle section of the curve represents a lower discriminating power. It means, that both higher and lower ability students have nearly the same probability of having the right answer. However, a steeper curve suggests a higher discrimination value (Baker, 2001). The theoretical (modelled) curve is drawn by a solid line, while the empirical

curve is illustrated by a broken line on each curve (See Figures 22 to 36 in Appendix 5).

An indicator of the characteristics of items is their Discrimination Parameter Estimate, which is a coefficient denoting the correlation between the students' total score (overall achievement on the test) and the score on the item (Molnár, 2013; See Table 23). It was examined whether this estimate was higher than .2 for a reasonable discriminative power.

According to Baker (2001), the rate of discrimination of an item could be described using the following terms. The value 0 denotes no discrimination value. From .01 to .34 the rate of discrimination could be described as very low, from .35 to .64 as low, from .65 to 1.34 as moderate, from 1.35 to 1.69 as high, from 1.70 up as very high and positive infinity as perfect (See Table 21).

Table 21: Descriptors of rates of discrimination by Baker (2001, p. 35)

Very low	.0134
Low	.3564
Moderate	.65 - 1.34
High	1.35 - 1.69
Very high	> 1.70
Perfect	+ infinity

Weighted Likelihood Estimate expresses another ability parameter which, related to the right response, could demonstrate the well-functioning of the items of a test. In the test the WLE averages related to the right and wrong responses were compared to detect any malfunctioning demonstrated by the small difference between the WLE Average of right and wrong responses.

A further item parameter is the item difficulty index (item threshold). It gives information about the location on the ability scale where a certain item functions. An easy item is expected to function among low ability students. At the same time, a hard item functions among the students with high ability levels (Baker, 2001). Thus, item thresholds were also focused on during item analysis for test development purposes. Besides, having a deeper

examination of which items could be regarded as difficult or easy provided a more delicate approach to item difficulty analysis than students' mean scores as described earlier.

A questionnaire was also administered to collect data about background variables. As the content of the questionnaire used in this phase of the research project was identical with the one used in the first phase, the focus of analysis in this phase was not on the statistical figures of the responses themselves — whose results were analysed in a previous assessment investigating a similar age range (grades 7 and 10 in phase one and grades 5, 8 and 10 in this phase) in chapter 4.1.5. —, but on the relationships between the performance assessment test results and the questionnaire responses. Consequently, correlation analyses were performed between the test results and the questionnaire responses.

4.2.5. Results and discussion of the partly simulation-based test and related questionnaire

Internal consistencies of the CAIQ were high (Cronbach's  $\alpha$ =.91), but the reliability coefficient of the CAIPT proved to be relatively low due to the comparatively low number of (only 14) administered tasks, and limited sample size (Cronbach's  $\alpha$ =.68). Consequently, contrary to our assumption, hypothesis 4 regarding reliability could only be confirmed in case of the CAIQ, but not totally in case of the CAIPT. Further development of the test was needed in terms of the number of tasks and items as well as elaborating the existent ones in order to improve the consistency of the test, which is a rather complicated task in case of such a complex construct as ICT literacy even though only one component is to be measured.

Viewing the CAIPT in a national context, performance assessment of no ICT literacy component had been carried out preceding it. In an international context, only the largest institutions or joint organizations (ACARA, 2015; ICILS, 2014; The Nation's Report Card, n. d.) [funded by economically well-grounded governmental or international organizations such as OECD (OECD, 2003), or National Assessment Governing Board in the United States (NAGB, 2013)] responsible for assessment have ventured pilot or large scale assessment of ICT literacy. Consequently, CAIPT was a novel assessment instrument even at this stage of development. Hypothesis 4 regarding reliability and validity was also partly confirmed as construct validity could not be ascertained by confirming convergent and discriminant validity as in assessment in an international context (Katz & Macklin, 2007; Zelman et al., 2011). This might have been because of the small-scale assessment, the comparatively low number of items and their diversity in terms of layout. The limited interactivity (and authenticity) offered by the imitated

online surfaces might have contributed to the fact that no consistent correlations could be detected between performance and self-reported confidence. Further, empirical analysis of validity was needed in case of further development of the test.

With a total score of 20 (for 24 items, as some of the tasks included two or three items), the mean score for the tasks was 8.41 (SD=3.26). As regards relationship between the mean time allotted and the mean score achieved, significant correlations were found (r=.240; p=.013). According to the one-way ANOVA conducted, no significant difference between the grades could be detected in terms of the time allotted (F=1.935; p=.150) or regarding the total score (F=1.395; p=.253). The analysis of the results of the different grades revealed that there was small difference in routine information seeking tasks between the grades tested (H5).

In terms of frequencies, girls' mean scores outnumbered boys' mean scores in 8 out of the 14 tasks, and the two genders' mean scores were identical in one task (See Table 13).

Table 13: Mean achievement and standard deviation (SD) for boys and girls

	Task	Boys	′ mean	Girls' mean	
		%	(SD)	%	(SD)
Imitation	1. Jeweller's	.76	(.43)	83	ı(.40)
	2. Navigate back	.69	(.47)	79	(.41)
	3. Project	.71	(.46)	71	(.46)
	4.Type search term	.35	(.48)	42	(.50)
	5. Netgift	a63	(.49)	46	(.50)
	6. Presentation	.45	(.50)	50	(.50)
	7. Wiki	.78	(.42)	79	(.41)
	8. Hairgel	.39	(.49)	27	(.45)
	9. Local paper1	.73	(.45)	83	(.38)
	10. Local paper2	26	(.27)	28	(.27)
Simulation	11. Wingsuit	.53	(.28)	49	(.23)
	12. Decoration	14	(.26)	24	u(.38)
	13. Aqualand	.02	(.14)	.08	.(.27)
	14. Skiing	34.	(.36)	27.	. (.35) .

Taking into account that the genders in the sample were represented at nearly the same proportion, it could be said that hypothesis 5 was partly confirmed. Although the girls' overall

performance shown by their mean achievement percentage in 8 tasks – the majority of the tasks – was higher than that of the boys, no significant difference could be detected between the overall mean scores of boys and girls.

In hypothesis 1 the assumption was expressed that students' task difficulty order reflected by their task mean scores will be at least 70 per cent identical with the task difficulty order represented by the sequence of tasks – from least to most complex – in the test administered. Analysis revealed variations in task difficulty order both across genders and as compared with the sequence of tasks in the test administered (see Table 14). However, the hypothesis was partly confirmed as with very little variations students had the lowest mean achievement in tasks 8 and 11-14, in the second part of the test, which might indicate that they found these tasks the most difficult.

Table 14: Comparison of intended and actual order of task difficulty demonstrated by performance across gender

Intended order of		.Boys		.Girls		
difficulty of tasks in CAIPT	Actual task difficulty order	Mean performance (%)	SD	Actual task difficulty order	Mean performance (%)	SD
1. Jeweller's	2.	76	(.43)	1.	83	r(.40)
2. Navigate back	5.	,69	(.47)	2.	79	r(.41)
3. Project	4.	.71	(.46)	3.	71	(.46)
4.Type search term	10.	.35	(.48)	7.	42	(.50)
5. Netgift	6.	63	(.49)	6.	46	(.50)
6. Presentation	8.	.45	(.50)	4.	50	(.50)
7. Wiki	.1.	.78	(.42)	2.	79	(.41)
8. Hairgel	.9.	.39	(.49)	9.	27	(.45)
9. Local paper1	3.	.73	(.45)	1.	83	(.38)
10. Local paper2	12.	26	(.27)	8.	28	(.27)
11. Wingsuit	7.	.53	(.28)	5.	49	a(.23)
12. Decoration	13.	14	(.26)	10.	24	r(.38)
13. Aqualand	14.	.02	(.14)	11.	08	r(.27)
14. Skiing	.11.	34.	(.36)	9.	27.	. (.35) .

Regarding both genders, the first six places in the task difficulty order - based on students mean performance – were taken by tasks 1-3, 5, 7 and 9. At the lower end of the task difficulty scale, tasks 1 and 3 simply focus on one technological aspect of ICT literacy (which button to click on to print or to project) and only on a recognition level (see Appendix 2/ task 3 kivetites). At the higher end, three of the tasks using simulation – tasks 12, 13 and 14 – together with the imitation kind task 10 (having more than 1 item) had been assumed to be among the most complex and thus most complicated ones. The difficulty level of these tasks was found the highest by both genders. This indicates that complex web search activities aimed at accessing information require the mobilisation of multiple skills, which not all the students are equipped with (see Appendix 2/ tasks 11 szarnyasrepuloruha1-2). In addition, task 8 (Hairgel) was also found difficult by students. The reason might be that for successful solution of this task critical thinking and decision making – the cognitive aspects of ICT literacy – need to be mobilised, which are higher order skills. As a result, they need greater mental efforts than simply recognising an icon or button. The fact that the first six and the last three places in the task difficulty order based on students mean achievements proved to match the intended difficulty levels allow for the conclusion that the direction of the test development in terms of task difficulty is correct. However, the proportion of this match was below the hypothesized 70% (hypothesis 1). Further investigation would be needed to reveal whether the causes behind the discrepancy between boys' and girls' task difficulty order based on mean performance is gender-based or not. Whether it was the 1st, 2nd or third easiest task for one gender or the other might not have a serious message, for example in case of the Jeweller's, Wiki or Local paper1 tasks. All of them were easy tasks according to item thresholds as well. It might or might not imply that the topic of finding a Jeweller's could appeal more to one gender than the other (girls), whereas the topic of online harassment might be more interesting for boys than girls. In case of typing a search term, which was a hard task according to item thresholds, and was rated as 7th in the girls' difficulty order by their mean achievement and 10th most difficult in boys' difficulty order by their mean achievement, it could be suspected that girls' advantage over boys in typing might have played a role in causing the discrepancy between the genders' results. The order of difficulty was further investigated using Generalised Item Response Modelling software, in which item thresholds were seen as the parameters of item difficulty. This is described further on where item analysis is described in detail.

The correlations between time on task and achievement scores

In hypothesis 2 a relationship between successful task completion and the time spent completing it was expected across all grades and genders. Analysis showed strong correlation between the mean time spent on tasks and the mean score achieved in Grade 8 (r=.775; p<.01), significant but weak and negative correlation in Grade 5 (r=-.269; p<.05) and no significant correlation in Grade 10 (see Table 15) due to the low number of grade 10 students in the sample. Uncertainty because of a lower level of experience resulting in strain and lower results – despite the length of time used – might have caused the negative correlation in Grade 5, where students have just entered the upper primary grades. Or the negative correlation might be explained by the heterogeneity of the grade 5 cohort with latent variables affecting the results. Nevertheless, further investigation is needed to reveal the causes. The fact that the relationships between mean time and mean achievement were not significant in grade 10 were probably caused by the low number of (n=9) grade 10 students in the sample.

Table 15: Correlations between mean time-on-task and mean scores in imitated online surface tasks 1-10 across grades

	Grade	Mean score
	5	269*
Mean time-on-task	8	.775**
	10	232

Note: \* p< .05, \*\* p<.01

As revealed by the one-way ANOVA analysis of the differences between the rates of successful task 1-10 (on imitated online surfaces) completion across grades, there is significant difference between grades 8 and 10 in terms of successful task completion of tasks 1-10 on imitated online surfaces (F=2.56, p=.026) (See Table 16). Although the results of our pilot assessment could not be generalized because of the small sample, the fact that significant differences were found between two grades is in line with research in an international context (ACARA, 2015), where significant developmental change of students' ICT literacy could be detected between grades 6 to 10. The period was narrowed to the years between grades 8 and 10 during this second phase of our research. Further investigation of where the most intensive period of the development of the ICT literacy component *access* could be was conducted in

further phases of the research (see Figure 19).

Table 16: Multiple comparisons of successful task completion of tasks 1-10 (imitated online surfaces)

	(1)	(I) (J) Mean				95% Confidence Interval	
	Grade	Grade	Difference	SD	Sig.	Lower	Upper
			(I-J)			Bound	Bound
	Е	8	.900	.578	327	. <del>-</del> .519	.2.320
	5	10	-1.661	.745	138	3.795	473
Dunnett	Dunnett 8	,5	900	.579	327	-2.320	519
T3		10	-2.561	.860	026	4.844	278
-	10	5	1.661	.745	.138	473	.3.795
	10	8	2.561	.860	026	278	4.843

Hypothesis 3 proved to be confirmed. It was expected that students' performance in the access dimension of ICT literacy could be tested in 45 minutes applying the set of tasks in the pilot test administered across all grades and genders. The mean total time was 629.96 seconds (10.5 minutes) with 1540 seconds (25.66 minutes) being the longest time spent in the CAIPT. The mean total score was 8.41 (42%) (SD 3.265) from 20 points.

As regards the relationships between the performance assessment test results and the questionnaire responses, the correlations detected between how confident students reported themselves in certain areas of the questionnaire (see in Appendix 1) and how successfully they completed the actual tasks in the imitated online task set (Appendix 6, Table 34) were weak but significant. For example, their self-reported confidence in reading different sources and finding information on the screen, on web sites or in diagrams or images on the web showed significant correlations with several imitated online surface tasks. Most correlations between imitated online task responses and self-reported confidence were found with respect to reading magazines, reading course books, navigating in menus, understanding audial information – probably because the instructions could also be heard –, finding information in texts and diagrams on the web or on social network sites. In terms of the simulated online task set, weak but significant correlations were found between reading magazines (r=.227, p<.05), texts in free time (r=.257, p<.01) and task 12 (finding products on the imitated web site of a decoration studio) (Appendix 6, Table 36). Frequent leisure time information searching activities correlated (r=.194, p<.05) with task 11 (information search about wingsuit flying) but

the hours of internet use per week did not correlate with the simulated online tasks. Negative correlations were detected between self-reported confidence in reading from images and the simulated web site task responses (r=-.214, p<.05) in task 13 (finding information about prices in an aqua park) and (r=-.210, p<.05) in task 14 (searching for information about ski instruction and ski slope entrance fees). Contrary to expectations, self-reported confidence in simple calculations was not related to tasks 13 and 14, where also abilities to execute calculations was needed. Similarly, self-reported confidence in typing words was not correlated with task 13, where the response had to be typed in. However, it was in line with the assumptions that there could be a reverse relationship between confidence in finding the most appropriate search term and tasks 11 (r=-.255, p<.05) and 14 (r=-.253, p<.05), where no search term was needed for the successful completion of the task.

Our assumption, that the two types of construct validity (convergent and discriminant validity) would be confirmed by the correlations between the responses to online web search-related questions and results of performance assessment tasks was not proven (hypothesis 4). Contrary to research in an international context (Sommerville, Smith, & Macklin, 2008; Katz & Macklin, 2007), in our case, it could not be stated that all of the measures (that are expected to be related) would correlate significantly with performance.

In terms of hypothesis four (H4), by using the item-total correlations statistics analyses as a first step, 16 items were selected, which resulted in a higher reliability measure. Reliability was improved to .74 by selecting 16 items from the original set of 24 (Table 17 in Appendix 10). Also, eight items were selected for deletion because of their low discrimination parameter (unweighted MNSQ), which was lower than .2 and/or the WLE average of the students giving the right response on the item was only slightly higher than that of those giving the wrong response (for example 0.12/0.06 as opposed to -1.25/0.60 in case of the right item, Item 1). These items did not discriminate well between high and low achiever (ability) students. The filtered items also had a low point-biserial correlation (from .01 to .17), which indicates the low correlation between the student's total score and the response to the item suggesting irregular item behaviour as well.

Looking at the Weighted FIT, it could be seen that the Weighted MNSQ was within the confidence interval of all items (See Table 19). Also, mean-squares observed in a sample of around n=200 are expected to be within the range 0.8 to 1.2 (Molnár, 2013), which requirement was met by the items of the test. Both of these results suggested that the items fit the model. In case of 15 of the 16 items the model fit could be regarded as almost perfect, and item 16 as well was very close to the expected measure (See Table 19). Consequently, our eighth hypothesis (H8) was proven to be confirmed.

Table 19: Model fit of the 16 items in the partly simulation-based ICT literacy test

		L. Jen
	Weighted Fit	
	MNSQ	Cl
1	.78	(.73, 1.27)
2	.81	(.76, 1,24)
3	.93	(.79, 1.21)
4	1.02	(.83, 1.17)
5	1.00	(.85, 1.15)
6	1.08	(.85, 1.15)
7	0.87	(.75, 1.25)
8	1.05	(.80, 1.20)
9	0.92	(.75, 1.25)
10	1.07	(.78, 1.22)
11	1.16	(.64, 1.36)
12	0.88	(.66, 1.34)
13	1.17	(.79, 1.21)
14	0.98	(.85, 1.15)
15	1.04	(.81, 1.19)
16	1.26	(.70, 1.30)

Regarding item characteristic curves, which are related to the discrimination value of the items, they visualized the discriminating power of the items already known from the discrimination parameters (See Figures 22 to 37 in Appendix).

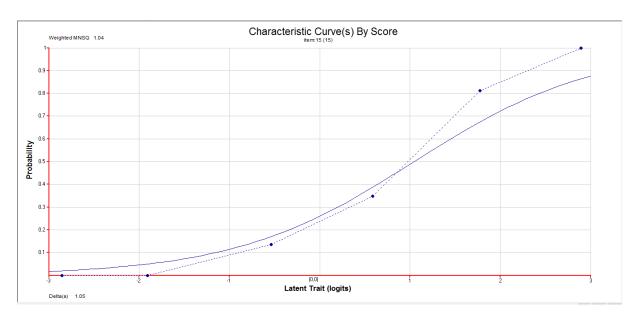


Figure 35: Characteristic curve of Item 15 Dekorstudio\_valasz\_szalagos

The item characteristic curve of item 15 (Figure 35 also in Appendix) – drawn by a broken line – with its discrimination parameter .47 has a flatter curve, a flatter slope in the middle section, indicating lower (moderate) discriminating power. Such a flat curve with a moderate discrimination value suggests that higher ability level students have nearly the same probability of having the right answer as lower ability students have. Item 1 (Figure 21 also in Appendix), however – with its discrimination parameter .64 has a comparatively steeper slope in the middle section indicating a higher discriminating power.

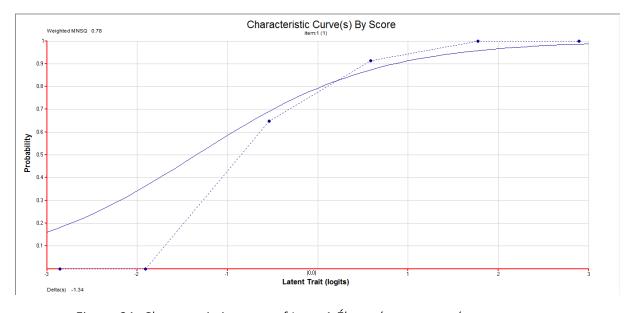


Figure 21: Characteristic curve of Item 1 Ékszerész nyomtatás

Based on the descriptors of rates of discrimination by Baker (2001), item 1, for example, (See Figure 21) – with its weighted fit index MNSQ= .78 – has a low-moderate discrimination value (.64). In terms of the measure of discrimination, 14 of the 16 items could be labelled as low-moderate (See Table 18). In this respect, our hypothesis, that our items would discriminate, was partly confirmed (H6).

Regarding difficulty, the difficulty levels of the items – Item Thresholds (see Appendix 7, Tables 20-21), the ability level where the probability of the correct response to the item is .5 – were between minus 1.78 and plus 2.29 with 44% of them regarded as hard, 18% of them as medium and 38% of them as easy items – based on the rate of students giving the right or wrong response on the item (see Appendix 7, Tables 20-21). Very hard and very easy items turned out to be missing from the test (See Table 18), however the test covered the ability scales from -2 to +2 on the ability scale from ability levels -3 to +3 (See Figure 14 Item-person map). Consequently, it can be said that our hypothesis regarding item difficulty was partly proven.

As regards the results of task difficulty based on students' mean scores – described earlier – and item difficulty thresholds – just discussed, the more delicate method led to an almost identical outcome. However, no direct comparison could be made as the earlier order was on task, while the latter order was on item level. Another reason for the differences between the results of the two approaches is that the first approach – arranging the tasks in the order of increasing difficulty based on students' mean achievements – was used for the total number of tasks (including all items), while the second approach - comparing item thresholds – was applied to the 16 items selected by item analysis (using item analysis). In some cases, the very same task had two extremely different difficulty level items, for instance the Wingsuit task, which involved the lowest (Item threshold -1.78) and the highest (item threshold 2.29) difficulty level items itself (see Appendix 12, Table 39). As a result, task difficulty level based on boys' mean achievement in this task was medium. Having said that, the item difficulty levels by item thresholds were identical with the task difficulty levels based on boys' mean achievements. Compared with girls' mean achievements slight differences could be seen in three cases, where task difficulty levels based on girls' mean achievements appeared easier than based on boys' achievements.

It could also be seen that the last three tasks were found equally difficult by both genders (based on their mean achievements). However, these items were omitted after selection using item analysis results as the items did not work appropriately. In these items the WLE average of the students giving the wrong response on this item was hardly different from the WLE average of the students giving the right response. For example, for the very last item of the original 24 (within task 14) it resulted in a WLE average of -0.06 for the wrong and .36 for the right response. Also, the discrimination parameters of the omitted items were very low, indicating the low discriminative power if the items (for example, for omitted item 22: .01).

Similarly – closely related to the discrimination parameter –, the point biserial indices of these items indicated weak correlations between the students' test result and their achievement on the item. These measures might suggest that it was not simply the difficulty caused by the complexity of these items – as hypothesized earlier – that caused the students hardships but the inexplicable behaviour of the items. The point biserial indices of the items in question showed low correlations between the overall result of the students and their result on the item, implying the wrong functioning of the item. Similarly, these items had very low discrimination parameters, which means that they poorly discriminated between low and high ability students. Also, the inappropriate behaviour or functioning of these items is shown by the fact that the WLE average of the students giving the wrong or the right response on these items hardly differed.

Table 18: Item difficulty and discrimination (weighted MNSQ and discrimination parameter) indices of the 16 items selected

Item	Item Name	MNSQ	Discrimination Level	Discrimination	Difficulty
Number	(Translated)			Parameter	Level
1	Jeweller's	.78	Low-Moderate	.64	Easy
2	Navigate back	.81	Low-Moderate	.63	Easy
3	Project	.93	Low-Moderate	.53	Easy
4	Type search term	1.02	Low-Moderate	.44	Hard
5	Netgift	1.00	Low-Moderate	.44	Medium
6	Presentation	1.08	Low-Moderate	.53	Medium
7	Wiki (Online	.87	Low-Moderate	.51	Easy
	harassment)				
8	Hairgel	1.05	Low-Moderate	.41	Hard
9	Local paper1	0.92	Low-Moderate	.49	Easy
10	Local paper2	1.07	Low-Moderate	.37	Hard
11	Wingsuit2_d2_free	1.16	(Very) Low	.22	Hard
12	Wingsuit	.88	Low-Moderate	.46	Easy
	2_there_is-1				
13	Decoration	1.17	Low-Moderate	.34	Hard
	_response_2				
14	Decoration	.98	Low-Moderate	.48	Medium
	_response_normal				
15	Decoration _	1.04	Low-Moderate	.47	Hard
	response _szalagos				
16	Decoration _	1.26	(Very) Low	.22	Easy
	response _vilagito				

The Discrimination Parameter Estimate denoting the correlation between the students' total score (overall achievement on the test) and the score on the item (Molnár, 2013; See Table 18) was over or equal .2, in case of all 16 items. As a result, it could be stated that the 16 remaining items after selection work appropriately.

The results of plotting the students and the items along the ability scale between the ability levels of -3 to +3 showed that the selected items roughly cover the ability levels from -2 to +2. However, our findings also suggest that development of further items to cover higher and lower ability levels is needed (H7). Thus, our hypothesis regarding the appropriacy of the items for the ability levels of the students was partly confirmed (See Figure 29).

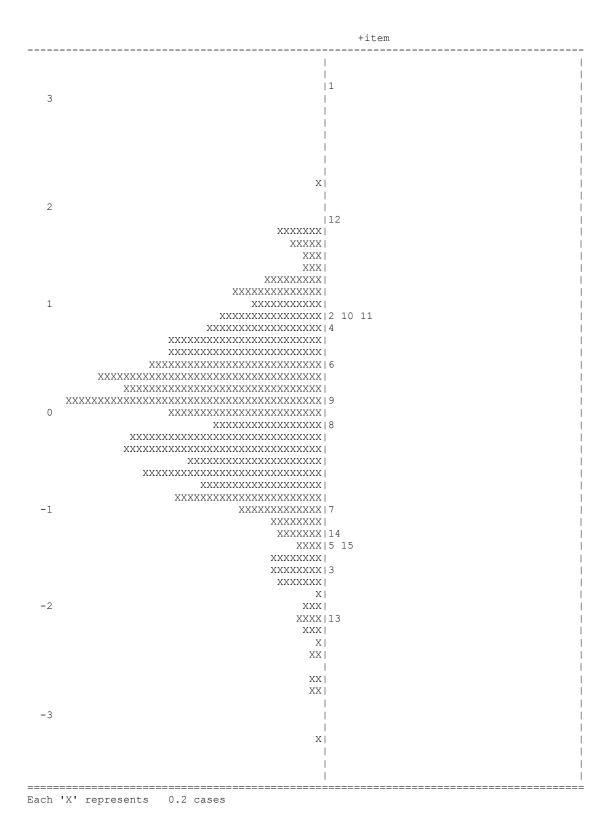


Figure 14: The item-person map of the test

In the test the lowest WLE was -2.92 and the highest WLE was 2.95. Looking at the WLE averages, it is visible, that in each item the ability parameter WLE average of the students giving the right response was much higher than that of the ones giving the wrong answer, which also

suggests that the items function appropriately. For example, in item 1 the WLE average of students giving the wrong answer is -1.25, that of the right answer is .60 (See Tables 20 to 21 in Appendix 8).

It was concluded that further development in terms of the number and the elaboration of the tasks and items together with empirical testing of validity proved to be necessary. However, further elaboration of the instrument could result in an effective means of measurement to achieve further, large scale performance assessment of digital literacy. The significance of the test was that it meant the application of an innovative, authentic, partly simulation-based, online performance assessment instrument devised in a national context with immediate feedback to students and educators. It gave the opportunity to identify developmental characteristics of grades 5 and 10 students and gender differences. It also involves the yet unexploited potential to compare the results of the performance assessment with the measures in the self-reported questionnaire to reveal possible correlations regarding the confidence of ICT literacy use, which could also contribute to testing validity.

### 4.2.6. Limitations on the results of the test

Limitations on the interpretation of the results of the pilot research are to be imposed owing to sampling and reliability measures because of the limited sample size and the low number of tasks. Due to the fact that a comparatively small number of students of standard state school classes participated in the testing without the individuals being chosen randomly, an overrepresentation of some strengths or demographic features may have occurred, which might affect the results.

In spite of the unquestionable improvement made in terms of test development, certain restrictions had to be made in interpreting the results. As the test was only partly simulation-based, it might not meet the requirements of full authenticity regarding the assessment of a component of ICT literacy inherently dynamic and internet-based. Furthermore, although an expert panel's opinion was considered, empirical testing of validity was only based on seeking correlations between the self-reported confidence in information search activities and the actual performance, which lead only to partial results.

## 4.2.7. Conclusion and further research opportunities

Further development of the test was needed in terms of the number of tasks and items as well as elaborating the existent ones in order to improve the consistency of the test, which is a rather complicated task in case of such a complex construct as ICT literacy even though only one component is to be measured (Tongori, 2014b). Further development of items relating to the dynamic, simulated websites appeared to be imperative. Also, emphasis should be put on developing further items to cover a wider ability range.

This pilot test was to serve as a basis of an assessment instrument being developed to gauge students' confidence in accessing information in digital environments. In terms of the analysis of the items, reliability measures for the performance test – although could be raised to Cronbach's  $\alpha$ =.74 – were comparatively low, which was partly caused by the low number of tasks and the limited sample size. Also, the diversity of the tasks might have contributed to the reliability measure. Further examination of the results relating to item analysis (also shown in Table 17 in Appendix 10) might lead to elaboration of a performance assessment test with more favourable measures. Validity of the test was only partly tested (by expert panel, pilot testing, reliability measure), consequently, further, large scale empirical testing of validity is needed.

The internal consistency measure was raised, it could and should be further improved. One way of providing a higher-level consistency could be to ensure uniform items all through the test, which in the pilot version discussed did not happen. Consequently, further development of the assessment instrument in this respect was needed. To provide uniformity, which should contribute to higher internal consistency, moving towards a fully simulation-based test (instead of the partly simulation-based structure) seemed to be the solution. A completely simulation-based design was expected to be a more authentic method for testing the core ICT literacy component *access*.

## 4.3. The third phase: A simulation-based pilot assessment tool and instrument

Further observing the international trends in assessment of the field urged not simply the inclusion of third generation (Csapó, Ainley, Bennett, Latour, & Law, 2012; Molnár, Greiff, Wüstenberg, & Fischer, 2017), simulation-based applications but rather placing the whole measurement based on authentic, life-like online environments. For this reason, because of the rethinking of the test development from the points of view of authenticity and consistency, reconstructing the novel simulation type items of the previous phase was decided on. The simulation-based tasks had a major aspect fundamental for ICT literacy assessment, that is, authenticity, which made them desirable in a present-day measurement instrument of one of the 21<sup>st</sup> century skills and abilities. Thus, these simulation type 'website-based' tasks with their authentic appearance were put in the focus of test development. Exploiting the authenticity of the fictional websites already existing – as they had been used in the previous phase of the research project – meant creating as many items within each simulated website as possible.

Furthermore, although in the second phase of test development the pilot test was delivered to a limited sample, which might have contributed to its reliability measure, an even higher internal consistency was desirable. It was assumed that the wide variety of the presentation of the items (as well as the partly imitation-, partly simulation-based design) prevented the whole test from being substantially uniform even though only one component of ICT literacy was in the focus of the assessment. To provide uniformity and consistency but to be authentic and simulation-based at the same time, a novel, uniform framework structure was introduced in the third phase of the test development, which was made possible by the parallel development of the eDia online assessment platform (Molnár & Csapó, 2013; Molnár et al., 2015a). The simulation-based, virtual websites were fully embedded in the assessment instrument and all their elements were stored within the servers used to operate the tests. Each item of every virtual website appeared in the same frame (one frame per one item, to be described in *The assessment instrument design* section of this phase under 4.3.4. Methods) and no exiting the test environment was needed. The pilot assessment was administered in June 2016 in primary and secondary schools of two major cities in Hungary.

### 4.3.1. Aims

On the one hand, our aim was to devise a reliable and valid, simulation-based, third generation assessment instrument with a high discriminative power and having the right range of task difficulties covering the ability range of students to measure how confidently students of grades 5, 6, 8 and 10 operate their abilities in an online environment in one component of ICT literacy, that is, accessing information. It was also one of the goals of the pilot test to collect evidence about the hypothesized time allotment needed. On the other hand, besides testing the operation of the assessment instrument devised, data collection by means of a performance assessment test and background questionnaire and analysis of data from students of the given grades was also in the centre of our research to gauge what the developmental trends of the grades in question were in terms of accessing information and how successfully the grades could cope with resolving the tasks.

### 4.3.2. Research questions

- (Q1) How could the earlier test be developed into a reliable and valid but entirely simulation-based, third generation assessment instrument to gauge in an authentic context the ability of students to find information confidently and effectively in an online setting?
- (Q2) Is the number of items and the assumed time frame appropriate for the purposes of assessing the access component of ICT literacy of the student?
- (Q3) How does the test differentiate between grades? Can the test be applied to measure both grades? What is its difficulty level like? Do the students' results comply with the results of students tested in international contexts, that is, a substantial developmental change of students' ICT literacy could be noticed between grades 6 to 10 (ACARA, 2015)?

# 4.3.3. Hypotheses

As a result of the changes that had been introduced in the test, the internal consistency was expected to be higher than in the earlier version (H1). In terms of the time needed for completion, it was hypothesized that two 45-minute sessions (lessons) would provide enough time for all levels (H2) as research into assessment of various components of ICT literacy at a time had proved to be feasible in 50 minutes in case of the NAEP TEL test (The Nation's Report Card, n.d.) and 60 minutes in case of the IEA ICILS test (Fraillon et al., 2013). It was assumed that the performance of the higher-grade students will be better (H3) than that of the lower grade students (Fraillon et al., 2015). Also, higher grade students were supposed to complete

both parts of the assessment (test and questionnaire) within a shorter time than lower grade students (H4). As regards validity, it was assumed that one dimensional structural equation modelling (SEM) using the Mplus software would result in good fit parameters suggesting the validity of the test (H5). On the one hand, our assumption was based on the fact, that no resources had been found suggesting that the abilities activated to solve tasks related to any component of ICT literacy would be more than one dimensional. On the other hand, confirmatory factor analysis (CFA) — a method of SEM — with its fit indices is used to provide empirical evidence of fit between the data and the theoretical model, validating the measurement this way (Yu & Hsu, 2013).

### 4.3.4. Methods

# *The sample*

The sample was comprised of Grades 5, 6, 8 and 10 students (n=103). 90% of the students completed the whole test (n=94). In the analysis, data from all students who completed the test (n=103) – and attempted completing items at least up to the second simulated website (from the four) – were included, with grade 5 students n=24, with grade 6 students n=21; with grade 8 students n=16; and grade 10 students n=42. Regarding the ratio of genders, they were almost equally represented across all grades, with a slight overrepresentation of the girls (boys n=49; girls n=54). Looking at the genders within grades, in the 8<sup>th</sup> grade an equal representation of the genders could be seen, in grades 5 and 6 the girls, whereas in grade 10 the boys were overrepresented (See table 24 below).

Table 24: The sample regarding the simulation-based pilot test

		Grade						
	5	6	8	10				
Boys	10	7	8	24	49			
Girls	15	13	8	18	54			
Total	25	20	16	42	103			

### The Assessment instrument design

In the simulation-based, third generation online test to assess the confidence of accessing information online, the students were asked to respond to the 61 items of the ICT literacy test delivered online in eDia assessment platform (Molnár & Csapó, 2013; Molnár et al.,

2015a), students encountered a third-generation testing environment facilitating interaction between test takers and tasks in which they were expected to find the relevant information in a simulated internet setting. The assessment instrument consisted of four different virtual websites representing four different themes. The themes were meant to be relevant to grade 5 to 11 students' real life (search) experiences related to various seasonal activities - for example, looking for party supplies or sports and leisure activities – but at the same time arouse their interest to such an extent that test taking should be supported by interest. Therefore, offers that supposedly appeal to students were included, such as holographic party plates and animal shaped lanterns, extreme sports, aqua and adventure park opportunities. Similar topics could be found in research in an international context, for example, planning a trip in the Hong Kong assessment (Law et al., 2009), whose counterpart in our instrument is an outing to the aqua park with grandparents. Furthermore, the choice of topics was intended to appeal to both girls and boys. The first of the fictional websites was a party supplies one. The second one was a website of a parachute jumping and wingsuit flying association, the third one was the website of an aqua and adventure park and the last one was a website providing information about ski resorts. The first item related to each website had a brief scenario to provide the context of the searching activities. Figure 1 demonstrates a typical task from the test, where the student is expected to find for which day a discount is offered to students aged 14-18 and enter his or her answer by mouse clicking on the radio button with the right response.

Fourteen to seventeen items belonged to each virtual website – fourteen items within the party supplies website, sixteen items within the parachute jumping website, seventeen items within the aqua and adventure park website and fourteen items within the ski resorts website –, which added up to 61 items altogether. The information to be found in case of each item was presented in various ways, for instance, in short texts, charts, diagrams or images. The questions (dichotomous items) were presented in a linear arrangement, each appearing at the bottom quarter section of a separate screen (See Figure 31). The upper three quarters of each screen was occupied by the virtual website, where actual navigation and browsing activities could be done. Various pieces of information were at a different distance from the home page of the virtual website: some were only one or two, others three or more mouse clicks away also depending on the path the student took. Students could find the answers navigating on the website by clicking and scrolling. Then they could give their answers by

clicking on one of the four radio buttons given in the bottom section of each screen dedicated to the tasks. Then after clicking on the Tovább (Next) button, the next question was presented. Within one virtual website, the simulated internet environment remained unchanged from screen to screen. As a result, when students were presented a new question in a new screen within the same virtual website task, they could continue browsing from that point of the virtual website, where they stopped when responding previously. This technological solution was intended to make the test using simulated websites as authentic as possible. For the same reason, students were also allowed to move back and forth within the test as many times as they wished before completing the test. However, a time limit was given.

Students' scores (and movements within the test) were logged by eDia online assessment platform (Molnár et al., 2015a). Each correct answer was given one point and after each set of questions belonging to a certain virtual website the students were provided with a screen giving feedback on their results up to that point (See Appendix 2). This technical solution also served the role of ensuring that at least up to the last completed section, students' responses and scores were saved in case of technical problems arose or if the student was not able to complete the whole test. When the time was over, the student was informed on a screen about his or her result up to that point. There was no warning before the time was over. Information about the length of the test time was given by the invigilators and students could see the passing of time by looking at the computer clock.

Another piece of information provided by the invigilators was that students could enlarge or reduce the size of the image on the screen by pressing the Ctrl and +/- keys on the keyboard when needed. This way no disadvantage because of not being technologically literate hindered any student.

To have the opportunity of analysing background data, the questionnaire, which was used in the earlier phases of the research project – whose description is detailed in chapter 4.2.4.2. of this dissertation – was also administered.

### **Procedures**

The time frame for students to resolve the tasks and answer the questions in the questionnaire was not restricted within the assessment instrument. However, based on pretesting of individual 10<sup>th</sup> graders, a 45-minute session and possible extension over the break

was requested from volunteering schools. Each student was administered the same set of tasks. The test was delivered through eDia online platform (Molnár et al., 2015a). Throughout the analyses classical test theory and structural equation modelling were used. Reliability (or in other words, internal consistency) of the test was described by the coefficient Cronbach's  $\alpha$ .

Structural Equation Modelling was applied to check the – at that point – one-dimensional model fit. This procedure was to confirm the validity of the instrument.

Changes in the efficiency of accessing information across grades 6 to 11 and gender was tested using the means of classical test theory (t-test, ANOVA, mean, standard deviation, frequency and logistic fitness function).

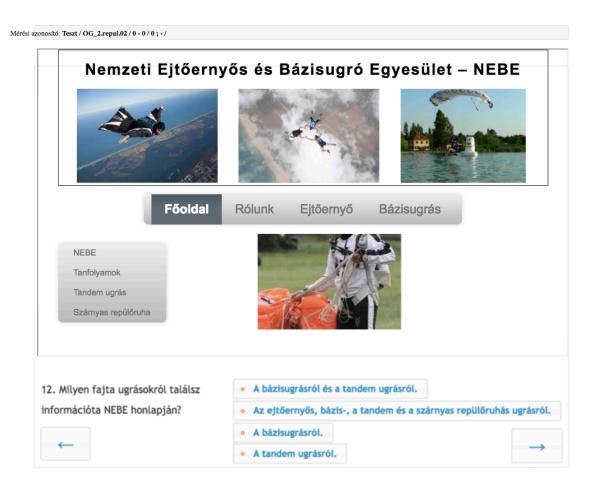


Figure 15: A sample task from the test

### 4.3.5. Results and discussion

Reliability of the test and descriptive statistics

Owing to the test development procedures in terms of standardising the framework of the assessment instrument, the reliability measures were high. The internal consistency of the performance assessment test for 61 items was Chronbach's  $\alpha$ =.89. After reducing the number of items applying item total correlation analysis, the reliability measure of the performance test for 45 items was Chronbach's  $\alpha$ =.92. Reliability coefficient of the questionnaire was Chronbach's  $\alpha$ =.91.

Regarding students' mean scores, it could be seen that there was a gradual rise in mean scores from grades 5 to grade 10. Although there was only a slight difference between the mean scores of Grades 5 and 6 students, and similarly, between grades 8 and 10 students, a great performance difference could be seen between the results of grades 6 and 8 students (See Table 25). The results of the students in this test, however small scale the assessment was, conformed with the findings of large scale assessment in an international context in that respect that substantial developmental change of students' ICT literacy could be noticed between grades 6 to 10 (ACARA, 2015). While grades 5 and 6 students' mean score was around 20, grade 8 and 10 students doubled that amount by having mean scores around 40.

Table 25: Mean scores across grades on the 61-item pilot test

Grade	N	Mean score	SD	Mean score %
5	24	22.00	8.66	36.06
6	21	23.61	8.57	37.70
8	16	41.00	7.06	67.21
10	42	41.76	5.77	68.85
Total	103	33.57	15.32	55.03

In order to decide if the performance assessment test and the questionnaire could be administered in two 45-minute sessions, the time students spent on them had to be examined. Although the time spent completing the test items and the questionnaire was in some cases longer than expected, it could be noted that 90 per cent of the students in each grade spent less than 90 minutes completing the two parts of the test (performance assessment test and questionnaire) altogether (see Table 26). It could be seen that the majority of the higher-grade

students needed a shorter time to complete both parts of the assessment. Grade 10 students spent 72, grade 8 students spent 80 and grade 5 students spent 88 minutes on average completing the whole test (including the performance assessment test and the questionnaire). Grade 6 was an exception: their time on task was 62 minutes. The reason for this was that due to organizational difficulties at the end of the school year, these students could not be provided extra time over the 45 minute session for the completion of the whole assessment, only one lesson and a break, which was a shorter time than what the other grades could spend completing the assessment. As a result, these students only completed the test and a part of the questionnaire.

Table 26: The time spent in test and questionnaire altogether in the third phase of the research

90% of the students in the given grade	Total test time of 61 items plus
	questionnaire (minutes)
Grade 5	88
Grade 6	62
Grade 8	80
Grade 10	72

Measures proved to certify, as expected, a good, one dimensional model fit. After reducing the number of items from 61 to 45 applying the item total analysis, the RMSEA (Root Mean Square Error of Approximation) estimate, which refers to the variance of residuum and is generally expected to be lower than .08 (Fan & Sivo, 2005), was RMSEA=.028 (C.I. .001, .040; Probability RMSEA<= .05). At the same time both CFI (Comparative Fit Index) and TLI (Tucker-Lewis Index) indices, which describe the explained variance (variance explained by the model), were over .9 (CFI=.970; TLI=.969), as generally expected (Bentler, 1990), which suggest a good model fit. Consequently, our hypothesis regarding the model fit (suggesting validity) of the assessment instrument (the test) proved to be right.

As the focus of this phase of the research project was on testing the reliability and the validity of the further or rather newly developed, totally simulation-based performance assessment test, the responses of the background questionnaire are to be analysed. However, there is no total lack of analysis of the questionnaire responses or their relationships with the

performance of the students. Questions of the background questionnaire were almost 100% identical with the ones applied in the previous pilot assessments in the first (see chapter 4.1.5.) and second phases of the research project (see chapter 4.2.5.), where the results of an age range of students similar to the sample of students in this assessment (grades 7 and 10 in the first phase, grades 5, 8 and 10 in the second phase and grades 5, 6, 8 and 10 in this phase) had been analysed. In the first phase results of the questionnaire were described. In the second phase results regarding the relationships between the performance assessment test and the questionnaire responses were detailed.

The primary aim of phase 3 was to improve the reliability measure by developing a more consistent structure. Consequently, a decision to devise new items in the 3rd phase exploiting the authentic, simulation-based websites of the 2nd phase was made. For this decision, the weak but significant correlations found between the imitated online surface task responses and the questionnaire responses had a lower importance. Because of time constraints, the questionnaire in the 3rd phase – although administered – is yet to be analysed. The large-scale ICT PA assessment test was to be delivered as part of an overall research into thinking abilities and before the deadline of a project. Item analysis, reducing the number of items to a feasible test battery solvable in 45 minutes and model fit were the primary focus. However, as two previous rounds of pilot research had included the same questionnaire – analysed –, and practically the same questionnaire was planned to be used in the 4th phase, the emphasis shifted over to item development instead of the repeated analysis of the questionnaire.

# 4.3.6. Conclusion and further research opportunities

Reducing the number of items from 61 to 45 could ensure that a 45-minute lesson should be the right time allotment for the performance assessment part of the test. With further development, the pilot test proved to be a reliable and valid assessment instrument to measure grade 5, 6, 8 and 10 students' confidence in mobilizing their abilities in the access component of ICT literacy to find online information effectively. Based on the results and evidence, a large-scale measurement of the access component of ICT literacy of grades 5-12 students was prepared. The educational relevance of the results of the pilot test was that it was proven that it is possible to devise a reliable, third-generation, simulation-based, authentic and valid assessment instrument to measure students' performance in the most fundamental component of ICT literacy.

The results of the students in this performance assessment test conformed with the findings of large scale assessment in an international context. Although the results of the test cannot be generalized, as it was a small-scale pilot assessment, developmental change of the students' ICT literacy in the sample could also be detected between grades 6 to 10. However, further, large-scale investigation is needed to confirm that the same findings are valid in our national context as those in an international context.

Analysis of the data collected in this assessment using a reliable questionnaire is a further research opportunity. Although the questionnaire was identical with the ones applied and analysed in the first and second phases of the research project with a similar age or grade range in focus, the rate of novel items in the test of this phase – developed based on the simulation type tasks of the second phase test – would make it reasonable to carry out detailed analysis of the questionnaire responses and their relations with the test results.

Although the data collected by the questionnaire was not exploited because of the focus being on transforming and piloting the performance assessment test, the whole assessment — with its potential for future analysis — prepared and facilitated the large-scale application of a novel, authentic, simulation-based performance assessment test of the access component of ICT literacy commencing shortly after piloting.

# 4.4. The fourth phase: A large scale, third-generation, simulation-based, online assessment tool and instrument

In this part of the dissertation an assessment instrument which matches the 45-minute lesson time span of the Hungarian public educational system and therefore can be applied in Hungarian public educational settings to gauge grades 6 to 11 students' effectiveness of accessing information will be introduced. The analysis is based on the results of a large scale, wide age range data collection involving over 10.000 students. To the best of the knowledge of the author of this dissertation, no third generation, simulation-based performance assessment of any components of ICT literacy were devised and applied in a national context preceding this measurement. The assessment instrument introduced is the result of a several-year development process the results of whose pilot tests have been published (Tongori, 2013b, 2013c, 2013d, 2014a, 2014b, 2016a, 2016b).

At first, the third generation, online assessment instrument devised to measure the level of ICT literacy of grades 6 to 11 students will be dealt with. The goodness of measurement instrument, reliability and item difficulty are presented in the light of the general ability level of the population measured. The evaluation of dimensionality of the construct will also be recounted. Finally, the process of the development in grades 6 to 11, correspondence and differences detected between the genders will be reported on.

### 4.4.1. Aims

The aim of the analysis was to provide evidence that it is possible to devise an assessment instrument for a wide age span in public school settings, which can be applied to gauge the efficiency of accessing information – which is a major component of ICT literacy – effectively in a computer- and simulation-based environment, providing instant feedback to educators about the developmental stages of their students' ability of key importance in the 21<sup>st</sup> century. Over the course of analysis, test reliability was to be examined. It was also to be investigated how the different difficulty level items fit the ability level of the sample. Furthermore, the research was aimed at studying how the data fit the theoretical model as the basis of the development of the assessment instrument. A further goal of the measurement was to collect information about the effectiveness of accessing information of the two genders and grades 6 to 11. Ability levels within grades were to be examined as well. The final goal was to analyse background variables and their relationships with the students' results.

## 4.4.2. Research questions

Five research questions were formed: (1) Could it be reconfirmed that it is possible to devise a reliable, third generation online test giving instant feedback on the effectiveness of grade 6 to 11 students' browsing activities; (2) is the difficulty level of the items of the test appropriate for the respective age group and which items need to be amended or what level items need to be added when further improvements of the test are made; (3) how many dimensions could the model of grade 6 to 11 students' ability to access information be described by; (4) is there a detectable divergence between the genders and if yes, what is it? (5) What is the performance of the different grade students like across types of school? (6) Could the development of the ability needed to find information online efficiently be described by a logistic curve? (7) How are certain background variables related to and how do they influence the performance of students?

## 4.4.3. Hypotheses

According to hypothesis 1 (H1), based on the preceding pilot research, it could be confirmed that it is possible to devise a reliable, third generation online test giving instant feedback on the effectiveness of grade 6 to 11 students' browsing activities. It was also hypothesized (H2) that item difficulty of the test items was suitable for the ability level of the age group examined. It was assumed (H3) that the accessing information component of ICT literacy could be characterised by two dimensions. Distinct abilities were supposed to operate finding primary information accessible only a short search path away (for example, on the home page of a website or one mouse click away) or accessing information which could be obtained by following a longer and possibly more complex path (for example, several mouse clicks away or needing to visit different sources of primary information to retrieve the one needed. Another assumption made (H4) was that besides detecting major inequalities within grades, development to a significant extent could be detected from grade 6 to 11. It was hypothesized that the development of the ability necessary for successful online information search could be described by a logistic curve (H5) as in descriptions of the development of other abilities (Molnár et al., 2013). Substantial differences between ability levels within the grades (H6) were hypothesized. Based on ICT literacy assessment in an international context, focussing on the grades in question (ACARA, 2015; ICILS, 2014; The Nation's Report Card, n. d.) as well as a selfreported questionnaire administered in a national context (Tongori, 2013d), girls' level of abilities necessary (H7) for confidence in and effectiveness of information seeking tasks were expected to be significantly higher than that of boys'. (H8) Different levels of performance were hypothesized across different types of school with an advantage of secondary grammar school ('gimnazium') over secondary technical school ('szakgimnázium') or secondary vocational school ('szakközépiskola') based on the results of these school types in mathematical and reading literacy in the national assessment (Szabó, Szepesi, Takácsné, & Vadász, 2018). Significant relationships were hypothesized between students' academic achievements in information technology and test results (H9). Further relationships between students' test result as dependent variable and their questionnaire responses as independent variables were expected (H10).

## 4.4.4. Methods

## Sample

Analysis was based on the responses of 10,064 students from 567 classes of 150 primary and secondary schools. Major parameters and the distribution of the students per grades are presented in Table 27. Before the analysis all the data of the students who had not completed at least the first half of the test were deleted from the data base (N=284). Furthermore, 280 students had failed to provide their gender at the time of data collection. As a result, these students were omitted from analyses where gender as a variable played a role. The students were roughly between the ages of 12 and 19 with an age mean of 12.9 for the 6<sup>th</sup>-graders, 13.9 for the 7<sup>th</sup>-graders, 14.9 for the eighth-graders, 16.0 for the 9<sup>th</sup>-graders,16.9 for the 10<sup>th</sup>-graders and 18.0 for the 11<sup>th</sup>-graders. The ratio of boys and girls was balanced on the lower three grade levels, but a slight overrepresentation of girls could be detected in the secondary school grades (years). Grade 6 students represented about one third of the sample, grade 7 students about one quarter and grade 8 students around one fifth. The higher the grade (year) was, the lower number of students represented it. Grades 9 and 10 students accounted for around a tenth each of the whole sample, while grade 11 students were scarce: they composed only around 6% of the whole sample with 571 students from the 10,064.

Table 27: Sample of the large-scale study

Grade	N	N percent	Ratio of Boys	Age Mean	Age (sd)
6	3041	30.2	50.1	12.9	0.60
7	2379	23.6	48.9	13.9	0.62
8	2123	21.1	48.8	14.9	0.59
9	1037	10.3	43.8	16.0	0.70
10	913	9.1	40.3	16.9	0.64
11	571	5.7	42.7	18.0	0.69
Total	10064	100.0	47.6	14.5	1.71

# *Instrument and design*

While responding to the 44 items of the ICT literacy test delivered online in eDia assessment platform (Molnár & Csapó, 2013; Molnár et al., 2015a), students were expected to find the relevant information in a simulated internet setting, which meant that the students were faced with a third-generation testing environment, facilitating interaction between test takers and tasks. The assessment instrument was comprised of four different virtual websites representing four different themes. The themes were intended to be relevant to grade 5 to 11 students' real life (search) experiences relating to various seasonal activities (looking for party supplies, sports and leisure activities) but at the same time arouse their interest to an extent that test taking should not be hindered by lack of interest. Therefore, offers that supposedly appeal to students were included, such as holographic party plates and animal shaped lanterns, extreme sports, aqua and adventure park opportunities. The fictional websites were as follows: the first virtual website was a party supplies web site, the second one was a website of a parachute jumping and wingsuit flying association, the third one was the website of an aqua and adventure park and the last one was a website providing information about ski resorts. The first item related to each website had a brief scenario to provide the context of the searching activities. Figure 1 demonstrates a typical task from the test, where the student is expected to find for which day a discount is offered to students aged 14-18 and enter their answer by mouse clicking on the radio button with the right response.

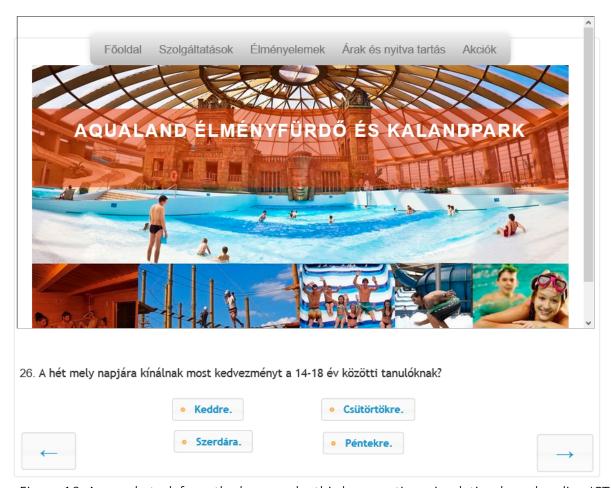


Figure 16: A sample task from the large scale, third-generation, simulation-based, online ICT literacy test

Eleven (items) belonged to each virtual website, which comprised 44 items altogether. The information to be found in case of each item was presented in various ways, for instance, in short texts, charts, diagrams or images. The questions (dichotomous items) were presented in a linear arrangement, each appearing at the bottom quarter section of a separate screen (See Figure 31). Three quarters of each screen (the upper part) was occupied by the website, where actual navigation and browsing activities could be done. Students could find the answers by clicking and scrolling on the website, then give their answers by clicking on one of the four radio buttons given in the bottom section of each screen. Then after clicking on the Tovább (Next) button, the next question was presented. However, within one virtual website, the simulated internet environment did not change from screen to screen. When students were presented a new question in a new screen within the same virtual website task, they could continue browsing from that point of the virtual website, where they stopped when giving the previous answer. This technological solution was intended to make the test using simulated

websites as authentic as possible. For the same reason, students were also allowed to move back and forth within the test as many times as they wanted before completing the test within the given time limit.

Students' scores (and movements within the test) were logged by eDia online assessment platform (Molnár et al., 2015a). Each correct answer was given one point and after each set of questions belonging to each virtual website the students were provided with a test screen giving feedback on their results up to that point (See Appendix 2). This technical solution also served the role of ensuring that at least up to the last completed section, students' responses and scores were saved in case of technical problems arose or if the student was not able to complete the whole test.

## **Procedures**

The time allotment for students to resolve the 44 tasks was 40 minutes. Each student was administered the same set of tasks. The test was delivered through eDia online platform (Molnár et al., 2015a). Analysis was based on students' achievement as every student solved the same tasks. Throughout the analyses classical test theory, probabilistic (item response) test theory and structural equation modelling were used. Reliability (or in other words, internal consistency) of the test was described by the measure/coefficient Cronbach's  $\alpha$ .

Item-person maps were used to visualize the appropriateness of item difficulty for the ability level of the sample. No plausible values (Molnár, 2013) were calculated as the same test had been administered in each grade. The percentage of students' result was found sufficient as the basis of analysis.

Confirmatory factor analysis based on structural equations was used to test model fit. To check the one- and the two-dimensional model fit, several measures were applied: the absolute fit index, Chi-squared test statistic; the root mean square error approximation (RMSEA) index, which also takes the model complexity into account; and the incremental (relative) indices, CFI and TLI. The value of CFI and TLI indices, which describe the explained variance (variance explained by the model), is generally expected to be over .90 (Bentler, 1990) whereas the value of RMSEA index, which refers to the variance of residuum, is generally expected to be lower than .08 (Fan & Sivo, 2005). Given the fact that the items of the test are

dichotomous, model fit was examined by Weighted least squares mean and variance adjusted (WLSMV) estimates, and THETA parametrization (Muthén & Muthén, 1998-2010). Comparison of the one- and two-dimensional models was made by applying a special Chi-squared test (DIFFTEST).

Changing of the effectiveness of accessing information across grades 6 to 11 and gender was tested using the means of classical test theory (t-test, ANOVA, mean, standard deviation, frequency and logistic fitness function). Correlations were analysed and regression analysis was carried out to find out what percent of variance of the dependent variable test result is explained by the independent variables that is questionnaire responses.

### 4.4.5. Results and discussion

Reliability of the test and descriptive statistics

Reliability (Cronbach's  $\alpha$ ) of the whole test was .904, which means that the test results characterize the effectiveness of students' accessing information in a reliable way. Mean student performance was 51.4% (SD= 19.8% point).

Reliability measures of the test across grades are shown in Table 28 along with specific grade students' minimum and maximum performance (achievement) measure, mean performance (achievement) measure and standard deviation. The test proved to be reliable in each grade and differentiated students appropriately, according to their ability. Internal consistency of the test is demonstrated by Cronbach's  $\alpha$  measures of over .8 in grade 6, .85 in grades 7 to 9 and 11 and .9 in grade 10. The appropriate extent of differentiation is indicated by the mean performance (achievement) measure and standard deviation per grade. The hypothesis that lower grade students would find the test more difficult, which would result in lower performance measures, whereas higher grade students would find it easier with higher performance measures proved to be right. The mean performance measure of grade 6 students was 41%, while that of grade 11 students was 72%, which suggests that major development could be seen between grades 6 and 11 in the field examined.

Table 28: Descriptive statistics of the large-scale test across grades

Grade	Cronbach-α	Minimum	Maximum	Mean	SD
Grade	Cronbach-u	(%)	(%)	(%)	(%-point)
6	.830	.00	95.45	41.60	16.13
7	.871	6.82	95.45	47.58	17.83
8	.884	4.55	95.45	52.58	18.77
9	.876	13.64	97.73	64.98	17.96
10	.904	.00	100.00	62.92	20.16
11	.884	15.91	100.00	72.44	16.07

Appropriacy of the range of task difficulties for the spread of students' ability levels

Appropriacy of the range of task difficulties for students' ability levels also reflecting the mean ability levels of grades is shown in the person-item location distribution of Figure 32. On the whole, the test proved to have the right range of task difficulties for the sample examined. However, covering the ability scale is not perfectly even. Items with an appropriate difficulty level for the modelled average ability level (logit 0) of 6-11 graders are missing. In case further development of the test should follow, deletion of the last item (item 44) and its substitution by an easier one was considered. However, further investigation of the task difficulties per grade provided valuable, detailed information about how suitable the difficulty levels of the items are for each grade.

Overall review of the task difficulties suggested that in the primary school grades 6-9 the lowest ability level (easiest) items; in the lower secondary grades 9-10 the lowest ability level (easiest) and the highest ability level (most difficult) items, while in the upper secondary grade 11 the highest ability (most difficult) items appeared to be missing. The apparent lack of both the lowest and the highest difficulty level items in grades 9-10 suggests that the representation of different types of secondary school in the sample might be held responsible for this wide spread of distribution – as it is later discussed in the passage *The development of the ability of accessing information. Differences between genders and grades across and within grades 6 to 11.* 

A more thorough examination of the suitability of the difficulty levels of the existing items per dimensions per grade revealed the areas of possible future test development. The findings are summarized in Appendix 13, Table 40. In grade 6, in both dimensions the lower ability level (easy) items are missing. It suggests that the actual ability levels were lower than

expected during test development. In grade 8, missing tasks could be found related to both lower and higher ability levels only in one dimension, that is dimension 2 (the dimension which involves the operation of abilities necessary for finding less easily accessible information). However, it would be favourable to have more items related to dimension 1 as well. The further we go up on the grade scale, the more ability levels we find with missing items in both directions: easy and difficult ability levels/items. The phenomenon, which might be regarded as irregular, is that in secondary school grades 10 and 9 – as in primary school grade 8 – in dimension 2 we can still find students around the ability level -4. But at the same time, in grade 10, ability level 4 at the higher end of the ability scale also appears to be with no items. This phenomenon confirms the findings about the representation of different types of secondary school in the sample discussed in the passage The development of the ability of accessing information. Differences between genders and grades across and within grades 6 to 11. In line with the discrepancy between the distribution of ability levels in grades 9-10 and other grades, changes in the developmental trend of the information searching abilities (demonstrated by the logistic curve) could be detected between grades 9 and 10. Secondary technical school students' ability level differences might have caused the change. Further research would be needed to reveal the causes. Contextualisation in an international and national context would be interesting. However, the author has found no relevant literature so far regarding the construct investigated.

In grade 11, in dimension 1, items appropriate for the higher ability levels (logits 2 to 4.5) appear to be missing, while in dimension 2 the lower ability level (logits -3 to -2) items would be needed. Regarding item 44, which was earlier considered for deletion (by looking at the entire test across grades), in grades 11 and 10 in dimension 2 it appears to be appropriate in terms of difficulty. Further elaboration on the nature of the dimensions is needed so that the direction of the development of further items for two ability levels in one dimension could be realized. Only one characteristic, for example, the distance of information (given in the number of mouse clicks) from the home page of a website, might not be sufficient to devise multiple tasks appropriate for the whole ability range of an ability level in one particular dimension.

Possible further development will have to focus on covering the ability range more evenly and including more items on the required difficulty level of the respective grades in the test.

Overall, the ability level of grade 6-11 students falls within the interval defined by the item difficulty levels of the test. Moreover, major ability level gaps were solved on an individual level as well and devising a test which measures on a wide difficulty range was successful. Major differences between the grades were detected ( $\chi^2$ =33353.63; df=5, p<0.001). Differences within and across grades is also dealt with in detail, concerning research question 4 on dimensionality.

In the part of the person-item location distribution representing students, the distribution curve has two modes (see Figure 17). When observing the item-person maps of each grade, the same phenomenon could be detected. It is assumed that the reason for this bimodal distribution could be the separation of the two kinds of abilities that are in operation when solving tasks related to simple, easily accessible or more complex information with a more difficult path (see Appendix 8, Figures 38-49). Empirical examination of this hypothesis is given in the following passage.

# Assessing dimensionality of the test construct

Regarding the third research question whether the abilities operating simple and complex information search are separated, dimensionality assessment was carried out applying Mplus software (Muthén & Muthén, 1998-2010). The results of the analysis showed good fit of both the one-dimensional (CFI=0.936, TLI=0.933, RMSEA=0.037) and the two-dimensional model (CFI=0.939, TLI=0.935, RMSEA=0.037; See Table 29) to the data with respect to the entire sample. However, based on the special  $\chi^2$  difference test comparing nested models, the two-dimensional model fit proved to be significantly better. Consequently, the ICT literacy component *accessing information* could be regarded as not a one- but a two-dimensional construct.

The confirmed hypothesis was that distinct abilities operated finding primary information accessible only a short search path away (for example, on the home page of a website or one mouse click away) or accessing information which could be obtained by following a longer and possibly more complex path (for example, several mouse clicks away or needing to visit different sources of primary information to retrieve the one needed while using short term memory). However, further, large-scale investigation of dimensionality might reveal further factors playing a significant role in information search, for example, different cognitive abilities such as mathematical ones, or the sources of information (text, image, graph or table).

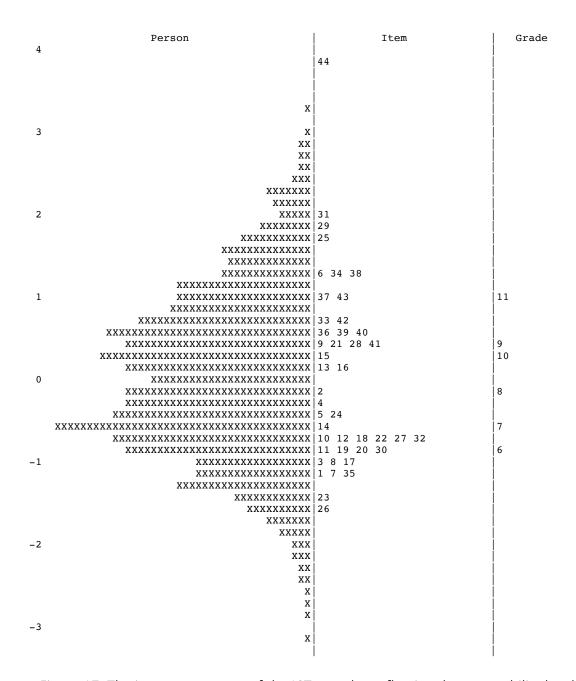


Figure 17: The item-person map of the ICT test also reflecting the mean ability levels of grades (every 'X' representing 16 students)

Grade-level analysis also confirmed the results received concerning the entire sample. With respect to grades 6 to 11, the two-dimensional model showed a significantly better fit to the data in every grade than the one-dimensional one. As a result, it was empirically confirmed, that finding information which is one or two clicks away needs different abilities from those needing more complex search paths.

Table 29: Goodness of model fit of the one- and the two-dimensional model

Sample	Model	$\chi^2$	df	р	CFI	TLI	RMSEA	$\chi^2$	df	р
Entire -	1-dim.	11074.57	739	.001	.936	.933	.037	291.5	1	<.001
	2-dim.	10361.00	738	.001	.942	.939	.036	291.3	1	<.001
Gr. 6 -	1-dim.	3673.22	739	.001	.891	.885	.036	597.5	1	<.001
Gr. o -	2-dim.	3429.07	738	.001	.900	.894	.035	397.3	1	<.001
Gr. 7 -	1-dim.	2363.34	739	.001	.937	.934	.030	66.77	1	<.001
GI. 7 -	2-dim.	2255.45	738	.001	.941	.938	.029	- 00.77	1	<.001
Gr. 8 -	1-dim.	2272.18	739	.001	.945	.942	.031	- 76.62	1	<.001
GI.O	2-dim.	2153.93	738	.001	.949	.946	.030	70.02	1	<.001
Gr. 9 -	1-dim.	1583.01	739	.001	.922	.918	.033	50.86	1	<.001
GI. 9 -	2-dim.	1506.90	738	.001	.929	.925	.032	30.60	1	<.001
Gr. 10 -	1-dim.	1720.14	739	.001	.935	.932	.038	38.13	1	<.001
G1. 10 -	2-dim.	1661.96	738	.001	.939	.936	.037	36.13	1	<.001
Cr 11	1-dim.	1202.01	739	.001	.896	.891	.033	26.75	1	1 001
Gr. 11 –	2-dim.	1181.78	738	.001	.901	.895	.032	26.75	1	<.001

Note: The special  $\chi^2$  difference test comparing nested models (DIFFTEST) was used.

After having confirmed the two-dimensional model, repeated application of the analyses used to answer the second research question was carried out. Ability levels which can be plotted based on the achievements in the two dimensions, in line with the difficulty level of the items belonging to the different dimensions are presented in detail in the item-person map in Figure 18. According to the result, it could be claimed that the two modes found earlier in the distribution could have been caused by the two-dimensionality of the ability in focus. Mean performance of students in tasks related to easily reachable information was one logit higher than in tasks requiring more complex search. However, many actions are operated commonly by the two dimensions, as the correlation between performance in the two dimensions is also significant (r=0.92, p<0.001).

Both dimensions included easy and difficult tasks. Easier information seeking tasks scattered on a wider scale than more difficult information seeking tasks. It could be explained by the fact that identification of the number of clicks and the ease of finding the information were always counted from the home page of the given website. However, to make the test as authentic as possible, the state of the browser was not reset to the home page when the student was given a new question. As a result, the information sought for might have only been

one click away from the main page but several clicks away from the point the student started his or her search from. Nevertheless, the dimensionality analyses confirmed the assumption that searching for information with a simple or complex tracking path needs the operation of different abilities.

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Figure 18: The two-dimensional item-person map of the ICT test.

Performance in the tasks referring to more easily (Dimension 1) and less easily (Dimension 2) reachable information are dealt with in separate dimensions (Each 'X' represents 32 students.)

A closer look at the item-person maps and comparing the one- and two-dimensional item-person maps per grade gives way to further considerations. The bimodal distribution of

the one-dimensional model might refer to different phenomena. It might mean the twodimensionality of the construct, indicating that the access component of ICT literacy measured has two different dimensions, that is different abilities are activated for solving one of the sets of tasks from those activated for solving the other set of tasks. It might also indicate the existence of two sub-samples within the sample, which could be distinguished along ability levels. It might also refer to the lack of average difficulty tasks together with the lack of corresponding student ability levels. Having confirmed the two-dimensional model, there is a high probability that the bimodal distribution shown in the one-dimensional item-person map suggests the two-dimensionality of the construct. In the one-dimensional model two sub-sets are shown on the item-person map. One sub-set (the 'more difficult' task set) has its mode around logit -1 with related items (6, 9, 13, 15, 16, 17, 21, 25, 28, 29, 31, 33, 34, 36, 37 and 44). Another sub-set could be seen in the one-dimensional model with a mode slightly below logit 0 with related items (1, 2, 4, 5, 7, 8, 10, 11, 12, 14, 18, 19, 20, 22, 23, 24, 26, 27, 30 and 32). The first sub-set of the one-dimensional model could be identified with dimension 2 in the twodimensional model and the second sub-set might be identified with dimension 1 in the twodimensional model (see Figures 17-18).

Analysis of the item-person maps of the one- and two-dimensional models per grade reveals further information about the range of ability levels of the actual grades. In general, in case of four of the six grades (6, 8, 9 and 10) the one-dimensional item-person maps show a wider range of ability levels than what could be seen in case of the two different dimensions (easier and more difficult tasks). In grade 6, ability levels are between logits -3 and +2 in the one-dimensional model but between logits -2 and +2 and logits -3 and +1 in the 'easier' and 'more difficult' dimensions. It might suggest that the two-dimensional models provide more accurate information about the level and nature of the abilities needed for successful completion. However, we must take into consideration the fact that in the one- and two-dimensional item-person maps the number of cases represented by one x is not the same. The lower number of cases represented by an x, the wider the range of abilities appear to be present. Still, it could be said that the two-dimensional item-person maps provide more detailed information about the characteristic features of the construct (see Appendix 8: Figures 38-49: Item-person maps of the grades in the large-scale ICT literacy test).

Having the two dimensions on the same scale, interpretations based on the comparisons of the two dimensions could be made with more certainty. The two dimensions are clearly distinguishable from each other by having at least one-logit difference between them: the 'easier' tasks in dimension one make students ability levels appear at least one logit higher in general than the 'more difficult' tasks in dimension two (see Appendix 8: Figures 38-49: Item-person maps of the grades in the large-scale ICT literacy test). However, in higher grades (the secondary school level grades 9-11), in dimension two (in the 'more difficult' tasks) the ability levels deviate more and are scattered along a wider ability range than in dimension one (in the 'easier' tasks). In grade 6, ability levels are between logits -2 and +2 in the 'easier' and logits -3 and +1 in the 'more difficult' dimension of tasks. In grade 7, between logits -2 and +3 for dimension one and between logits -3 and +2 for dimension 2, in grade 8 the values are -2/+3 and -3/+2. From grade 9 to 11 this pattern changes. In grade 9, the values are -2.5/+3.5 (6 logits) for dimension one but -4/+3 (7 logits) for dimension 2. In grade 10, the values are -2/+4 (6 logits) and -4/+4 (8 logits), in grade 11 the values are -1.5/+4.5 (6 logits) and -3/+4 (7 logits). The greatest difference between the range of ability levels in the two dimensions could be detected in grade 10, where there is a two-logit difference. Further research is needed to reveal the reason. It could be assumed that the same cause as the one suspected behind describing the developmental trend across grades (see Figure 17 and its description), that is the representation of the different types of school in the sample, lies behind these differences, too. The diversion might have been caused by the ability level difference between students of secondary technical schools ('szakgimnázium'), which has caused the ability levels to appear on a much wider range in dimension 2.

The distribution of the students and items in the item-person maps per grade reveals that the items do not cover the whole ability range of students in either grade or dimension. For grade 6 easier tasks are missing in both dimensions. However, in dimension two except for 4 tasks appearing below logit -1, average level items are also missing. The situation is about the same in grades 7 and 8, whereas in grade 9 and 10 students' ability levels have shifted towards the higher levels, as a result, both easier and higher level items would be needed for them. In grade 11, higher ability level items appear to be in demand.

Table 30: Numbers and names of items grouped

No.	Name of item	No.	Name of item
1	1.dekor.02_b	23	3.aqua.01_d
2	1.dekor.03_c	24	3.aqua.03_b
3	1.dekor.05_a	25	3.aqua.04_d
4	1.dekor.06_a	26	3.aqua.05_c
5	1.dekor.07_b	27	3.aqua.06_d
6	1.dekor.08_b	28	3.aqua.07_c
7	1.dekor.09_a	29	3.aqua.08_c
8	1.dekor.10_c	30	3.aqua.11_a
9	1.dekor.11_1	31	3.aqua.12_abc
10	1.dekor.12_1	32	3.aqua.13_c
11	1.dekor.13_1	33	3.aqua.16_b
12	2.repul.02_b	34	4.si.01_b
13	2.repul.04_b	35	4.si.03_c
14	2.repul.05_a	36	4.si.04_a
15	2.repul.06_d	37	4.si.05_d
16	2.repul.07_c	38	4.si.06_abcde
17	2.repul.08_d	39	4.si.07_d
18	2.repul.09_b	40	4.si.08_a
19	2.repul.10_b	41	4.si.09_b
20	2.repul.12_a	42	4.si.11_b
21	2.repul.14_d	43	4.si.12_a
22	2.repul.16_c	44	4.si.13_abd

Table 31: The grouping of the items (1-44) into two dimensions (D1 and D2) according to confirmatory factor analysis

							Items						
Dimension 1	1	2	3	4	5	6	7	8	9	10	11	12	13
Dimension 1	14	17	18	19	20	23	24	26	27	28	29	35	37
Dimension 2	15	16	21	22	25	30	31	32	33	34	36	38	39
Dimension 2	40	41	42	43	44								

The development of the ability of accessing information. Differences between genders and grades across and within grades 6 to 11

In terms of the success in accessing information, a rising tendency of students' ability levels per grade could be detected (Figure 19). On average, grade 6 to 11 students' ability levels grew by one third standard deviation per year, which suggests a more rapid development than what had been experienced about abilities not explicitly improved at school (Molnár et al.,

2013). As a comparison, inductive reasoning develops by about one quarter standard deviation per year (Molnár et al., 2013), which implies a slower pace of progress. Further review of the literature in an international and national context might reveal valuable findings in terms of the development of various abilities. However, no exact data have been found regarding the developmental trends of students' ICT-related abilities or components of ICT literacy.

The coefficient of determination was  $R^2$ =.98. The four-parameter logistic curve fitted the empirical data adequately. In line with descriptions of the development of other abilities, the logistic curve with its parameters described the ability to access information appropriately.

The most intensive phase of development, twice as rapid as the average rate of annual development (12.4 % point), could be seen between grades 8 and 9, which is confirmed by the position of the point of inflexion of the curve (8.84). After grade 9, the rate of development apparently slowed down. The behaviour of the curve is different from those seen in case of thinking skills, where the pace of development was significantly slower, with a point of inflexion of the curve positioned at grades 6 and 7 (Molnár et al., 2013). The underlying cause could be that although the ability of accessing information in not necessarily explicitly improved at school, students' everyday browsing activities spontaneously develop their abilities of the kind.

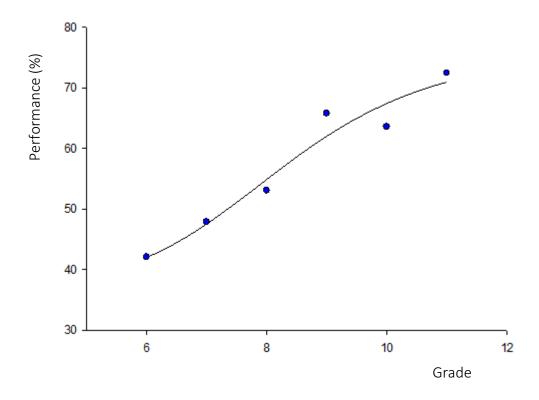


Figure 19: Development of the ability of accessing information across grades 6 to 11

Further research is needed to reveal the causes of the changes between grades 9 and 10. It could be assumed that the representation of the proportion of the different types of school in the sample could be held responsible for the diversion. If the performance of grades 9 and 10 secondary grammar school ('gimnázium') students, who were highly represented in the sample (85% of the sample in grade 9, 80% of the sample in grade 10 and 92% of the sample in grade 11) was compared, this phenomenon could not be seen. The performance of grades 9 and 10 grammar school ('gimnázium) students was not significantly different (t=0.517. p>0.05). The diversion was caused by the ability level difference between grades 9 and 10 students of secondary technical schools ('szakgimnázium').

In accordance with what had been experienced about other abilities, analysis per types of school (See Table 32) detected significant differences between the abilities of students of the same grade but different types of school. [Due to the low sample size, classes of vocational schools ('szakközépiskola', formerly 'szakiskola') were deleted from the sample.] After-primary-school (junior school and middle school) selection intensified the differences between students attending the same grade but different type of school. The rate of difference grew even greater during the years of secondary education with an average rate equivalent to one year's development on grade 9 and two years' on grades 10 and 11. However, restrictions on generalising the results across types of school have to be made because of the different rates of representation in the sample.

Table 32: Performance of different grade students across types of school

Grade	Type of school	N	Mean	SD	t	р	
9	Secondary Technical School	127	59.52	17.45	2 02	~ 001	
9	Secondary Grammar School	878	66.03	17.97	3.83	<.001	
10	Secondary Technical School	182	52.57	19.67	7.97	<.001	
10	Secondary Grammar School	726	65.55	19.50	7.97	<.001	
11	Secondary Technical School	33	61.09	18.10	2 02		
11	Secondary Grammar School	528	73.44	15.55	3.83	<.001	

Within the grades, the rate of ability level difference detected was equivalent to several year's difference (Figure 20). The ability level differences within the grades appeared to be greater than between grades 6 and 11 in general.

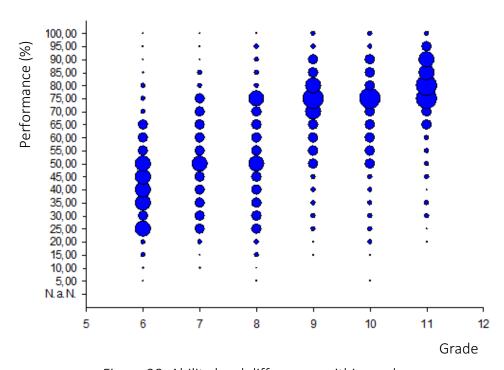


Figure 20: Ability level differences within grades

The great extent of differences is shown by the fact that even among grade 6 students the performance of some rivalled with that of students from the highest-level grade 11 students. At the same time, some 11th-graders' ability levels were only as low as that of the lowest ability level 6th-graders.

Based on the analysis the aim of which was to reveal the correspondence and differences between the two genders, it could be stated that regarding the entire sample, girls significantly outperformed boys (Mean\_girls=53.97; SD\_girls=19.58; Mean\_boys=48.71; SD\_boys=20.20; t=-13.19, p<.001) and boys' results had a higher variability than those of girls. In other words, a greater rate of difference could be detected between the highest and lowest performing boys than the one between the highest and lowest performing girls. According to the analysis across grades, the performance differences within the primary school grades could be accounted for the mean performance difference in terms of the entire sample, as no difference between the results of the two genders could be seen in secondary school.

In primary school, higher ability levels could be associated with a generally higher level of reading literacy (Balázsi, Lak, Ostorics, Szabó, & Vadász, 2016) because the students had to rely on their reading literacy while solving the tasks. However, on the other hand, this assumption was not confirmed by the data from secondary school students, where contrary to research into the levels of reading literacy in an international context (OECD, 2016; Ostorics, Szalay, Szepesi, & Vadász, 2016), girls had no advantage over boys in this field.

Table 33: Differences between the performance of genders across grades

Grade	Gender	N	Mean	SD	t	р
6	Воу	1524	39.48	16.01	-7.33	<.001
Ь	Girl	1505	43.75	15.97	-/.55	<.001
7	Воу	1164	44.41	17.87	0.74	4 OO1
7	Girl	1195	50.75	17.33	-8.74	<.001
8	Воу	1035	50.02	18.54	-6.36	<.001
Ŏ	Girl	1072	55.18	18.66	-0.30	<.001
9	Воу	454	64.31	17.88	1 00	n c
9	Girl	576	65.54	18.02	-1.09	n.s.
10	Воу	368	62.19	20.93	1.00	<b>D</b> 6
10	Girl	535	63.67	19.59	-1.09	n.s.
11	Воу	244	72.08	16.94	63	n. c
11	Girl	322	72.95	15.28	03	n.s.

Summarising the findings in this fourth phase of the research project, analyses regarding the development of the ability of accessing information showed a faster pace development than it had been seen in earlier research in case of other abilities not explicitly improved at school. In earlier research, it was found that the quantitative change of the development of abilities could be described by a four-parameter logistic curve (Molnár & Csapó, 2003; Molnár et al., 2013). Likewise, the development of the ability to access information confidently and effectively in an online environment, could also be represented by a logistic curve with four parameters: the lowest and highest response probabilities, the steepness of the curve and the point of inflexion, where the curvature of the response line changes. The most intensive period of development falls in grades 8 and 9. Within each grade, significant performance differences among students could be detected. Regardless of the grade, both students with the highest achievements and those with the lowest achievements

are on approximately the same ability level, however, their ratios change over time. Analyses according to type of school confirmed the findings regarding other abilities, that is the differences between students in different types of school are huge and could be measured in years. When analysing the differences between genders, on average, the advantage of girls could be seen, however, extreme performance among boys could also be detected. Significant differences (p<.001) were detected between the achievements of the girls and the boys – in favour of the girls – in the lower grades of public education: grades 6, 7 and 8. The greatest difference were detected in grade 7 (t=-8.74), then in grade 6 (t=-7.33). Significant gender differences in the field disappeared by the years of secondary school.

Background variables in the questionnaire were also investigated to detect relationships between them and the performance of the students in the test (H6). Looking at the relationship between the test results and students' academic achievements – that is end of year grades in different subjects, diligence and conduct – significant correlations (p<.001) were found across all grades among all thirteen subjects (foreign language, Hungarian, mathematics, science, history, biology, physics, geography, chemistry, music, information technology, art, physical education), diligence, conduct and the ICT literacy test results. The latter two academics related categories given in Hungarian public educational settings reflect students attitude towards learning and education. Stronger (medium) significant correlations (p<.001) were found across all grades between the results in the ICT literacy test and students grades in foreign language (r=.439), Hungarian (r=.435), mathematics (r=.433) and science (r=.411) and weak, significant correlations with the rest of the fields. Stronger – medium –, significant (p<.001) correlations were found between the ICT literacy test results and the subjects in lower grades (6-8), while in higher grades the significant correlations tend to be weak only, the level of significance is lower in some cases, or the correlations are not significant. Unlike in lower grades – negative correlations are also detected. Table 37 in Appendix 9 shows that in grade 9 only eleven from fifteen subject-related areas (including diligence and conduct) are correlated on a high (p<.001) significance level with the test results: foreign language, Hungarian, mathematics, science, history, biology, physics, geography, chemistry. Conduct and P.E. are not correlated with the ICT test results and music is negatively correlated in grade 9. In grade 10 fourteen subjectrelated fields correlate significantly and on a high significance level (p<.001) and music is not significantly correlated. Art is negatively correlated with the ICT test results in grade 10 as well.

In grade 11 only nine of the fifteen areas are marked as significant ones on a high level (p<.001), two with a lower significance (p<.005) level and biology, P.E. and art are not significantly correlated with ICT test results. Art is also negatively correlated.

Regression analysis was also carried out to investigate further relationships between variables in the self-reported questionnaire and the results of the performance assessment test. Various fields of students' confidence in online information search-related activities were used as independent variables, while the result of the performance assessment test of the access component of ICT literacy was used as the dependent variable. The proportions of variance of dependent variable explained by the independent variables are shown in percentages. (Beta coefficients were multiplied by the correlation coefficients per grade and then multiplied by 100). Values whose significance was below p<.05 were put in brackets (Appendix 11, Table 38).

Regression analyses based on the results of the performance assessment test and the self-reported confidence variables related to accessing information had very different results across grades. Identical variables explain 13.7% of all known effects in grade 6, while 27.1% in grade 7 and 31.5% in grade 8. A huge diversion could be seen in grade 9, where only 2.7% of all known effects could be attributed to the variables. This might be because of changing educational levels (transferring from primary to secondary education), where they might not be able to assess their confidence realistically and under- or overestimate it). Consequently, their falsely rated confidence might not predict their success in the performance assessment test. The most significant predictors of success in the online information searching (ICT literacy) test across grades are confidence in reading different sources (school course books, digital texts - clickable or non-clickable, online or just on the computer screen) handling roll-down menus, evaluating the sources in terms of appropriacy for the actual goals, and confidence in online security. This latter variable played a significant role in predicting success in the information searching (ICT literacy) test in four of the six grades examined. It was probably because without feeling safe in an environment individuals are not willing to and able to engage in activities efficiently as safety is a major concern (Wanless, 2016). As a result, only confident individuals will be successful. The fact that reading and evaluating information were of great predicting power was not surprising as the literature regards both reading and evaluating factors closely related to information search (Henry, 2006).

#### 4.4.6. Limitations

Despite the considerably huge sample number, generalization of the findings should be restricted by certain factors. One of these factors is the constraints of the sampling method. The sampling method used was accidental (as opposed to random), which means that convenience sampling based on availability (Etikan, Musa, & Alkassim, 2016) was used involving the students of the schools volunteering to participate in the research. Consequently, the sample was not representative of region, type of school, grade or gender. Within the sample, secondary school grades are underrepresented compared with primary school ones.

When interpreting the results at the present state of the research, no specifications of the levels of education were separated, therefore, no subtypes of education (for example, 4-, 6- or 8-grade secondary schools, foreign language preparatory grades, secondary grammar or technical schools) were dealt with separately. Within ICT literacy, assessment of the ability of grades 6 to 11 students needed for effectively accessing information online does not fully cover the entire population to be mapped. Due to the low sample number, vocational school classes were excluded from the analysis according to types of school.

While testing dimensionality, dividing information into the categories *easily accessible* and *not easily accessible* could be restricted by the fact that categorization was partly based on the distance of the target information (the length of the path) from the home page (as starting point) of a website indicated by the number of the minimum necessary mouse clicks. However, when starting a new item within the same website, the students did not necessarily start searching from the home page but, for the sake of higher authenticity, from the point they stopped searching for the answer to the previous item. Consequently, the student might have been several mouse clicks away from the home page.

A further restriction could be made owing to the fact, that no parallel reading ability or literacy assessment was made. As a result, no specific relationship between the abilities behind reading literacy and effective online information accessing could be measured. Hypotheses could only be formed based on national and international literature regarding reading competences and literacy (the terms used based on the foci of assessment in the literature).

Finally, the fact that the present research focussed on only one (although the most essential) of the seven components of ICT literacy, namely accessing information effectively through browsing online as opposed to the entire ICT literacy of students of the grades in question, could also be regarded as a restriction.

## 4.5. Conclusion and further opportunities

The overall objective of the entire research project was to examine the reliable use of an authentic measurement instrument in a computer-based environment, devised for and aimed at the assessment of ICT literacy focussing on the most fundamental *access* component in a wide age spectrum in public education settings. According to the results, devising and applying a reliable, third-generation online test giving instant feedback on the level of grade 6 to 11 students' ability to browse online confidently and efficiently, in other words to gauge the confidence of students in the access component of ICT literacy, was successful.

Further importance of the research is that educators can get instant feedback on the level of their students' indispensable, 21st century skills and ability to confidently and efficiently access information in a computer-based environment, which setting is identical with that of the ability assessed. The volunteering schools are not only given instant, but a more detailed feedback on the results. Their volunteering might suggest that their innovative teachers feel responsible for the development of their students' abilities in the respective fields. It is hoped that these teachers will find the ways to develop those abilities of their students that need improvement, however, development strategies are beyond the scope of this research.

The issue of the possible hindering effect of an instant feedback for low-achiever students or ones with a low self-esteem might be raised. However, a decision had to be made whether to give an instant feedback or not. And in our online-game-based world, where youngsters might be used to being given constant and instant feedback, our decision fell on having this option. On the long run, such information about their abilities might raise their awareness of their weaknesses and might result in their stronger willingness to develop their skills and abilities.

Furthermore, it was analysed how the difficulty levels of the items devised fitted the ability levels of the students of the grades examined. The difficulty level of the items of the test in general proved to be appropriate for the sample. As the test differentiated the students well, its applicability for diagnosing the effectiveness of grade 6 to 11 students' online browsing activities was proven.

Analysis of how the data fitted the theoretical model as the basis of devising the assessment instrument was carried out to certify the validity of the test. Throughout analyses the assessment model was confirmed. The access component of ICT literacy could be characterised by two dimensions: finding the easily accessible information with a short and simple path, and the less easily accessible, more complex information with longer and less simple paths.

The changing of the effectiveness of accessing information was mapped across genders and grades. In accordance with the hypotheses, significant differences were detected between the ability levels of accessing information of the boys and girls regarding the entire sample in favour of the girls. In terms of performance differences across grades and genders, girls' advantage over boys was only detectable in the primary school grades of 6 to 8, and not in the secondary school grades of 9 to 11, presumably because of the higher level of reading literacy of girls certified by research into this field.

As it had been hypothesized, overall, the ability of students to access information showed a continuous development between grades 6 to 11 despite the great differences within grades. On average, students' ability levels grew by one third standard deviation per year. It is a more rapid development than that of abilities not explicitly improved at school. The reason could be the spontaneous self-developing effect of students' independent browsing activities, as no specific, targeted improvement of this component of ICT literacy takes place in school.

The development could be represented by a four-parameter logistic curve (fitting data) already used to describe the development of other abilities, whose steepest part demonstrating the most intense development is at grades 8 and 9. After grade 9 the pace of development slowed down. Compared with the development of thinking skills, where the point of inflexion of the logistic curve is at grades 6 and 7, the behaviour of the curve describing the development of the abilities needed for confident and effective browsing is different, having its point of inflexion positioned later, at grades 8 and 9 underlining that for effective

information seeking a certain developmental level of thinking skills is a prerequisite (Catts & Lau, 2008). Abilities needed for finding information could develop based on thinking skills.

Analysis of the results from four different approaches revealed that secondary school level grades' results did not follow the same pattern as those of other grades'. According to the comparison of the item-person maps of the two dimensions in higher grades (the secondary school level grades 9-11) showed that in dimension two (related to the less easily accessible information searching tasks) the ability levels deviated more and were scattered along a wider ability range than in dimension one (in the more easily accessible information searching tasks). The greatest difference between the range of ability levels in the two dimensions could be detected in grade 10, where there was a two-logit difference. Looking at the logistic curve representing the development of the ability of accessing information across grades 6 to 11 also raised the question regarding the causes of the changes between secondary school grades 9 and 10. Detecting the correlations between academic achievements - that is end-of-year grades (marks) in academic subjects, diligence and conduct also drew the attention to diversions of secondary school level results from those of lower level grades (years). Further research is needed to reveal the reasons for the change between grades 9 and 10 and the diversions of secondary school results from those of lower grades (years) of public education, to find answers to the questions whether they were caused by the uneven representation of the different types of school in the sample.

Also, several years' difference could be seen within the grades, which results in greater ability level differences within each grade than across grades 6 to 11 on average. The causes of these ability level differences within grades together with background variables could be the subject of further research as well.

Further elaboration on the nature of the dimensions is needed so that the direction of the development of further items for two ability levels in one dimension (for example, logit 2 to 4.5 in dimension 1 in grade 11) could be realized. A future research question could be what characterises the dimensions exactly besides the distance – measured in mouse clicks – of the information from the home page and the complexity of the item.

## 5. Summary of Results

## 5.1. Summary

In this dissertation, after reviewing the related literature on ICT literacy and ICT literacy assessment as well as having an insight into the research concerning the theory and assessment of information search in both international and national contexts, the four phases of a test development project were described. Each phase was planned as a further step towards the development of a 21st century, third-generation, simulation-based, online assessment instrument to test those abilities of grades 5 to 11 students which are operated to access information online confidently, in a digital environment, using computers, as in the assessment instruments applied in international contexts.

The test development also reflected the author's advancement in research alongside the four-phase evolution of a simulation-based performance assessment test. The first phase included an online questionnaire on self-reported confidence in computer and internet use, students' confidence in interpreting online and offline information, their frequency of computer and internet use, their technology-related habits and attitudes and different variables of their socio-economic background and gender. The second phase included a partly simulation-based test to assess multiple aspects of ICT literacy. Besides students' ICT literacy regarding their confidence in accessing information online, also their confidence in basic technology use and confidence in evaluating the usefulness of given sources of information was assessed. At the same time, students' cognitive abilities and the cognitive aspect of ICT literacy was also gauged. Students' achievements in the performance assessment test were compared with their responses to the questions in the questionnaire regarding their confidence in information search related activities and factors. Generalised item response modelling software was applied to analyse the operation of the items and their characteristics. This resulted in a selection of 16 items which worked appropriately. The results of this phase also focused our attention on further improving both the internal consistency of the test and on developing items for the higher and lower ability levels as well. As a following step, the third phase included a more uniform, fully simulation-based performance assessment test solely focusing on accessing online information. This fully simulation-based, third generation performance assessment test then was further developed by omitting again the items that failed to contribute to the reliability of the test because of their poor item-total correlations statistics. In the fourth phase a large-scale assessment was administered to measure in a focused manner one component, the accessing information component of students' ICT literacy.

Through all the phases of the research the parallel goals of assessment instrument development – to gauge grade 5-11 students' ICT literacy – and application of the instrument to measure students' ICT literacy from various perspectives were set. Each piloting phase added a new perspective to the research project as each phase had an additional focus. Besides gradually extending the number of grades involved within the grade range of 5 to 11 – from two, three, four and finally seven grades - in the successive phases of the research, an expansion of the methods could be experienced. While in the first phase only analysing students' responses to a self-reported questionnaire, and testing the reliability of the questionnaire devised took place, in the second phase applying the same questionnaire together with a newly developed, imitation- and simulation-based performance assessment test, comparing the results of the two instruments (by analysing correlations between the responses to each), and analysing the items (in terms of discrimination, difficulty, appropriacy for the ability levels of the grades and model fit) commenced. Based on the literature suggesting simulation-based assessment as the authentic method for testing ICT literacy, in the third phase the focal point was further item development aiming at the highest possible level of test authenticity, reliability and validity with a good model fit to prepare the final phase of the large-scale assessment. During the fourth phase a large-scale assessment applying the fully simulation-based, authentic, third-generation performance assessment test was administered together with the perfected questionnaire so that relationships between the background variables and the test results could be detected by correlation and regression analysis. As well as reconfirming the validity and dimensionality of the measurement instrument by using a structural equational modelling software, the focus in this phase was identifying developmental characteristics of the abilities operating the activities which result in confident and successful online information search, that is, the access component of ICT literacy.

Besides, the evolution of the assessment instrument and the expansion of its tool, the online eDia platform (to facilitate the embedding of simulated websites) were processed simultaneously, however independently. From the third phase, eDia online assessment platform was ready for the implementation of a simulation-based ICT literacy component assessment in public educational settings.

## 5.2. Results and to what extent hypotheses were confirmed

While introducing all the hypotheses and results of the respective phases of the research project in earlier chapters, detailed description together with theoretical background was given. In this summarising chapter, we dispense with the repeated references to the literature. Instead, the results are contrasted with what was hypothesized at the beginning of each phase. The aim of this is to provide a comprehensive re-examination of the findings.

## 5.2.1. The first phase of the research project

As regards the results of the questionnaire with a proven reliability (Cronbach's  $\alpha$ =.85) (H6) in the first phase, our hypothesis (H1) regarding students confident use of social network sites appears to be confirmed: almost 80% of the students felt totally confident in finding information by navigating on social network sites with nearly 70% of students admitting visiting social network sites several times per week. Our hypothesis (H2) regarding higher numbers of students totally confident in decoding audial or visual imagery information than in paper-based printed information was confirmed in terms of comparing total confidence in decoding images and printed text: decoding visual information with total confidence reached 60%, while audial information and printed text decoding with total confidence was only 56.9%. It was hypothesized (H3) that grade 7 students would play computer games more frequently than grade 10 students, while the higher-grade ones were expected to be more frequently engaged in online social networking activities, which assumptions were confirmed. We assumed that girls would report themselves more confident in digital reading and typing related activities, whereas boys were assumed to report more confidence in using technology for games based on research by Gentile (2009) (H4). Girls did prove to be more confident in typing (Z=-2.29; p<.01), however, boys' advantage only showed in frequency of online or computer games (Z=-4.11; p<.01). In terms of reading related activities, girls proved to be more frequent blog readers than boys (Z=-3.14; p<.01). It was assumed (H5), that with the lower grade students and girls in general a notable number of students would have less positive attitudes towards using the computer or the internet and had more fears for the negative consequences of computer or internet use. Nearly 85% of the students reported having had negative experience while using the internet and a vast number of students reported having sometimes or rarely ("not really") fears of the negative consequences of computer or internet use. As far as technology use is concerned, the vast majority of the students (84.6%) reported themselves totally confident in using a mouse, the majority (63.1%) found themselves totally confident in using a keyboard for typing characters or words but only slightly over half of them (52.3%) rated themselves as totally confident in using the keyboard for typing texts. The results might be explained by the students' daily encounter with activities involving use of peripherals. Less frequently pursued activities such as typing texts appeared to result in lower levels of confidence. Students felt totally confident in finding information by navigating on social network sites or reading digital texts (nearly 80%).

# 5.2.2. Second phase of the research project

In the second phase of the research project, regarding test development, task difficulty order based on the mean achievements of the students was expected to be 70% identical with the order of activities in the assessment instrument (H1). This assumption was partly confirmed. The actual task difficulty order based on the students' mean achievements was less than 70% identical with the order of activities in the instrument. However, most of the easy or medium tasks were towards the beginning and most of the difficult tasks were towards the end of the test with the lowest mean achievement in tasks 8 and 11-14, in the second part of the test, consequently the direction of the assumed difficulty order in this respect was right. When using Generalised Item Response Modelling software, the analysis of items showed that item difficulty based on item thresholds was roughly identical with task difficulty based on boys' mean achievements. However, it must be highlighted that some tasks — at the end of the test—involved more than one item, consequently no direct comparison could be made between task and item difficulties in case of the last part of the test. Girls' task difficulty rates showed slight diversions.

A relationship was expected between successful task completion – which is related to ability levels and task difficulty – and the time spent completing it across all grades and genders (H2). Strong, significant correlation was detected between the mean time spent on tasks and the mean score achieved in Grade 8 (r=.775; p<.01), significant but weak correlation in Grade 5 (r=-.269; p<.05) and no significant correlation in Grade 10 (see Table 15). The negative correlation in Grade 5 could be caused by the uncertainty owing to the lower level of experience in a lower grade. Or the students who have just entered a higher primary school

(middle school) level in the Hungarian educational system might be frustrated by the burden of performance, which might lead to higher levels of strain and lower results. However, further investigation is needed to reveal the causes.

Regarding our hypothesis (H3) about the possibility of testing students' performance in the access dimension of ICT literacy in 45 minutes – applying the set of tasks in the pilot test – administered across all grades and genders with a probable advantage of the higher graders over the lower ones in terms of speed and achievement, it was confirmed. The mean total time was roughly 10 minutes with approximately 25 minutes being the longest time spent in the test.

The set of tasks in the test were expected to compose a reliable and valid assessment instrument (H4) to gauge students' ICT literacy performance in the access dimension. However, it was presumed that reliability measures could be affected by the sample size. Regarding validity, it was assumed that the requirements of convergent and discriminant validity (to achieve construct validity) could be met by analysing correlations between responses to those parts of the self-assessment questionnaire and the performance test which were expected to be related. Internal consistencies of the questionnaire were high (Cronbach's  $\alpha$ =.91), and the reliability coefficient of the performance assessment test proved to be reasonably high or satisfactory considering the comparatively low number of (only 14) administered tasks, and the limited sample size (Cronbach's  $\alpha$ =.68). Consequently, contrary to our assumption, hypothesis 4 regarding reliability could be confirmed in case of the CAIQ, but not totally in case of the CAIPT. Further development of the test was needed in terms of the number of tasks and items as well as elaborating the existing ones to improve the consistency of the test. By using the item-total correlations analyses as a first step, 16 items were selected from the original set of 24, which resulted in a higher (Cronbach's  $\alpha$ =.74) reliability measure. The eight items selected for deletion had lower than .2 discrimination parameter (unweighted MNSQ), and/or the WLE average of the students giving the right response on the respective items was only slightly higher than that of those giving the wrong response. These items did not discriminate well between high and low ability students. The filtered items also had a low point-biserial parameter indicating the low correlation between the students' total score and the response to the item, which suggested irregular item behaviour.

As far as validity is concerned – contrary to research in an international context (Katz &

Macklin, 2007; Zelman et al., 2011) –, in our case, it could not be observed that all of the measures that are expected to be related would correlate significantly with performance. As a result, our assumption, that the two types of construct validity (convergent and discriminant validity) would be confirmed by the correlations between the responses to online web search-related questions and results of performance assessment tasks was not confirmed. However, another empirical method to test validity of the assessment instrument (structural equational modelling) confirmed the good model fit which was hypothesized (H8). Looking at the Weighted FIT, it could be seen that the Weighted MNSQ was within the confidence interval of all items. Also – because of the small sample size –, mean-squares were expected to be within the range 0.8 to 1.2, which requirement was met by the items of the test. Both results suggested a good model fit.

We expected significant differences in the access dimension of students' ICT literacy between the genders and we expected differences across grades (H5). Taking into account that the genders in the sample were represented at nearly the same proportion, it could be said that hypothesis 5 was partly confirmed. Although the girls' overall performance shown by their mean achievement percentage in 8 tasks – the majority of the tasks – was higher than that of the boys, no significant difference could be detected between the overall mean scores of boys and girls. The analysis of the results of the different grades revealed that there was small difference in routine information seeking tasks between the grades tested (H5).

It was hypothesized that the items would discriminate the students (H6). The Discrimination Parameter Estimate, which denotes the correlation between the students' total score (overall achievement on the test) and the score on the item was over or equal .2 in case of all 16 items. As a result, it could be stipulated that the items worked properly. Regarding item characteristic curves, which are related to the discrimination value of the items, they also visualized the discriminating power of the items already known from the discrimination parameters. 14 of the 16 items could be labelled as low-moderate. In this respect, our hypotheses, that our items would discriminate, were partly confirmed (H6).

In terms of task difficulty (H7), it was expected that the items would cover most of the ability range of the students. The results of plotting the students and the items along the ability scale between the ability levels of -3 to +3 showed that the selected items covered the ability levels from -2 to +2. However, our findings also suggested that development of further items

to cover higher and lower ability levels was needed. Thus, our hypothesis regarding the appropriacy of the items for the ability levels of the students was partly confirmed.

# 5.2.3. The third phase of the research project

Internal consistency was expected to be higher than in the earlier version (H1). Owing to the test development procedures in terms of standardising the framework of the assessment instrument, the reliability measures were high. The internal consistency of the performance assessment test for 61 items was Chronbach's  $\alpha$ =.89. After reducing the number of items applying item total correlation analysis, the reliability measure of the performance test for 45 items was Chronbach's  $\alpha$ =.92. Reliability coefficient of the questionnaire was Chronbach's  $\alpha$ =.91.

In terms of the time needed (H2) for completion of both parts, it was hypothesized that two 45-minute sessions (lessons) – as in the earlier pilot test – would provide enough time for all levels. 90 per cent of the students in each grade spent less than 90 minutes completing the two parts of the test (performance assessment test and questionnaire) altogether.

It was assumed that the performance of the higher-grade students will be better than that of the lower grade students (H3). It proved to be right. The mean performance measure of grade 6 students was 41%, while that of grade 11 students was 72%, which suggests that major development could be seen between grades 6 and 11 in the field examined

Also, higher grade students were supposed to complete both parts of the assessment (test and questionnaire) within a shorter time than lower grade students (H4). It could be seen that the majority of the higher-grade students needed a shorter time to complete both parts of the assessment. The time on task for the whole test on average varied across grades between 72 and 88 minutes.

As regards validity, it was assumed that one dimensional structural equation modelling (SEM) using the Mplus software would result in good fit parameters suggesting the validity of the test (H5). After reducing the number of items from 61 to 45 applying item total correlation analysis, validity measures proved to certify, as expected, a good, one dimensional model fit the RMSEA estimate .028 (C.I. .001, .040; Probability RMSEA<=.05). Consequently, our hypothesis regarding the validity of the assessment instrument (the test) proved to be right.

# 5.2.4. The fourth phase of the research project

As in the preceding pilot research, our hypothesis that it is possible to devise a reliable, third generation online test giving instant feedback on the effectiveness of grade 6 to 11 students' browsing activities – also hypothesized (H1) in this phase – was confirmed. The whole test had a reliability coefficient Cronbach's  $\alpha$ =.94. with mean student performance 51.4% (SD= 19.8% point). In each grade the test proved to be reliable and discriminated students appropriately according to their ability. Internal consistency of the test was demonstrated by Cronbach's  $\alpha$  measures between *over* .8 to .9 across grades. The appropriate extent of discrimination was indicated by the mean performance (achievement) measure and standard deviation per grade.

It was also hypothesized (H2) that item difficulty of the test items was suitable for the ability level of the age group examined. Overall, the test proved to have the right range of task difficulties for the sample examined. Possible further development will have to focus on covering the ability range more evenly and including more items on the required difficulty level of the respective grades in the test. Overall, the ability level of grade 6-11 students falls within the interval defined by the item difficulty levels of the test. Devising a test which measures on a wide difficulty range was successful. However, major differences between the grades were detected ( $\chi^2$ =33353.63; df=5, p<0.001).

Two dimensions (H3) were assumed to characterise the accessing information component of ICT literacy. It was presupposed that distinct abilities were needed to operate finding primary information accessible only a short search path away (for example, on the home page of a website or one mouse click away) or accessing information which could be obtained by following a longer and possibly more complex path (for example, several mouse clicks away or needing to visit different sources of primary information to retrieve the one needed). In the part of the person-item location distribution representing students, the distribution curve has two modes (see Figure 17) in each grade. The reason for this bimodal distribution might be the separation of the two kinds of abilities that are in operation when solving tasks related to simple, easily accessible or more complex information with a more difficult path (see Appendix 8, Figures 38-49). The dimensionality analysis followed by special  $\chi^2$  difference test comparing nested models, showed the two-dimensional model fit significantly better than the one-

dimensional one. Consequently, the ICT literacy component *accessing information* could be regarded as not a one- but a two-dimensional construct – as hypothesized in the fourth phase. Grade-level analysis with respect to grades 6 to 11 also confirmed the results received concerning the entire sample. The two-dimensional model showed a significantly better fit to the data in every grade than the one-dimensional one. As a result, it was empirically confirmed, that finding information which easily accessible needs different abilities from those needing more complex search paths.

Another assumption made (H4) was that development to a significant extent could be detected from grade 6 to 11. A rising tendency of students' ability levels per grade could be detected (Figure 19) with ability levels growing by one third standard deviation per year, suggesting a more rapid development than that experienced about other abilities not explicitly improved at school (Molnár et al., 2013). The most significant advancement – twice as rapid as the average rate of annual development (12.4% point) – could be seen between grades 8 and 9 confirmed by the position of the point of inflexion of the curve (8.84). The mean performance measure of grade 6 students was 41%, while that of grade 11 students was 72%, which also suggests major development between grades 6 and 11 in the field examined. Viewing our results from an international research perspective, according to the ACARA ICT literacy test (ACARA, 2015) results, grade 10 students achieved significantly higher than grade 6 students. The implication of their research was that substantial development should take place between those two grades. Our research narrowed the age or grade interval suggesting that the most intensive period of development of the abilities activated for confident information accessing might take place between grades 8 and 9, which implication was confirmed.

The logistic curve typical of describing the characteristic development of numerous other abilities (H5) was expected as in descriptions of the development of other abilities. The four-parameter logistic curve fitted the empirical data adequately and described the ability to access information appropriately.

Notable differences between ability levels within the grades (H6) were hypothesized. Within the grades, the rate of ability level difference detected was equivalent to several year's difference (Figure 20). The ability level differences within the grades appeared to be greater than between grades 6 and 11 in general.

Girls' level of abilities necessary (H7) for confidence in and efficiency of information

seeking tasks was expected to be significantly higher than that of boys'. Regarding the entire sample, girls significantly outperformed boys with boys' results having a higher variability than those of girls. The performance difference in terms of the entire sample was caused by the performance differences within the primary school grades.

Across different types of school, different levels of performance were hypothesized (H8) with an advantage of secondary grammar school ('gimnázium') over secondary technical school ('szakgimnázium') or secondary vocational school ('szakközépiskola') The performance difference of grades 9 and 10 was caused by the ability level difference between grades 9 and 10 students of secondary technical schools ('szakgimnázium').

Significant relationships were hypothesized between students' academic achievements in information technology and test results (H9). Among 13 other subjects, information technology significantly correlated (p<.001) with the ICT literacy test results across all grades.

Regression analyses were conducted based on the results of the performance assessment test and the self-reported confidence variables related to accessing information to check the hypothesized relationships between students' test result – as dependent variable – and their questionnaire responses – as independent variables (H10). Identical variables explain the highest percentage of all known effects in grade 8 (31.5%). The most significant predictors of success in the online information searching (ICT literacy) test across grades are confidence in reading different sources, handling roll-down menus, evaluating the sources in terms of appropriacy for the actual goals, and confidence in online security.

Altogether all hypotheses were confirmed – with 10 of the 28 only partly confirmed –, which indicates realistic goal setting and substantiated and verifiable hypotheses based on the related literature (detailed in chapters 1 and 2 of this dissertation as well as in the descriptions of hypotheses of each phase of the research in chapter 4). The result is a valid and reliable, authentic, simulation-based, third generation assessment instrument to gauge the most fundamental component of ICT literacy – that is accessing information online – of grades 6-11 students in public education settings in a national context.

#### 5.2. Limitations

However, restrictions on the interpretation of the results also apply. One restriction is that due to the constraints of the accidental (as opposed to random) sampling method used, which was convenience sampling based on availability (Etikan, Musa, & Alkassim, 2016), no representativeness regarding gender, type of school, type of settlement or region was achieved. The fact that from the second phase of the research project partly, but from the third phase entirely, the research into ICT literacy assessment was restricted to one component, that is accessing information online, could also be seen as a limitation, although this restriction is marked in the subtitle of this dissertation signalling the reduced focus. At the same time, the overall perspective, and the outlook for further research opportunities regarding the other components of ICT literacy are reflected in the main title.

## 5.3. Originality

In national context, there has been no performance assessment of ICT literacy skills and abilities applying a third generation, online test. In this respect, the research described in this dissertation is unique. It has been proven that valid and reliable measurement of the most fundamental *access* component of the ICT literacy construct vital from the perspective of lifelong, individual learning is possible in a wide age spectrum using the assessment instrument devised.

Further significance of the measurement is that with its 40-minute time span, it fits the 45-minute lesson length of the national educational environment as opposed to the 120-150 (ACARA, 2012; 2014; OECD, 2003), 60 or 50-minute length tests by IEA (Fraillon et al., 2015) or NAGB (NAGB, 2013) ever applied in an international context.

Finally, our research has contributed to the results in an international context. According to the results of the ICT literacy test administered by the Australian educational authorities, grade 10 students' ICT literacy achievements significantly outweighed those of grade 6 students' (ACARA, 2015). Their implication was that substantial development should take place between those two grades. At first, our small-scale research narrowed this period suggesting that the most intensive period of development of the core component of ICT literacy access might take place between grades 8 and 10. This implication was confirmed and the period further narrowed by the results of the final, large scale performance assessment test indicating that the abilities activated to confidently access information undergo the largest

development between grades 8 and 9.

The fact that it is delivered through the eDia online assessment platform (Molnár et al., 2015a) provides students instant and educators a quick and thorough feedback on learner achievement in the test to facilitate adjustments in instruction according to individual or gradelevel needs. To make proposals on or to promote implications of the results for educational practices, it could be stated that the lack of grade-level or individual adjustment of the curriculum to students' needs is a deficiency that should be managed. Cross-curricular development of information search – integrated in every subject – could be one solution, as the framework curricula (kerettantervek) of different subjects prescribe or suggest it. However, the majority of educators might not be prepared to and might not be supported by enough ready-made materials, teaching aids and reliably functioning ICT devices to be able to integrate developing information searching abilities into their syllabi. Another solution could be developing such abilities in IT lessons. However, in this case, the reduced number of IT lessons per week spread until only the 9th or tenth grades might not be sufficient (not to mention the outdated IT equipment and the lack of human resources at schools). The new National Curriculum and future adjustments of the career model of educators alongside inclusion of ICT literacy training of future teachers in teacher education together with further improvement of the school infrastructure might result in beneficial changes in ICT literacy development. Until then, students' ICT literacy development will lie in the hands of those innovative teachers – for example, the ones in the schools volunteering to participate in research –, who could benefit from the opportunity to test students' information searching abilities. By involving students in online projects, web quests or various search activities, they will further assist development of other abilities of students tested nationwide, such as reading competencies. Teacher's sharing ideas, methods, techniques, twinning and collaboration might also contribute to a positive advancement.

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# Appendix 1: Online questionnaire to map the confidence of accessing information component of grade 7 and 10 students' ICT literacy

1. Kérjük, válaszolj a követk	ező kérdésekre! *I	Nemed:			
Nő					
Férfi		,			
2. Kérjük, válaszolj a követk ~	ező kérdésekre! *I	Evfolyam			
<sup>₩</sup> 7.					
8.					
<sup>©</sup> 9.					
10.					
S. Melyik osztályba jársz? *Osztályod betűjele? Kérjük, értékeld. mennyire érzed tevékenységedet magabiztosnak a következő számítógépe nűveletek során. *Kérjük, válaszd ki az alábbiak közül az Rád leginkább jellemzőt!					
_	egyáltalán nem	kevéssé	eléggé	teljesen	
4. A billentyűzet használata karakterek. szavak begépelésére	C	С	С	C	
5. Billentyűzet használata számítógépes / online játékok használatára	C	С	С	C	
6. A billentyűzet használata szövegek begépelésére	С	С	С	C	
7. Egérhasználat (mozgatás. Kattintások, kijelölés, húzd és vond műveletek)	C	С	c	c	
8. Szöveg olvasása képernyőről	С	C	O	C	
9. Weboldalon/ képernyőn megjelenő	C	0	C	c	

szöveges

	egyáltalán nem	kevéssé	eléggé	teljesen
információban való eligazodás, információ kikeresése				
10. Weboldalon/ képernyőn megjelenő diagramokon való eligazodás, információ kikeresése	C	С	С	С
11. Weboldalon/ képernyőn megjelenő képi információkban való eligazodás, információ kikeresése	С	С	С	c
12. Weboldalon/ hangzó szöveg megértése, hallott instrukciók követése	С	С	С	С
13. Weboldalon lévő (legördülő) menükben való eligazodás a keresett információ megtalálására	C	С	C	С
14. Weboldalon/ képernyőn megjelenő táblázatokban való eligazodás, információ kikeresése	C	c	С	С
15. Internetes levelezőrendszerekben való eligazodás, információ kikeresése	C	C	С	С
16. Internetes adatbázisokban való eligazodás. információ kikeresése (pl. webáruház, online menetrendek stb.)	С	С	С	С

	egyaltal	án nem	kevéssé	eléggé	teljesen
17. Internetes közösségi oldalakon való eligazodás, információ kikeresése	С	;	C	C	С
<mark>érjük, értékeld, milyen g</mark> evékenységeket. *Kérjük					
,	soha	ritkán (hav vagy ritkáb	onta	elég akran (hetente- kéthetente)	nagyon gyakran (hetente többször vagy gyakrabban)
18. Számítógép használata iskolai feladatok megírására (szövegszerkesztő, prezentáció készítő, stb.)	С	O		С	С
19. Internet használata információkeresésre iskolai feladathoz vagy tanuláshoz	С	C		С	С
20. Internet használata információkeresésre szabadidődben	С	0		С	С
21. Számítógép/ internet használata játékra	С	C		С	С
22. Internetes közösségi oldalakon való tevékenység	С	C		С	c
23. Online filmnézés /sorozat nézés	C	С		O	О
24. Internetes csettelés	0	c		C	С
25. Elektronikus levelezés	C	c		C	C

	soha	ritkán (havonta vagy ritkábban)	elég gyakran (hetente- kéthetente)	nagyon gyakran (hetente többször vagy gyakrabban)		
26. Internetről zene, film, video stb. letöltése	С	С	С	C		
27. Képek, videók stb. feltöltése	C	C	C	С		
28. Internetes fájlmegosztó oldalakon való tevékenység	С	С	С	С		
29. Internetes tárhelyre képek, videók, dokumentumok fel- és onnan letöltése, megosztása	С	C	C	C		
30. Internetes fórumok olvasása	C	С	С	С		
31. Internetes fórumokra bejegyzés írása	C	С	C	С		
32. Blog(ok) olvasása	C	С	C	С		
33. Blog(ok)ba bejegyzés írása	C	С	С	С		
Add item						
After page 1						
Continue to next page						
Page 2 of 2						
A kérdőív utolsó részében olyan adatokra kérdezünk rá, melyek az életeddel, szokásaiddal, viszonyulásoddal, tapasztalataiddal kapcsolatosak! Kérjük, jelöld a megfelelő válaszokat!  34. Kivel élsz együtt? *						

• szülők, nagyszülők

• Kollégiumban

6	egy sincs		egy	kettő	háror	m vagy töb
Van-e számítógép otthon?	C	1	C	C		С
önyvek száma a csa	Száz	Jelöld a legink nál kevesebb (1-2 yvespolcnyi)	sább jellemz Száz és ö között (2 könyvespo	Ötszá tszáz kö: 2-10 könyvs	z és ezer zött (3 zekrényre való)	Ezerné több kön
36.Hozzávetőlege hány könyv van otthon a tankönyveken kívi (ha 1 könyvespolc könyv 40-50 könyv jelent)?	ül nyi	C	С		С	С
			igen		nem	
37. Az iskolában informatika órán k (pl. más tanórán) használsz-e számítógépet/internetet?	ĸívül		C		С	
38. Tanórákon kív iskolában használl számítógépet /int (pl. könyvtárban)?	natsz-e ernetet		С		C	
39. Az iskolán/kollégiumo az otthonodon kív e internet használ lehetőséged (pl. ir café)?	rül van- ati		С		c	

•	0	Kissé
•	0	Eléggé
•	0	Teljesen
	41.	Mennyire szívesen használod a számítógépet/internetet? *
•	0	Egyáltalán nem szívesen
•	0	Nem igazán szívesen
•	0	Szívesen
•	42.	Kifejezetten szívesen Tartasz-e a számítógép- vagy internethasználat negatív hatásaitól? *
•	0	Igen, általában tartok tőle
•	0	Igen, néha tartok tőle
•	0	Nem igazán tartok tőle
•	<ul><li>43.</li></ul>	Egyáltalán nem tartok tőle  Hetente hány órát töltesz az interneten? *
•	0	Semennyit
•	0	Heti 1-5 órát
•	0	Heti 6-10 órát
•	0	Napi 2-3 órát vagy többet
		Kortársaiddal összehasonlítva hogyan értékeled saját anyagi helyzeted? *
•	0	Az átlagosnál jobb
•	0	Átlagos
•		Az átlagosnál rosszabb A közvetlen környezetedben ki a legrendszeresebb számítógép/ internetet használó? aszd a legjellemzőbbet!
•	0	Édesapám
•	0	Édesanyám
•	0	Testvérem
•	0	Én
	-	Ért-e már kudarc számítógépes/ internetes tevékenységgel kapcsolatban? *
•	0	Igen, többször
•	0	Igen, párszor
•	0	Nemigen
•		Nem, soha
	47.	Volt-e negatív élményed internethasználat során? *
•	-	Igen, többször

- Igen, párszor
- Nemigen
- Nem, soha

# Add item

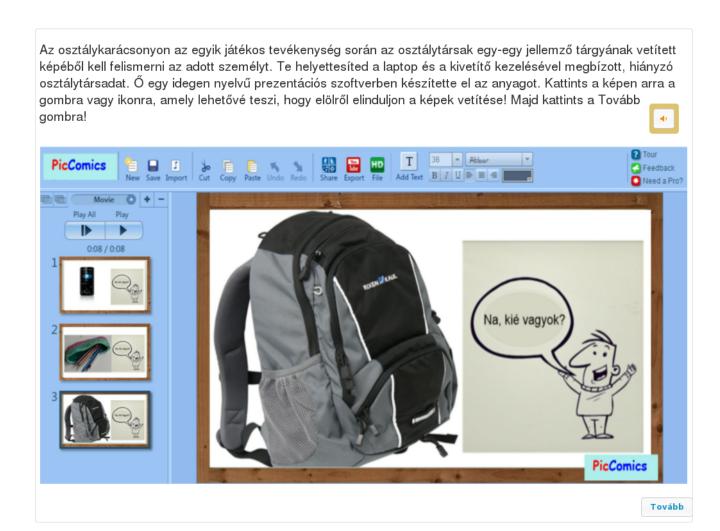
Confirmation Page

Confirmation message

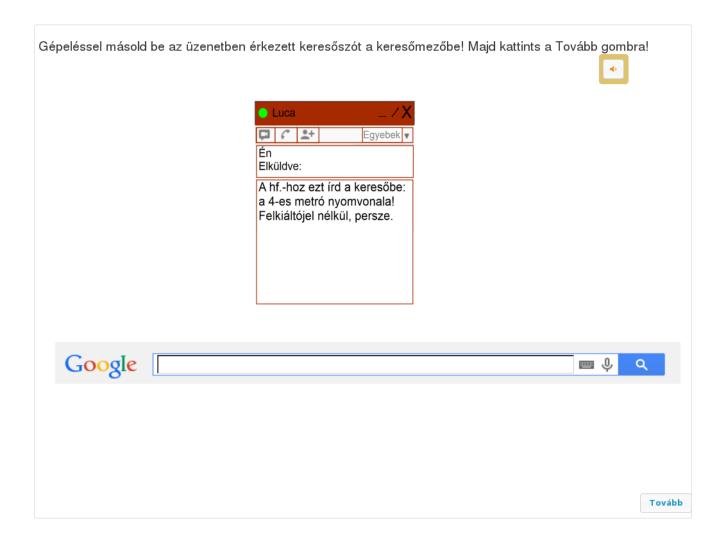


Show link to submit another response Publish and show a link to the results of this form Allow responders to edit responses after submitting Appendix 2: PDF document: Examples of the items of the semi-simulation based performance assessment test in the second phase of the test development project.

#### kivetites:



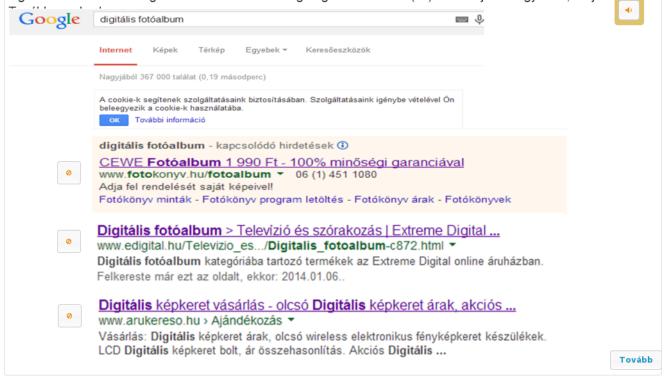
# keresoszogepel:



#### netajandek1:

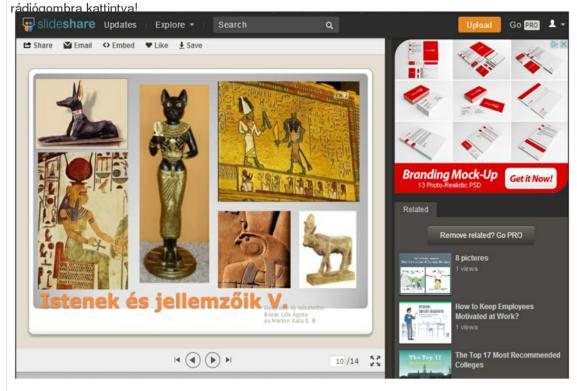
Osztályod úgy döntött, hogy a tanároknak pedagógus napra egységesen névre szóló gravírozott tollat ajándékoztok fejenként legfeljebb kétezer forint értékben. Az osztályfőnök ajándékára öt- és tízezer forint közötti összeget szántok az osztálypénzből. Neki digitális fotóalbumot szeretnétek. A hozzá tartozó asztali képkeret memóriakártyájára osztályfotókat tennétek föl a közös programokról.

Beírtad a keresőbe a kereső kifejezést az osztályfőnök ajándékához, és az alábbi eredményeket kaptad legelőször. Kattints a megadott szituáció szerinti legmegfelelőbb találat(ok) melletti jelölőnégyzetre, majd a



#### prezentacio1:

Osztálytársaddal prezentációt készítetek történelem órára az egyiptomi istenekről. Forrást még nem jelöltetek meg, de te emlékszel, hogy Mitológiai enciklopédia volt a könyv címe. Tanárotok ragaszkodik a szakirodalmi forrás pontos megjelöléséhez. A könyvtár már bezárt, az interneten kell megtalálnod a megfelelő szerzőt, címet, kiadót, kiadás évét. Használd a Tovább gombot a további weboldal képek megtekintéséhez, majd e feladat utolsó oldalán, válaszd a leginkább megfelelőnek látszó weboldalt a szükséges információ megtalálásához az alattalajó



wiki:

Osztályod közösségi oldalán társatokat sértő üzenet jelent meg. Barátod kíváncsi volt, jogszerű-e az ilyen magatartás közösségi portálon. A Wikipedia keresőjébe beírt szó nyomán a következő eredményeket kapta. Mi lett volna a pontosabb kereső kifejezés? Kattints a mellette lévő rádiógombra, majd a Tovább gombra!

#### A keresés eredménye

#### Battlefield Online

A Battlefield **Online** (koreaiul : 🖂 🖂 🖂 🖂 🖂 🖂 pethulphiltu onrain) egy ingyenes, többjátékos mód ban játszható belső nézetű lövöldözős játék 🔐

2 KB (290 szó) - 2013. március 15., 07:17

#### • TOM Online

A TOM **Online** internet es cég Kínában . A népszerű kínai nyelvű internetes portál (www. tom. com) **online** és mobiltelefon -szolgáltatásokkal ... 2 KB (326 szó) - 2014. március 18., 13:20

#### online vásárlás

Az **online** vásárlás a vásárlás azon formája, ahol a kirakat és az egész árukészlet megjelenik a képernyőnkön, így otthonunkból kényelmesen ... 3 KB (399 szó) - 2014. február 25., 09:11

# Gramofon Online

A Gramofon **Online** a Magyarországon nyomott és kiadott, 78-as fordulatszámú hanglemezek felvételeit gyűjti és dolgozza fel az 1906-os ...

2 KB (298 szó) - 2010. szeptember 6., 09:56

#### Online zaklatás

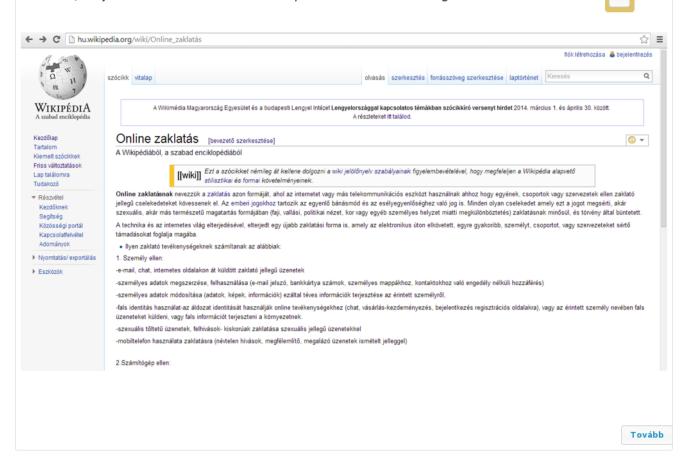
Online zaklatásnak nevezzük a zaklatás azon formáját, ahol az internetet vagy más telekommunikációs eszközt használnak ahhoz hogy egyének, ...
3 KB (389 szó) - 2012. március 25., 23:32

# Silkroad Online

A Silkroad **Online** (koreaiul: \_\_\_\_\_ magyarul: selyemút) egy koreai fejlesztésű fantasy MMORPG, amely az egykor Európát és a Távol- ... 6 KB (713 szó) - 2014. március 31., 17:45

#### wiki2:

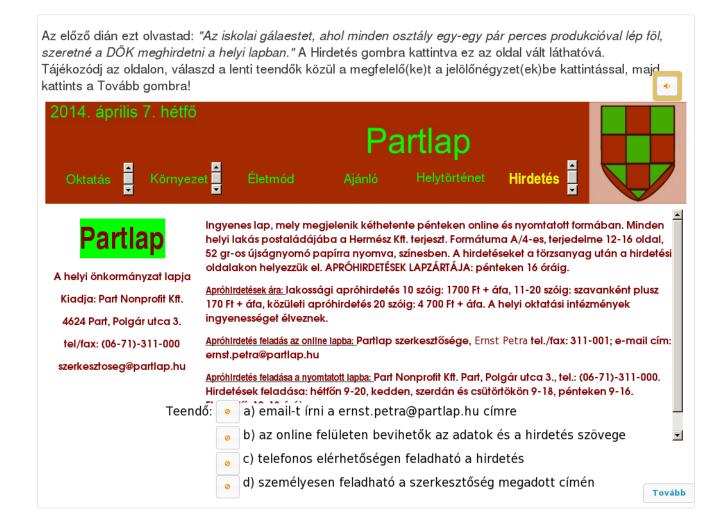
Remélem, jól választottál. Az *online zaklatás* lett volna az azonnali eredményre vezető kereső kifejezés. Alább olvasható, mit jelent. A következő diára továbblépéshez kattints a Tovább gombra!



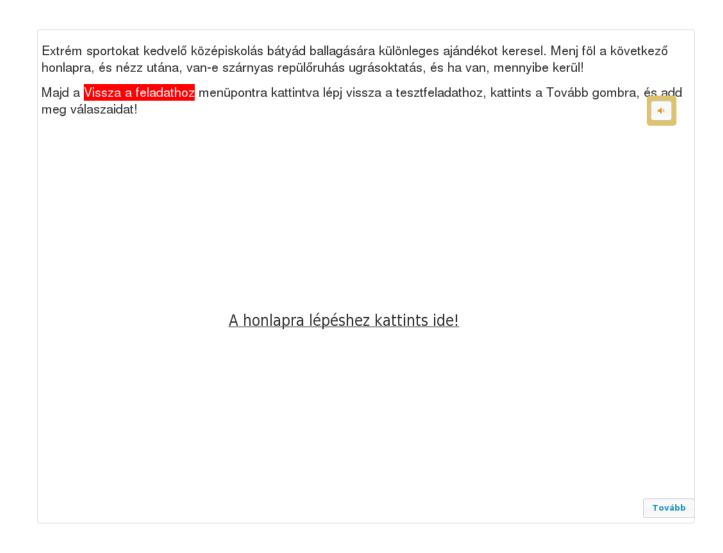
#### hajzsele:

Hétköznapi használatra keresel erős hajzselét ezer forint alatt. Az alábbi keresőben felkínált oldalak közül melyikre kattintva számíthatsz a leggyorsabban válaszra? Kattints a szerinted legígéretesebb weboldal cír melletti rádiógombra! Majd kattints a Tovább gombra! https://www.google.hu/search?q=hajzselé&oq=hajzselé&aqs=chrome..69i57 Professzionális Hajzselék - hajvarazs.hu www.hajvarazs.hu/ Alfaparf, Bed Hed, Fudge, Lisap Zselék és más profi fodrászkellékek Ön kétszer kereste fel a(z) hajvarazs.hu webhelyet. Utolsó látogatás: ma Képtalálatok - hajzselé Sértő képek bejelentése További képek a következő kifejezésre: hajzselé • Hajzselé - Gyakori kérdések www.gyakorikerdesek.hu/kereses.php?keres=hajzsel%E9 • 20+ elem - Találat a kategória címekben / kulcsszavakban: Valaki (főleg fodrászok) mondana valamiket a wax, zselé, meg a ... 0 válasz. Milyen a jó zselé 1 válasz. Taft hajzselé »-> ÁrGép www.argep.hu > Trend > TA > TAFT -10+ elem - Aktuális Taft hajzselé ajánlatok az ÁrGép-en. Hasonlítsa össze ... Taft hajzselé Looks Rough & Tough 150ml. Hosszantartó mega erős tartás a Taft hajzselé Looks V12 150ml. A Taft sorozat legjobbja!\* Turbó 2 alkalommal látogatta már meg ezt az oldalt. Utolsó látogatás ideje: 2014.03.17. Taft Power hajzselé Mega strong 250ml mindössze 1214 Ft-é... www.szepsegbolt.hu→...→ Hajformázók→ Krém, zselé, wax, por, gél ▼ Taft Power haizselé Mega strong 250ml krém, zselé, wax, por, gél mindössze 1214 Ft-Tovább

#### helyilap2:



# szarnyasrepuloruha1:



# szarnyasrepuloruha2:

Az előző honlapon utánanéztél, van-e szárnyas repülőruhás ugrásoktatás, és mennyibe kerül! Jelöld a helyes választ alább, a megfelelő rádiógombokra való kattintással! Majd kattints a Tovább gombra!

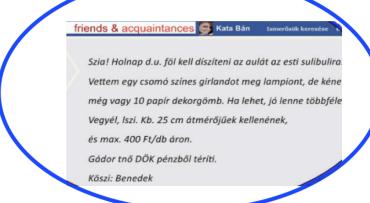
- 1. Van-e szárnyas repülőruhás oktatás?
  - ° Van.
- Nincs.
- 2\_Mennyibe kerül a szárnyas repülőruhás oktatás?
  - a) 46.000 Ft+ÁFA
  - b) 55.000 Ft+ÁFA
  - c) Nem derül ki.
  - 👛 d) Ingyenes.



Vissza

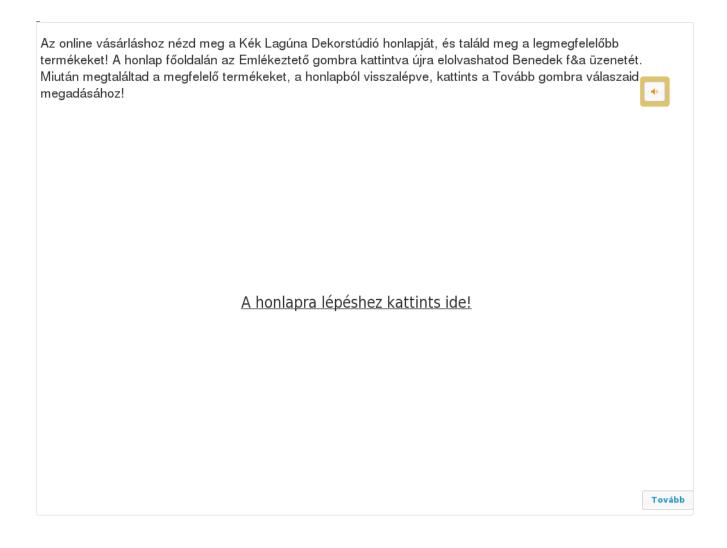
#### dekorstudio szitu:

A Diákönkormányzat (DÖK), melynek te is választott képviselője vagy, sulibulit szervez. A DÖK elnöktől a következő üzenetet kaptad az f&a közösségi oldalon.



Kattints a Tovább gombra a feladat elolvasásához!

#### dekorstudio feladat:



#### dekorstudio valasz:



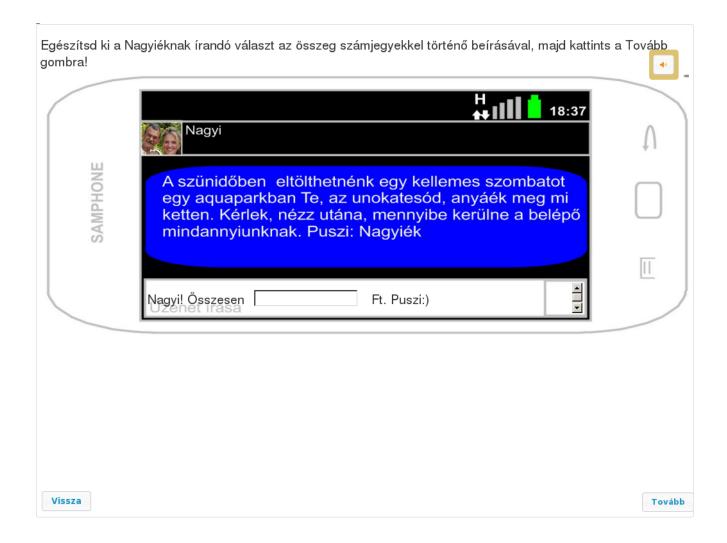
# aqualand szitu:



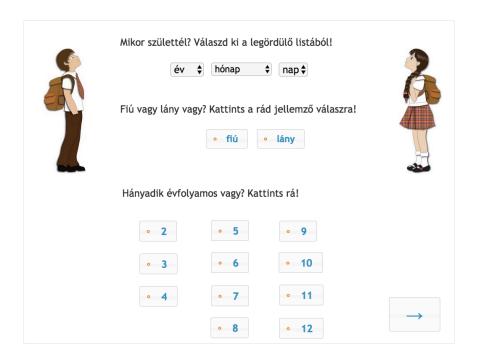
# aqualand feladat:



# aqualand valasz:



Appendix 4: PDF document including examples of both the questionnaire part and the actual performance assessment part of the test (the screenshots of those pages of the website where the relevant answer to the item could be found to map the abilities operating the effectiveness and confidence of the accessing information component of grade 5 and 11 students' ICT literacy)



# Gratulálunk! Az első feladaton nyújtott teljesítményed 0%-os.

A következő feladathoz kattints a tovább gombra!

Kattints a Tovább gombra!

Tovább

# Gratulálunk! Az első két feladaton nyújtott teljesítményed 0%-os.

A következő feladathoz kattints a tovább gombra!

Kattints a Tovább gombra!

#### Gratulálunk!

Sikeresen megoldottad az első három feladatot.

A következő feladathoz kattints a tovább gombra.

Ha lejárt az időd, a tovább gombra kattintás után látni fogod eddigi teljesítményedet.

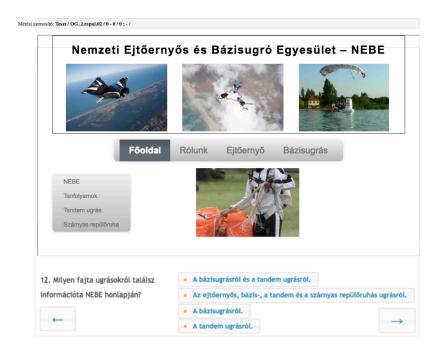
Kattints a Tovább gombra!



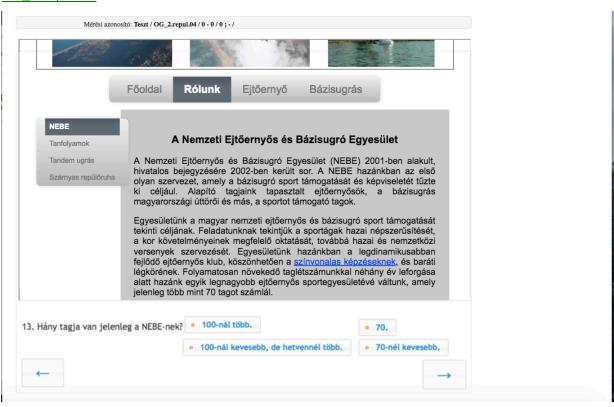
# Kerdoiv\_01a

# OG\_1.dekor.07

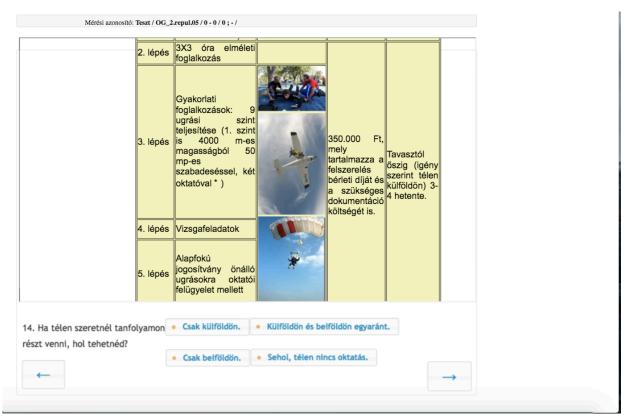




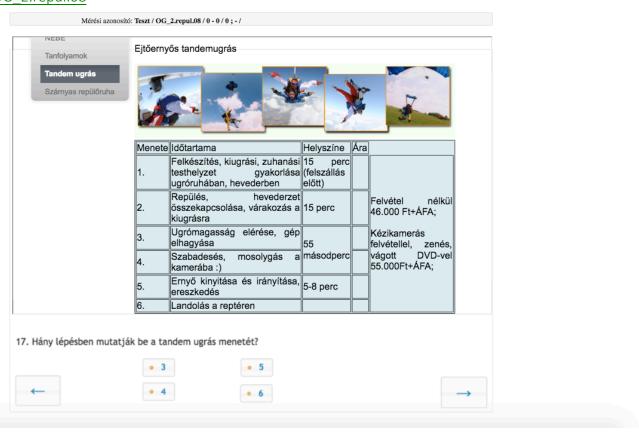
#### OG 2.repul.04



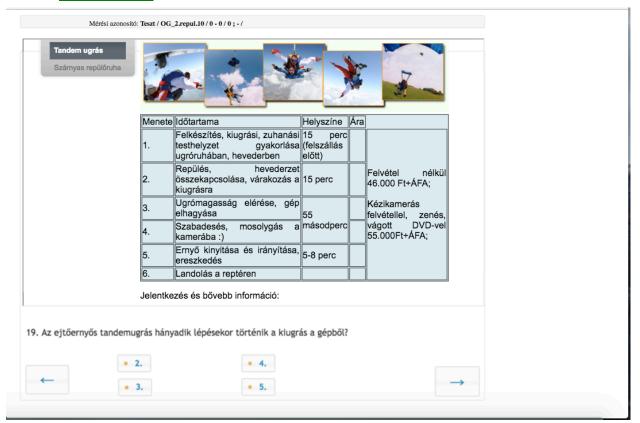
# OG\_2.repul.05



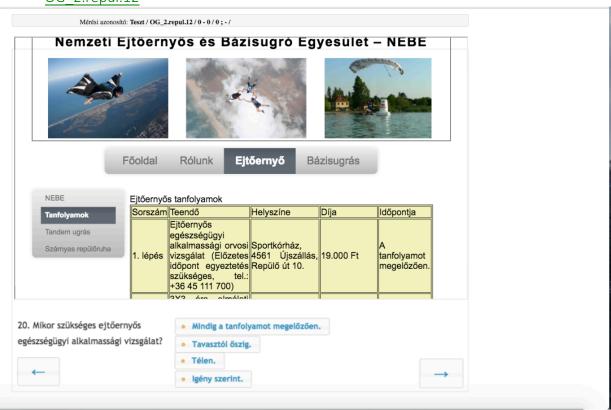
# OG\_2.repul.08



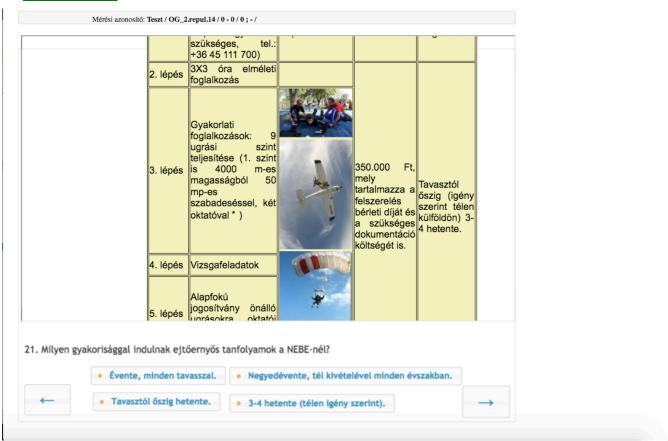
# OG\_2.repul.10



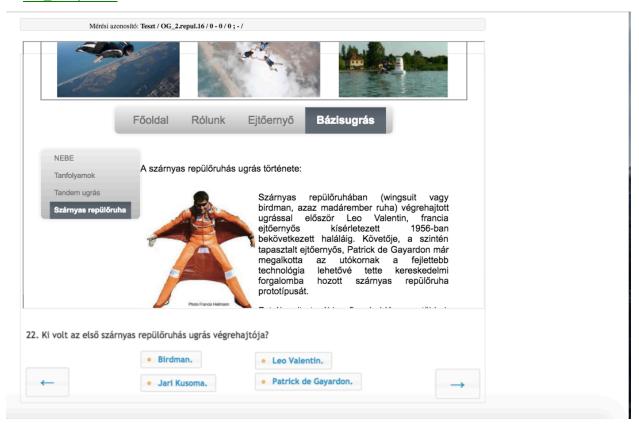
# OG\_2.repul.12

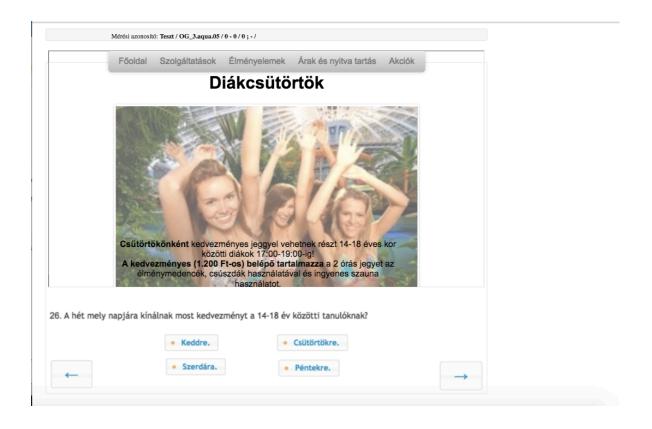


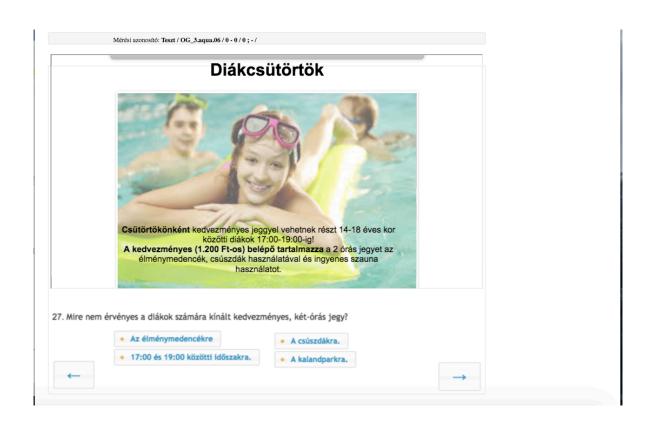
# OG\_2.repul.14

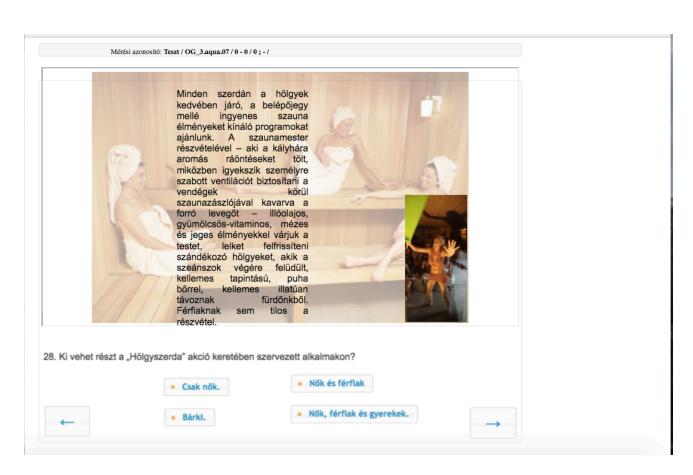


# OG\_2.repul.16

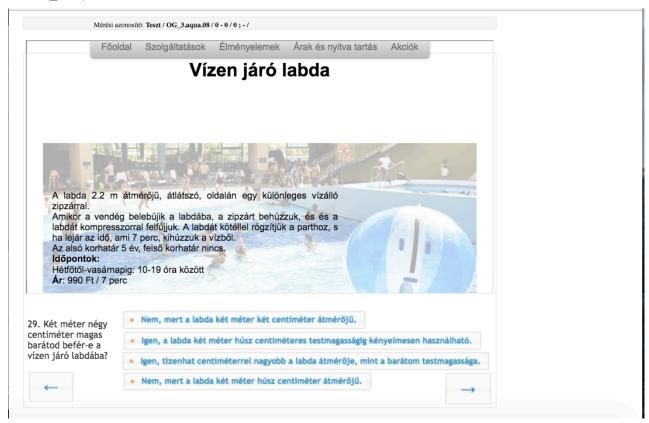




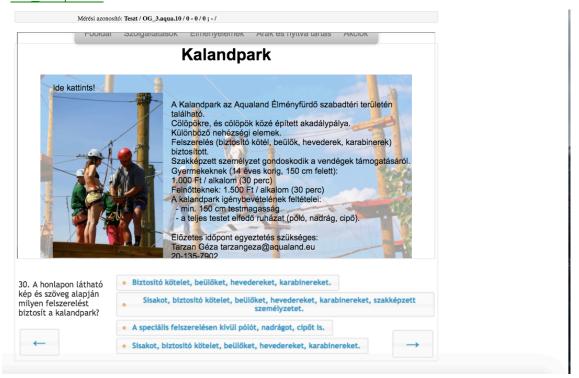




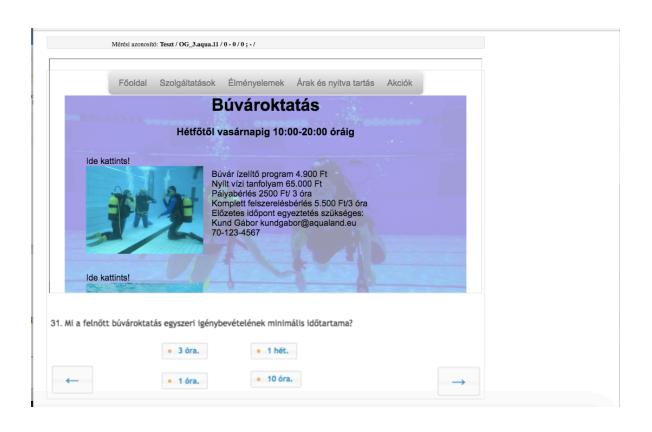
# OG\_3.aqua.08



# OG\_3.aqua.10

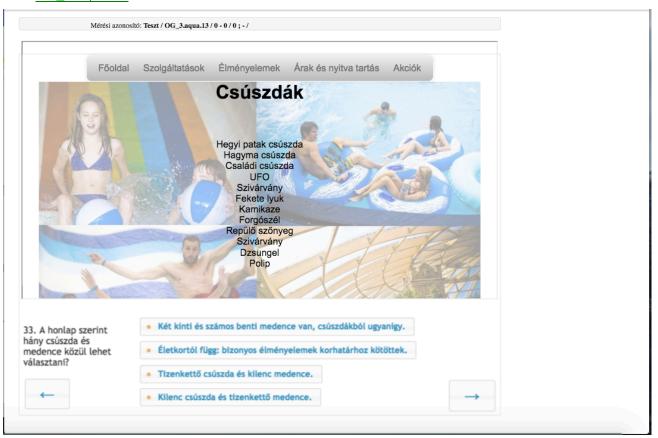


OG\_3.aqua.12

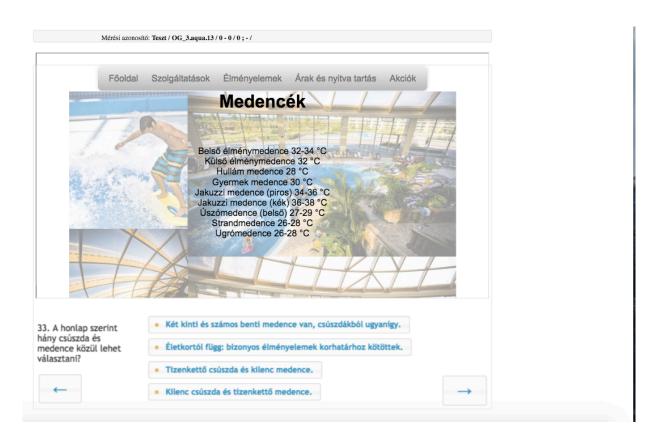


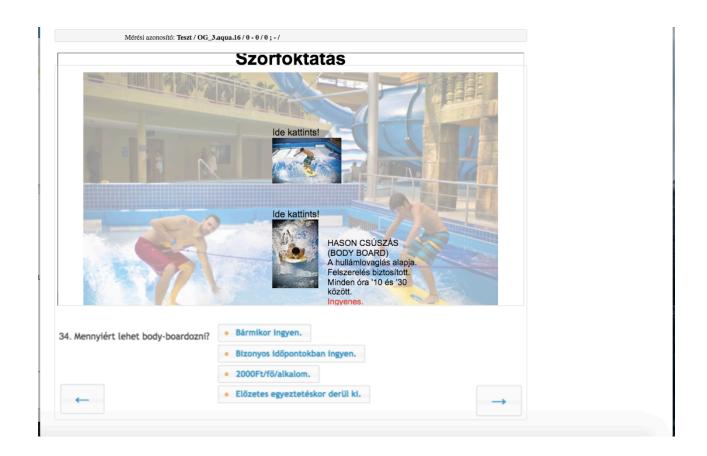


# OG\_3.aqua.13

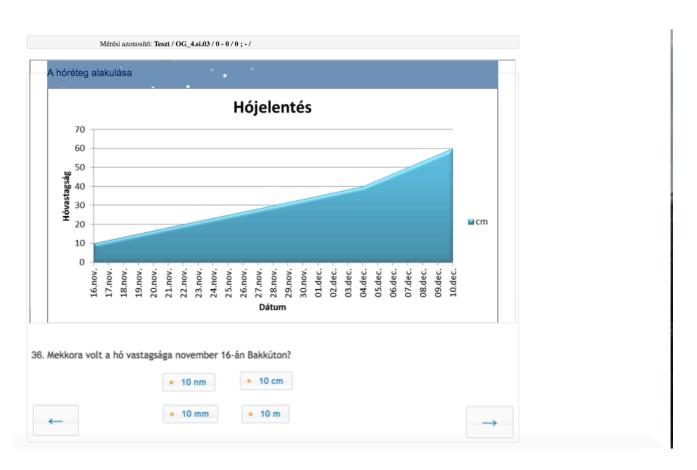


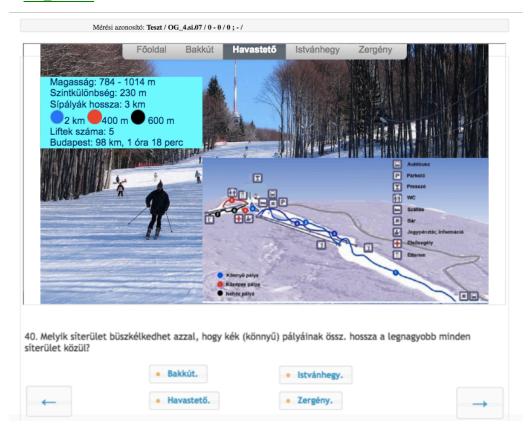
OG\_3.aqua.14

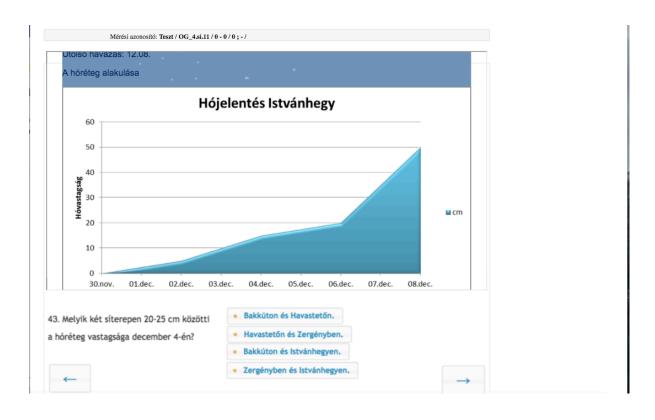




# OG\_4.si.04







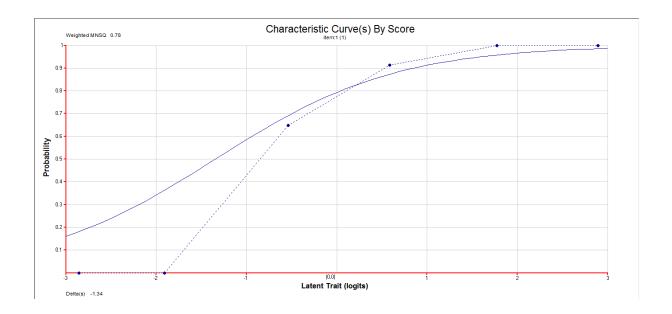


Figure 21: Characteristic curve of Item 1 Ékszerész nyomtatás

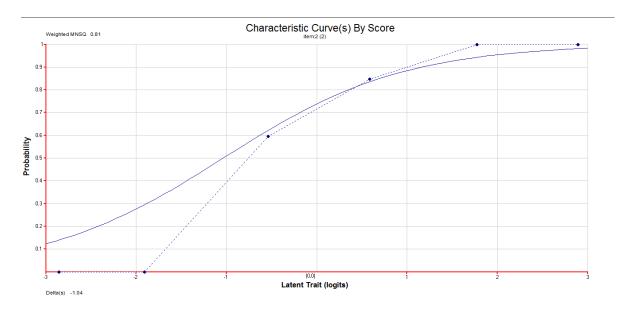


Figure 22: Characteristic curve of Item 2 Visszanavigal\_nyitolap

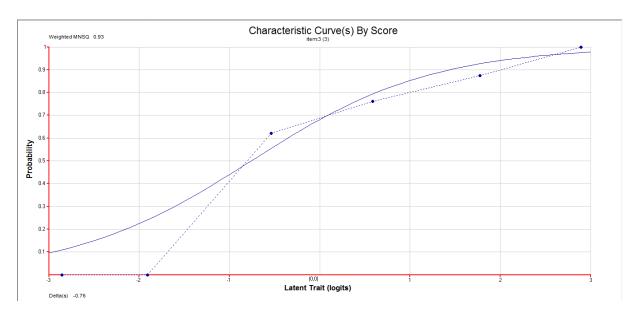


Figure 23: Characteristic curve of Item 3 *Kivetites\_kivetiteskep* 

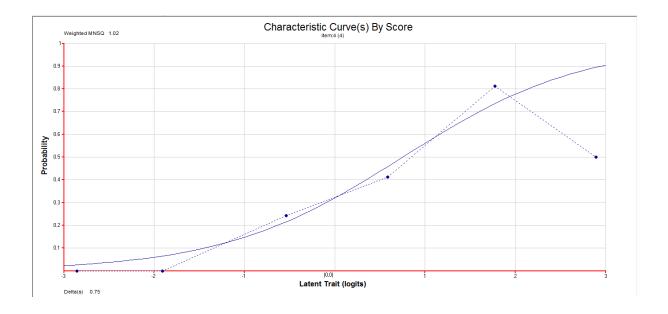


Figure 24: Characteristic curve of Item 4 Keresoszogepel\_

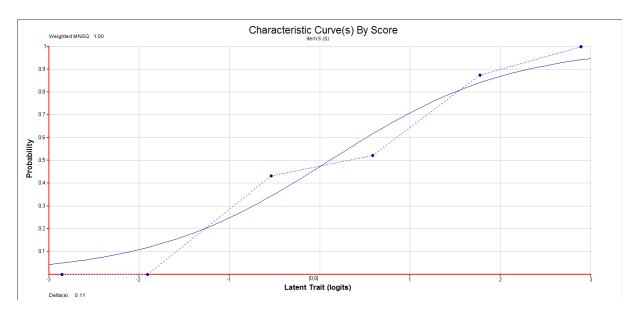


Figure 25: Characteristic curve of Item 5 *Netajandek* 

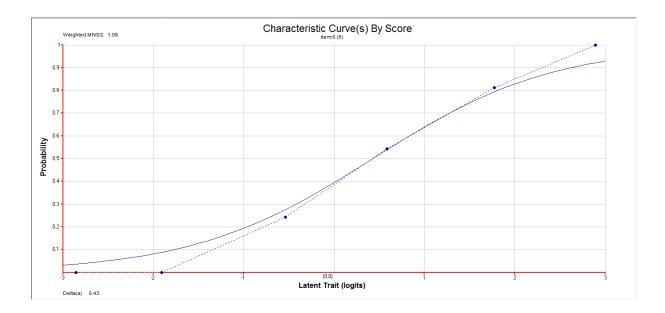


Figure 26: Characteristic curve of Item 6 *Prezentáció* 

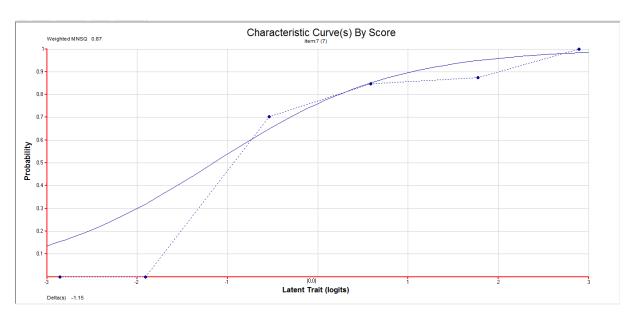


Figure 27: Characteristic curve of Item 7 *Online\_zaklatas* 

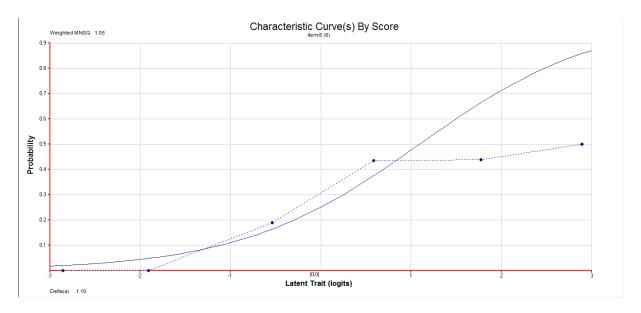


Figure 28: Characteristic curve of Item 8 Hajzselé

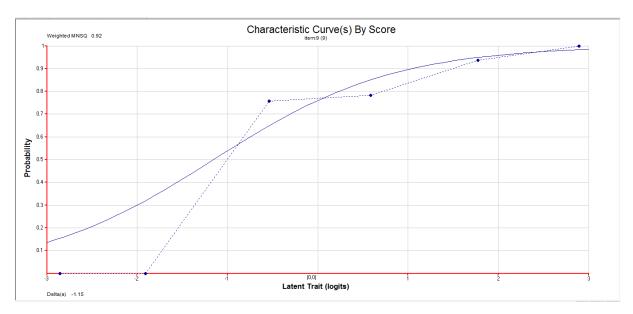


Figure 29: Characteristic curve of Item 9 *Helyilap\_hirdetes* 

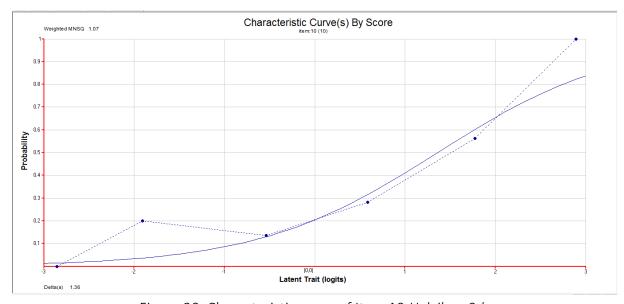


Figure 30: Characteristic curve of Item 10  $Helyilap\_2d$ 

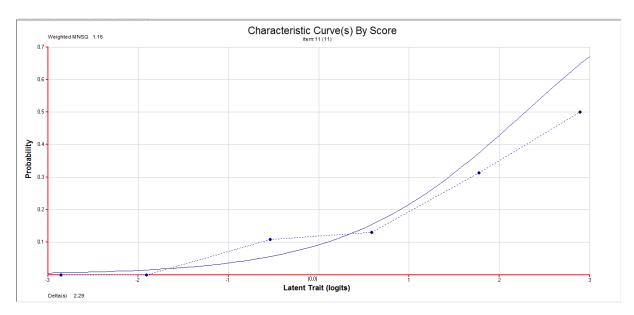


Figure 31: Characteristic curve of Item 11 Szarnyasrep\_ingyenes

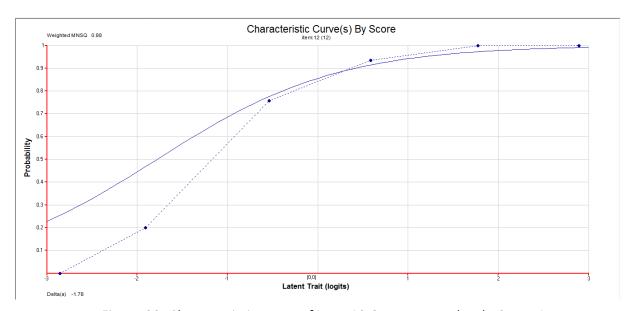


Figure 32: Characteristic curve of Item 12 Szarnyasrepuloruha2\_van1

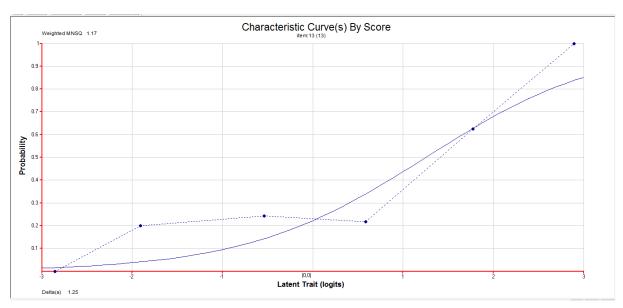


Figure 33: Characteristic curve of Item 13 Dekorstudio\_valasz\_ketto

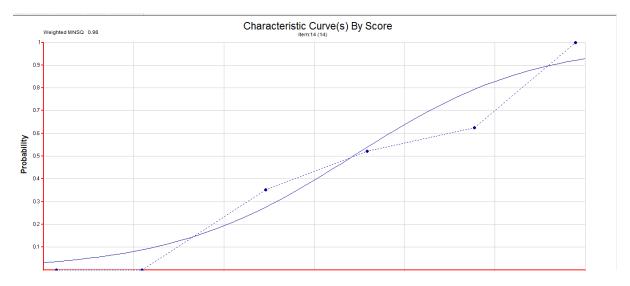


Figure 34: Characteristic curve of Item 14 Dekorstudio\_valasz\_normal



Figure 35: Characteristic curve of Item 15 *Dekorstudio\_valasz\_szalagos* 

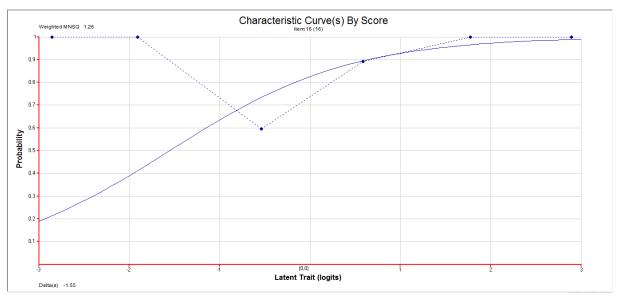


Figure 36: Characteristic curve of Item 16 Dekorstudio\_valasz\_vilagito

Appendix 6: Tables 34-35: Correlations between students' responses to the self-reported questionnaire and the performance assessment test of students' confidence in the access component of ICT literacy in the second phase of the research

Table 34: Correlations between students responses to the self-reported questionnaire and the performance assessment test of students' confidence in the access component of ICT literacy (Tasks 1-10. Imitated online surfaces)

	Imitate	d online t	tasks							
	1jewe	2navb	3prj	4serty	5netgi	6pre	7onha r	8hge	9loc1	10lo2
1.1. Reading texts in course books	.350* *	.356* *	n.s.	n.s.	n.s.	n.s.	.259* *	n.s.	.288* *	n.s.
1.2. Reading texts in free time	.308* *	263**	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
1.3. Reading Texts in Magazines	.268* *	.248*	n.s.	n.s.	.254* *	.244*	.222*	.250*	n.s.	n.s.
1.4. Reading on screen	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.209*	n.s.
1.5. Reading Online Texts	n.s.	.280* *	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.358* *	n.s.
1.6. Simple calculations without calc.	n.s.	n.s.	.249*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
1.7. Simple calculations using PP	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.223*
1.8. Simple calculations using calc.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.232*	n.s.
2.a. Typing Words	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
2.c. Typing Texts	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
2.b. Mouse use	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.238*	n.s.	n.s.
2.d. Reading from images	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.259* *
3.1. Info in web text	.271* *	.405* *	.265* *	.250*	n.s.	n.s.	n.s.	n.s.	.355* *	n.s.
3.2. Reading web diagrams	.213	.256* *	.2*72 *	n.s.	n.s.	.300* *	.291* *	n.s.	n.s.	n.s.
3.3. Info in website image	n.s.	.257* *	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.255* *

3.4. Listening	n.s.	.316* *	n.s.	.225*	.227*	n.s.	.232*	n.s.	.203*	.193*
3.5. Web menu info	.260* *	.198*	.211*	n.s.	n.s.	n.s.	.266*	.318*	.389*	.244* *
3.6. Web table info	n.s.	.260* *	n.s.	n.s.	n.s.	n.s.	.238*	n.s.	n.s.	n.s.
3.7. Web database info	.202*	n.s.	n.s.	n.s.	n.s.	n.s.	.243*	n.s.	.274* *	n.s.
3.8. Web social netw info	.291* *	.270* *	n.s.	n.s.	n.s.	.249*	.218*	n.s.	.266* *	n.s.
4.a. Decision where to search	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.207*	n.s.	n.s.	n.s.
4.b. Decision search term	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.222*	n.s.	n.s.	n.s.
4.c. Decision choose	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.266* *	n.s.	n.s.
5.1. Decision reliab	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.198*	n.s.	n.s.	n.s.
5.2. Decision best	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.290* *	n.s.	.233*	
6.a. Decision ethical	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.234*	n.s.	n.s.
6.b. Decision legal	n.s.	.242*	n.s.	n.s.	.205*	n.s.	n.s.	n.s.	n.s.	n.s.
7.3. Web info search free time	n.s.	.243*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
8.b. Grade	n.s.	n.s.	n.s.	n.s.	n.s.	.252*	n.s.	n.s.	n.s.	n.s.
9. No. of books	n.s.	n.s.	.229*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
10. Cars	n.s.	n.s.	n.s.	n.s.	207*			267*	219*	
12. a. No. of	n.s.	.255*	n.s.	n.s.	n.s.	.272*	.270*	n.s.	n.s.	n.s.
comp. at home		*				*	*			
12.c. Comp. use school outside lessons	n.s.	n.s.	208*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
12.d. Int use elsewhere	n.s.	n.s.	n.s.	.212*	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
13.a. Satisfied int.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	.204*	n.s.	n.s.	n.s.
13.c.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
14.a. Hours int. per week	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
14.b. Int. failure	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	194*
14.c. Neg. exp. Int.	n.s	n.s	n.s.	n.s.			n.s.	n.s.	n.s.	n.s

Table 35: Correlations between students responses to the self-reported questionnaire and the performance assessment test of students' confidence in the access component of ICT literacy (Tasks 11-14. Simulated online surfaces)

	Simulated	d online tasks		
	11	12	13	14
1.1. Reading texts in course books	n.s.	n.s.	n.s.	213*
1.2. Reading texts in free time	n.s.	.257**	n.s.	n.s.
1.3. Reading Texts in Magazines	n.s.	.227*	n.s.	n.s.
1.4. Reading on screen	n.s.	n.s.	n.s.	n.s.
1.5. Reading Online Texts	n.s.	n.s.	n.s.	n.s.
1.6. Simple calculations without calc.	n.s.	n.s.	n.s.	n.s.
1.7. Simple calculations using PP	n.s.	n.s.	n.s.	n.s.
1.8. Simple calculations using calc.	n.s.	n.s.	n.s.	n.s.
2.a. Typing Words	n.s.	n.s.	n.s.	n.s.
2.c. Typing Texts	n.s.	n.s.	n.s.	n.s.
2.b. Mouse use	n.s.	n.s.	n.s.	n.s.
2.d. Reading from images	.207*		214*	210*
3.1. Info in web text	n.s.	n.s.	n.s.	n.s.
3.2. Reading web diagrams	n.s.	n.s.	233*	
3.3. Info in website image	n.s.	n.s.	n.s.	212*
3.4. Listening	n.s.	.194*	n.s.	n.s.
3.5. Web menu info	n.s.	n.s.	n.s.	n.s.
3.6. Web table info	n.s.	n.s.	n.s.	n.s.
3.7. Web database info	n.s.	n.s.	n.s.	n.s.
3.8. Web social netw. info	n.s.	n.s.	n.s.	n.s.
4.a. Decision where to search	n.s.	n.s.	n.s.	n.s.
4.b. Decision search term	255*	n.s.	n.s.	253*
4.c. Decision choose	n.s.	n.s.	n.s.	n.s.
5.1. Decision reliab	n.s.	n.s.	n.s.	n.s.
5.2. Decision best	n.s.	n.s.	.215*	n.s.
6.a. Decision ethical	n.s.	.227*	n.s.	256**
6.b. Decision legal	n.s.	n.s.	n.s.	289**
6.c. Decision healthy time span	n.s.	n.s.	n.s.	n.s.
6.d. Decision healthy body posture	n.s.	n.s.	n.s.	240*
6.e. Decision physical/mental health	n.s.	n.s.	n.s.	196*
6.f. Decision on online personal security	n.s.	n.s.	n.s.	275**
7.3. Web info search free time	.194*	n.s.	n.s.	n.s.
8.b. Grade (Year)	.305**	n.s.	n.s.	336**
9. No. of books	.196*	n.s.	n.s.	216*
10. Cars	200*	n.s.	n.s.	n.s.
12. a. No. of comp. at home	n.s.	n.s.	n.s.	n.s.
12.c. Comp. use school outside lessons	n.s.	n.s.	n.s.	n.s.
12.d. Int. use elsewhere	n.s.	.198*	n.s.	n.s.
13.a. Satisfied int. access	n.s.	n.s.	n.s.	n.s.

13.c. Afraid of int.	n.s.	.251*	n.s.	277**
14.a. Hours int. per week	n.s.	n.s.	n.s.	n.s.
14.b. Int. failure	.194*	n.s.	n.s.	n.s.
14.c. Neg. exp. Int.	n.s.	n.s.	n.s.	n.s.

Appendix 7: Tables 22-23 of Generalised Item Analysis Statements of items 1-16 of the partly simulated performance assessment test of students' confidence in accessing information

Table 22: Generalised item analysis statements of items 1 to 8

	: Generalise SED ITEM ANA		Response M	odelling	Softwa	re	Thu Mar	12 12:46:
 tem 1								
 tem:1_(1	L)							
	this item eshold(s)		Discrimi Weighted					
Label	Score	Count	% of tot	Pt Bis	t			WLE SD:1
0 1	0.00 1.00	23 84	21.50 78.50	-0.64 0.64	-8.44 8.44	(.000)	-1.25 0.60	1.07 0.94
tem 2								
	2) this item eshold(s)		Discrimi Weighted					
Label	Score	Count				(p)	WLEAVg:1	WLE SD:1
0	0.00	28	26.17	-0.63	-8.25	(.000)	-1.06	1.11
1	1.00	79 	73.83	0.63	8.25	=====	0.65	0.93
tem 3								
item:3 (3 Cases for Ctem Thre	3) this item eshold(s)	107 -0.76	Discrimi Weighted					
Label	Score	Count	% of tot			(p)	WLEAvg:1	WLE SD:1
0 1	0.00 1.00	33 74	30.84 69.16	-0.53 0.53		(.000) (.000)	-0.75 0.63	1.33 0.92
Item 4  item:4 (4	1)							
ases for	this item		Discrimi Weighted					
Label	Score	Count	% of tot	Pt Bis		(p)	WLEAvg:1	WLE SD:1
0 1	0.00 1.00	65 42	60.75 39.25	-0.44 0.44	-4.98 4.98	(.000) (.000)	-0.23 0.88	1.14 1.06
Item 5								
item:5 (	(5)							
Cases fo Item Thr	r this item eshold(s)	0.11	Discrimi Weighted					
Label	Score	Count			t	(p)	WLEAVg:1	WLE SD:1
0 1	0.00	51 56	47.66 52.34	-0.44 0.44	-5.04 5.04	4(.000	) -0.37 ) 0.73	1.19 1.03
Item 6  item:6 (	·6)							
Cases fo	or this item eshold(s)			nation MNSO	0.53 1.08			
Label	score	Count				(p)	WLEAvg:1	WLE SD:1
0 1	0.00 1.00	58 49	54.21 45.79	-0.53 0.53	-6.3	3(.000	) -0.38 ) 0.90	1.12 0.97
							, 3.30	
Item 7	7)							
item:7 ( Cases fo Item Thr	./) or this item reshold(s)	107 -1.16	Discrimi Weighted	nation MNSQ	0.51 0.87			
Label	Score	Count						
0 1	0.00 1.00	26 81	24.30 75.70	-0.51 0.51	-6.0 6.0	1(.000) 1(.000)	) -0.89 ) 0.55	1.31 0.98
 Item 8								
item:8 (	(8) or this item	107	Discrimi	nation	0.41			
	r this item eshold(s)							
	Score							
0	0.00 1.00	72	67.29	-0.41	-4.64	4(.000	) -0.14	1.21

Table 23: Generalised item analysis statements of items 9 to 16

Item 9	->							
item:9 ( Cases for Item Thr	9) r this item eshold(s) 	107 -1.16	Discrimi Weighted	nation MNSQ	0.49 0.92			
Label	Score	Count	% of tot	Pt Bis	t	(p)	WLEAVg:1	WLE SD:1
0 1	0.00 1.00	26 81	24.30 75.70	-0.49 0.49	-5. 5.	80(.000) 80(.000)	-0.86 0.55	1.27 1.01
Item 10								
item:10 Cases for Item Thr	(10) r this item eshold(s)	107 1.36	Discrimi Weighted	nation MNSQ	0.37 1.07			
Label	Score	Count	% of tot	Pt Bis	t	(p)	WLEAVg:1	WLE SD:1
0 1	0.00 1.00	77 30	71.96 28.04	-0.37 0.37	-4. 4.	04(.000) 04(.000)	-0.09 0.95	1.07 1.31
====== Item 11								
item:11 Cases for Item Thr	(11) r this item eshold(s)	107 2.29	Discrimi Weighted	nation MNSQ	0.22 1.16			
Label	Score	Count	% of tot	Pt Bis	t	(p)	WLEAVg:1	WLE SD:1
0 1	0.00 1.00	91 16	85.05 14.95	-0.22 0.22	-2. 2.	33(.022) 33(.022)	0.08	1.15 1.45
======= Item 12								
item:12 Cases for Item Thr	(12) r this item eshold(s)	107 -1.78	Discrimi Weighted	nation MNSQ	0.46 0.88			
Label	Score	Count	% of tot	Pt Bis	t	(p)	WLEAVg:1	WLE SD:1
0 1	0.00 1.00	17 90	15.89 84.11	-0.46 0.46	-5. 5.	24(.000) 24(.000)	-1.09 0.45	1.28 1.07
Item 13								
item·13	(13) r this item eshold(s)	107 1.25	Discrimi Weighted	nation MNSQ	0.34 1.17			
Label	Score	Count	% of tot	Pt Bis	t	(p)	WLEAVg:1	WLE SD:1
0 1	0.00 1.00	75 32	70.09 29.91	-0.34 0.34	-3. 3.	70(.000) 70(.000)	-0.08 0.86	1.08 1.34
Item 14								
item:14 Cases for Item Thr	(14) r this item eshold(s)	107 0.43	Discrimi Weighted	nation MNSQ	0.48 0.98			
Label			% of tot					
0 1	0.00 1.00	58 49	54.21 45.79	-0.48 0.48	-5. 5.	68(.000) 68(.000)	-0.34 0.84	1.10 1.07
Item 15								
item:15 Cases for Item Thr	(15) r this item eshold(s)	107 1.05	Discrimi Weighted	nation MNSQ	0.47 1.04			
	Score	Count	% of tot	Pt Bis	t			
0 1	0.00 1.00	71 36	66.36 33.64	-0.47 0.47	-5. 5.	51(.000) 51(.000)	-0.21 1.02	1.11 1.05
 Item 16								
item:16	r this itom	107 -1.55	Discrimi Weighted	nation MNSQ	0.22 1.26			
Item Thr	(16) r this item eshold(s) Score	-1.55 	Weighted	MNSQ	1.26	(p)	WLEAVg:1	WLE SD:1

Appendix 8: Figures 38-49: The item-person maps of the one- and two-dimensional model of the large-scale, simulation-based assessment

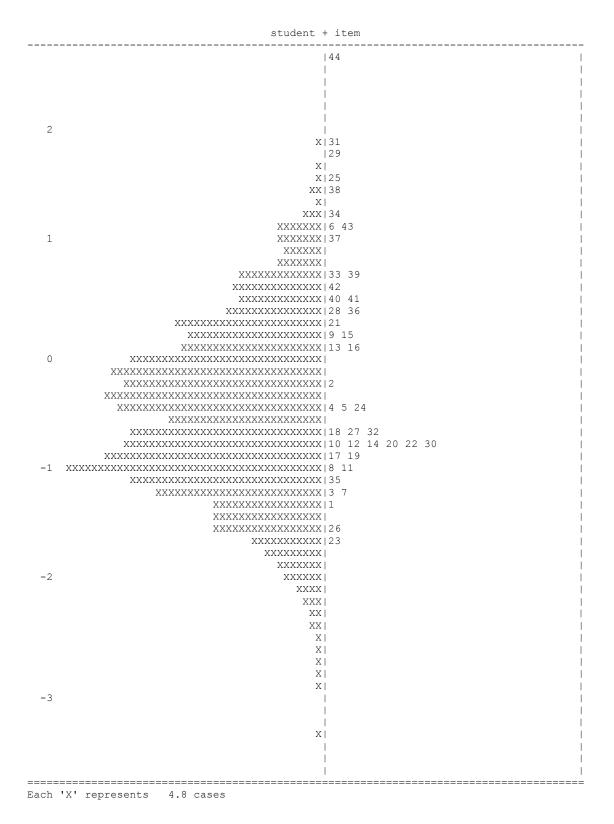


Figure 38: The item-person map of the one-dimensional model of the large-scale assessment of Grade 6 (with each x representing 4.8 cases)

Dimension 1 students	+ items	Dimension 2 students -	+ items
			44
3	 		 
			İ
X	29 		2
2 X	l		į
X XXX			 
XXX XXX	6 37		6
XXX	l		31
XXXXXX XXXXXX		X	
1 XXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXX	28	X	25
XXXXXXXX	•	X XX	
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		XX XXX	
XXXXXXXXXXXX	İ	XXXX	i i
XXXXXXXXXXX XXXXXXXXXXXXXX	•	XXXXX XXXXX	
0 XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	•	XXXXXX XXXXXXX	
XXXXXXXXXXXXXXX	10 12	XXXXXXXXXX	21
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	•	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	
XXXXXXXXXX XXXXXXXX	•	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	
XXXXXXXX	İ	XXXXXXXXXXXXXXXXX	i i
-1 XXXXXXX XXXXXX		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	 
		XXXXXXXXXXXXXXXXXXXXXX	11 22 30 32
XXXXX XXX		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	
XXX XX		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	
-2 X		XXXXXXXXXXX	
X X		XXXXXX	i i
	 	XXXXX	
		XXX	İ
	 	XX XX	
-3	 	X X	
	  -		į
4			į
-4	 		 
	 =======		 ====================================

Each 'X' represents 11.1 cases

Figure 39: The item-person map of the two-dimensional model of the large-scale assessment of Grade 6 (with each x representing 11.1 cases)

```
student + item
                  | 44
 3
                  ΧI
                  ΧΙ
                 XX I 31
                 XX |
                 XX | 29
                 XX |
               XXXXXXX | 25
               XXXXXXXI
                XXXXX |
               XXXXXXX|34 38
             XXXXXXXXXXX | 6
             1
             XXXXXXXXXXXX | 43
            XXXXXXXXXXXXXX | 37
         -1
       XXXXXXXXXXXXXXXX | 3 7
           XXXXXXXXXXXXXXXXX | 1
           XXXXXXXXXXXXXXXX | 35
              XXXXXXXXXXX
              XXXXXXXXXXXI
               XXXXXXXX|23 26
                XXXXX |
-2
                XXXXI
                 XXX |
                 XXX |
                  ΧI
                  ΧΙ
                  ΧI
-3
Each 'X' represents 3.9 cases
```

Figure 40: The item-person map of the one-dimensional model of the large-scale assessment of Grade 7 (with each x representing 3.9 cases)

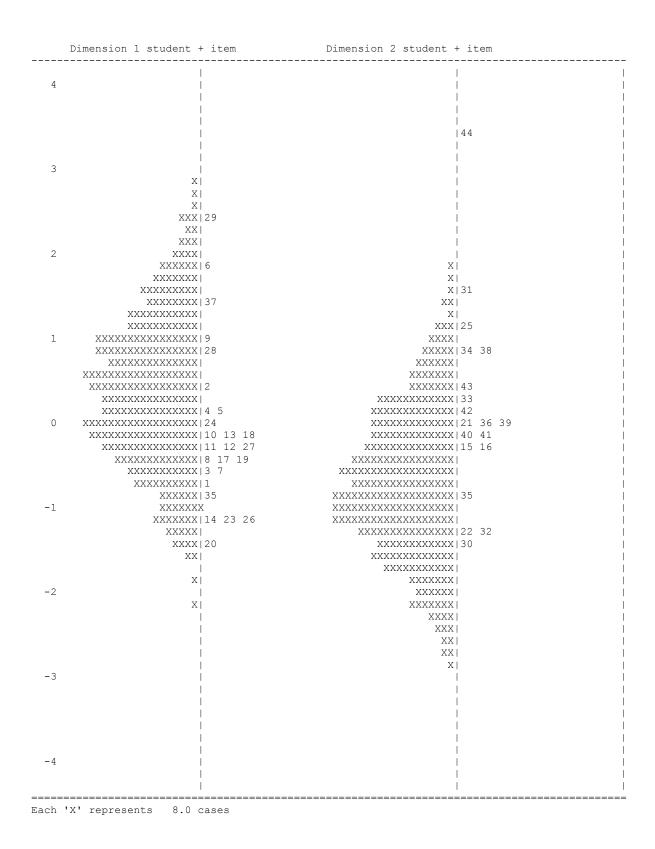


Figure 41: The item-person map of the two-dimensional model of the large-scale assessment of Grade 7 (with each x representing 8.0 cases)

```
student + item
               | 44
 3
               ΧΙ
               ХΙ
              XX |
              XXX |
             XXXXXX |
 2
             XXXXXXXI31
             XXXXXX |
             XXXXXX|25 29
           XXXXXXXXXXXX |
          XXXXXXXXXXXX | 6
         XXXXXXXXXXXXXXXI34 38
      1
      -1
         XXXXXXXXXXXXXXXXII 3 8 17 20
         XXXXXXXXXXXXX
           XXXXXXXXXXXI23
            XXXXXXXXXX | 26
             XXXXXXX |
              XXXXI
-2
              XXXX |
              XXXX |
               ΧI
               ΧI
               ΧI
               ΧI
-3
               Х |
               ΧΙ
Each 'X' represents 3.1 cases
```

Figure 42: The item-person map of the one-dimensional model of the large-scale assessment of Grade 8 (with each x representing 3.1 cases)

	Dimension 1 student +		- ILE		
4	ļ	i			
			44		
		i			
		I			
3	X   X				
	XX				
	XX	i			
	XXX				
	XXXXX XXXXXX	X I			
2	XXXXXXXX	X			
	XXXXXXX	X			
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXX   XXX			
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXX			
	XXXXXXXXXXXXXXX	XXXXX	25		
1	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXX			
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXX   XXXXXXXXX		8	
	XXXXXXXXXXXXXXXXXXX	XXXXXXXXXX			
	XXXXXXXXXXXXXXXXXX	XXXXXXXXXXX			
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXX   XXXXXXXXXXXXX			
0	XXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		9 40 42	
	XXXXXXXXXXXXXXX	XXXXXXXXXXXXXX			
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		6	
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXX   XXXXXXXXXXXXXX			
	XXXXXXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			
1	XXXXXXX	XXXXXXXXXXXXXXXX			
1	XXXXX XXXXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			
	XXX	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX			
	XX	XXXXXXXXXX			
	X	XXXXXXXXX   XXXXXXXX			
2	X	XXXXXXX			
		XXXXX			
		XXXX			
		XXX   XX			
	j	X			
_		X			
3					
	j	Х			
4					
	İ	i			
		!			

Figure 43: The item-person map of the two-dimensional model of the large-scale assessment of Grade 8 (with each x representing 6.8 cases)

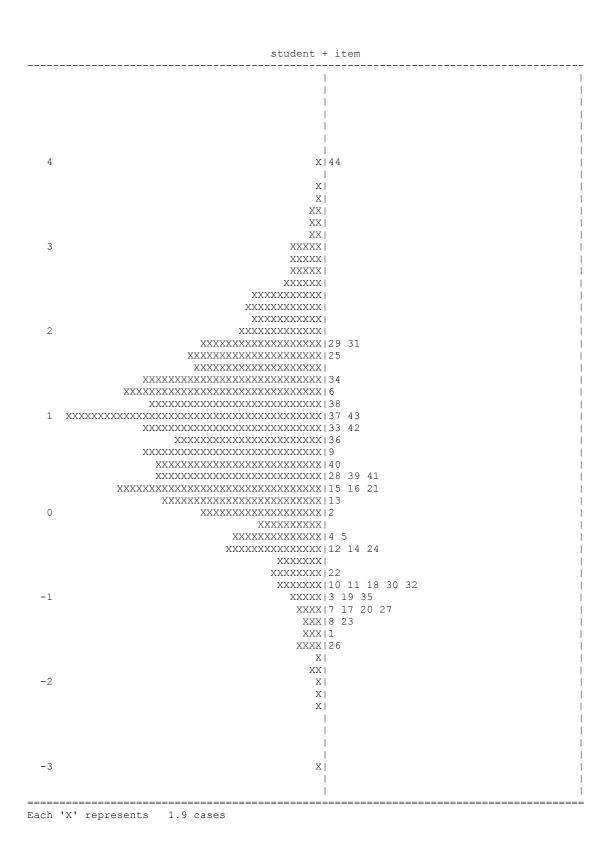


Figure 44: The item-person map of the one-dimensional model of the large-scale assessment of Grade 9 (with each x representing 1.9 cases)

	Dimension 1 student +						em 	
_					!			
5								
					ľ			
	i				i			
	ĺ				I			
4					ļ			
	XX				ľ	44		
	XX				i			
	XXX				I			
3	XXX				I			
	XXXXX				X			
	XXXXXXX				XX   XX			
	XXXXXXXX				XX			
	XXXXXXXXXX				XXXX			
2					XXXXX			
	XXXXXXXXXXXXXX				XXXXX			
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				XXXXXXX			
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				XXXXXXXX			
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				XXXXXXXXXX   XXXXXXXXXXX			
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX				XXXXXXXXXX			
1	XXXXXXXXXXXXXXX				XXXXXXXXX			
	XXXXXXXXXXX	28		XXXXXX	XXXXXXXXX			
	XXXXXXXXXXXXXX				XXXXXXXXX			
	XXXXXXXXXXXX				XXXXXXXXXX		4.0	
	XXXXXXXX				XXXXXXXXXX   XXXXXXXXXXX		42	
0	XXXXXXX				XXXXXXXXXXXXXXXX			
Ü	XXXXXX				XXXXXXXXXX			
	XXXX	10 18		XXXX	XXXXXXXXX	15	16 21	
		3 11 13 1	.9 35		XXXXXXXXX			
		7 17 27		X	XXXXXXXXXX			
.1		8 23 1 14			XXXXXXXXX			
Τ.		26			XXXXXXX			
	X				XXXXXX			
	i				XXXXXX			
	X				XXXX			
_					XXX			
2		20			XX			
	X				X			
	21				X			
	i				i			
					I			
2					X I			
3					77.1			
					X			
					i			
	ļ				X I			
4					I			

Figure 45: The item-person map of the two-dimensional model of the large-scale assessment of Grade 9 (with each x representing 3.9 cases)

```
student + item
 4
                      X | 44
                      ХΙ
                      ΧI
                      ΧI
                      XX |
                    XXXXX |
 3
                    XXXXXI
                    XXXXXX |
                    XXXXX |
                  XXXXXXXXXXI
                 XXXXXXXXXX |
                 XXXXXXXXXXX | 31
 2
                XXXXXXXXXXX |
            XXXXXXXXXXXXXXXXX | 25
          XXXXXXXXXXXXXXXXXX | 4 13 14
                  XXXXXXXXXX | 2 5 24
                 XXXXXXXXXXXXI12 22 30
                XXXXXXXXXXXXXI18 32 35
 -1
                  XXXXXXXXXI27
                  XXXXXXXXX | 1 3 10 11 19
                   XXXXXXXX|8 17 20 23
                   XXXXXXX | 7
                     XXXI
                     XXX | 26
                      XX |
 -2
                      ΧI
                      ΧΙ
                      ΧΙ
 -3
                      ΧI
                      ΧΙ
Each 'X' represents 1.7 cases
```

Figure 46: The item-person map of the one-dimensional model of the large-scale assessment of Grade 10 (with each x representing 1.7 cases)

	Dimension 1 student +	tem	Dimension 2 student	+ item
	I			 
5				 
J				
				<u> </u>
4	X			' 
			X	
	X   X			   4 4
	XX		X	
_	XX		X	
3	XXXXX XXXXXX		XX XX	
	XXXXXXX		XXXX	
	XXXXXXXX		XXX	
2	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		XXXX XXXXXX	
_	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		XXXXXX	
	XXXXXXXXXXXXXXXXXX		XXXXXXX	
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		XXXXXXXX	
1	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		XXXXXXXXXX XXXXXXXXXXX	
	XXXXXXXXXXX		XXXXXXXXXXX	
	XXXXXXXXXXXX		XXXXXXXXXXXXXXX	
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	
0	XXXXXXXXX		XXXXXXXXXXX	
	XXXXXXX		XXXXXXXXXXXX	
		18	XXXXXXXXX XXXXXXXXXX	
		8 17 23	XXXXXXXX	
		7 13 14	XXXXXXX	
1	X	26  30	XXXXXXX XXXXXXX	
		32	XXXXXX	
			XXXXX	
2	X	20	XXXX	'
2			XXXX XXXX	
	Ì		XXX	
			XX	'
3			XX X	
	į		X	I
				[ 
4	Ì		X	
			X	
_				
5				 
				1 

Figure 47: The item-person map of the two-dimensional model of the large-scale assessment of Grade 10

```
student + item
                  ΧI
                  ΧΙ
                  ХΙ
                  X | 44
                  ΧI
                 XXX |
                XXXXXX |
                 XXXX I
                 XXXX |
                XXXXXXX |
              XXXXXXXXXXX
            XXXXXXXXXXX |
             XXXXXXXXXXXX |
          2
         1
        XXXXXXXXXX | 15
             XXXXXXXXXXX |
            XXXXXXXXXXXXXX | 16
                XXXXXXX | 5
                XXXXXX|4 13 14
                XXXXX|2 12
                 XXXX | 24
                XXXXX | 10
                 XXXX | 22
                 XXX|18 32
-1
                 XXXXX|1 19 27 35
                  XX|3 11 17 23
                  XX|8 30
                  XX | 7
                  X|20
                  XX | 26
-2
                  ΧI
Each 'X' represents 0.9 cases
```

Figure 48: The item-person map of the one-dimensional model of the large-scale assessment of Grade 11 (with each x representing .9 cases)

			Dimension 2 student +	
		 		 !
5				 
	i			İ
	I			I
	X			
	X   X		X	 
4	X			
	XX		X	
	XX			
	XXX		V	'
	XXXX XXXXX		X	4 4
	XXXXX		XX	
3	XXXXXXX		XX	
	XXXXXXX		XX	
	XXXXXXXXXXXX		XXXXX	
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		XXXXXX XXXXXX	'
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		XXXXX	
2	XXXXXXXXXXXXXXXXX		XXXXXXXX	
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		XXXXXXXXX	'
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		XXXXXXXX	
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	'
	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX		XXXXXXXXXXXXXXXX	
	XXXXXXXXXXXXXXX		XXXXXXXXXXXXXXXX	'
1	XXXXXXXX	9 28	XXXXXXXXXXXXXXX	
	XXXXXXX		XXXXXXXXXXXXX	
	XXXXXXX		XXXXXXXXXXXXXX	
	XXXX XXXX		XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX	•
		2 12	XXXXXXXXX	
0	XXX		XXXXXXXXX	
	XX		XXXXXXX	
	XX		XXXXXXX	
		1 27  3 11 17 19 23 35	XXXXXX XXXXXX	
		8 13 14	XXXX	
-1		7	XXXX	
	I		XXXX	
		26	XXX	
	X		XX XX	•
	21		X	
	i		XX	
-2	I		X	I
		20		
				[ 
			X	
	į			
-3				
			17	
			X	 
	i			I

Figure 49: The item-person map of the two-dimensional model of the large-scale assessment of Grade 11 (with each x representing 2.2 cases)

## Appendix 9: Table 37: Correlations between academic achievements and ICT literacy test results across grades

Table 37: Correlations between academic achievements and ICT literacy test results across grades

	Foreign lang.	Hunga- rian	Maths	Science	History	Biology	Physics	Geog- raphy	Chemist ry	Music	IT	Con- duct	Art	Dili- gence	P.E.
Grade 6	,470 <sup>**</sup>	,478 <sup>**</sup>	,487**	,446 <sup>**</sup>	,491 <sup>**</sup>	,087**	,110**	,120**	,070**	,228**	,403**	,339**	,225**	,453 <sup>**</sup>	,218**
Grade 7	,518 <sup>**</sup>	,568**	,513**	,347**	,521**	,485**	,456**	,493**	,461**	,360**	,428**	,369**	,222**	,492 <sup>**</sup>	,224**
Grade 8	,401**	,433**	,430**	,383**	,360**	,433**	,461**	,361**	,376**	,266**	,298**	,249**	,139**	,342**	,147**
Grade 9	,323**	,308**	,330**	,190**	,308**	,198**	,133**	,222**	,166**	-,067	,318**	,086*	-,019	,164**	,023
Grade 10	,261**	,283**	,215**	,142**	,283**	,318**	,268**	,239**	,279**	,076	,302**	,188**	-,122**	,206**	,163**
Grade 11	,227**	,352**	,155 <sup>*</sup>	,143 <sup>*</sup>	,326**	,118	,157 <sup>*</sup>	,276**	,215**	,268**	,227**	,197**	-,047	,162**	,092

## Appendix 10: Table 17: Item-total correlations statistics of the 16 items selected in the second phase of test development

Table 17: Item-total correlations statistics of the 16 items selected in the second phase of test development

bach if Item eted '1
eted '1 '1
'1 '1
'1
'2
'3
'3
'2
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'3
'2
'3
<b>'</b> 4
'2
'4
'2
'2
'4

Appendix 11: Table 38: Result of regression analysis with the performance assessment test of accessing information as a dependent variable across grades

Table 38: Result of regression analysis with the performance assessment test of accessing information as a dependent variable across grades

Dependent Variable: Accessing Information Test						
Independent Variable/	Grade (Year)					
Effect %	6	7	8	9	10	11
Gender	(1.7)	.1	4.9	(.5)	(0)	(.2)
R.Coursebook	6.2	7.2	7.9	(2.7)	3.8	(3.4)
R.Mag	(2.3)	4.2	3.5	(2.8)	(-1.2)	(3.7)
DigitNonClickText	(2.8)	5.8	5.8	(1.9)	5.5	(6)
SimpleCalc.	(1.4)	4.6	(2.1)	5.2	3.9	8.7
WebTextNonClick	(2.5)	(3.4)	(.2)	(1.3)	(-3.7)	(5.4)
WebTextClick	(1.2)	5.3	(2.1)	(1.9)	4.9	(4.9)
WebDiagr	(1.1)	(2.3)	(2.8)	4.8	(2.9)	(2.4)
WebListening	(-3.1)	-5.7	.5	-4.6	(-3.7)	(-3.1)
RollDownMenu	(2.9)	(3.1)	7.7	(3.6)	11.2	(2.2)
DecReliableSource	(2.2)	-3.9	-4.7	-4.6	(-3.2)	-8.4
DecMostApprGoals	(.6)	5.5	(1.1)	(3.8)	(-2.1)	12.5
DecOffensiveWritten	(1)	(1.2)	(.3)	(.9)	(5)	7.8
DecLegal	3.8	4.8	(-1.3)	(.7)	(-1.1)	(-1.9)
DecHealthyBodyPosture	-6.9	-5.7	(.1)	-4.8	-6.6	-11.7
DecPhysicalmentalhealth	4.7	(1)	(.9)	6.7	(1.6)	10.9
DecPersOnlineSecurity	5.9	4.9	5.9	(-1.7)	5.2	(.8)
All Known Effect	13.7	27.1	31.5	2.7	27.9	19.8

## Appendix 12: Table 39: comparing item difficulty based on mean achievements and item thresholds in the test of phase two

Table 39: Comparing item difficulty based on mean achievements and item thresholds

Task N <sup>o</sup>	Task Name (Translated)	Boys' Diff. Order by Means	Girls' Diff. Order by Means	Item Nº	Item Name (Translated)	Item Threshold	Difficulty Level
1	Jeweller's	2	1	1	Jeweller's	-1.34	Easy
2	Navigate back	5	2	2	Navigate back	-1.04	Easy
3	Project	4	3	3	Project	76	Easy
4	Type search term	<u>10</u>	7	4	Type search term	.76	<u>Hard</u>
5	Netgift	6	6	5	Netgift	.11	Medium
6	Presentation	8	4	6	Presentation	.43	Medium
7	Wiki (Online harassment)	1	2	7	Wiki (Online harassment)	-1.16	Easy
8	Hairgel	<u>9</u>	<u>9</u>	8	Hairgel	1.10	<u>Hard</u>
9	Local paper1	3	1	9	Local paper1	-1.16	Easy
10	Local paper2	<u>12</u>	8	10	Local paper2	1.36	<u>Hard</u>
11	Wingsuit	7	5	11	Wingsuit2_d 2_free	2.29	<u>Hard</u>
11		it / 5	3	12	Wingsuit 2_there_is-1	-1.28	Easy
	Decoration	oration <u>13</u> <u>1</u>		13	Decoration _response_2	1.25	<u>Hard</u>
			<u>10</u>	14	Decoration _response_n ormal	0.43	Medium
12				15	Decoration _ response _szalagos	1.05	<u>Hard</u>
				16	Decoration _ response _vilagito	-1.55	Easy
13	Aqualand	<u>14</u>	<u>11</u>				
14	Skiing	11	9				
	Difficulty order by mean achievements: 1–5 Easy; 6–8 Medium; <u>9–14 Hard</u>						

Appendix 13: Table 40: Possible future item development areas of the accessing information component of ICT literacy regarding ability levels per dimension in each grade based on the large-scale simulation-based performance assessment test

Table 40: Possible future item development areas of the accessing information component of ICT literacy regarding ability levels per dimension in grades 6-11

Grade	Dimension	Further Items Suggested	Item Development Suggested
		on Ability Level (Logit)	for Ability Level (Logit)
6∆			1 to 1.5
	1	0 to 1.5	0 to 0.5
		0 to 1.5	-1.5 to -2.5
			-3.5
	2		-0.5 to -1
			-1.5 to -3
7∆	1	-1.5 to 2.5	3
	1	-1.5 to 2.5	-1.5 to -2
	2		2
		-1.5 to 1	0 to -1
			-1.5 to -3
	1	2	
<u>8</u> Δ -		0 to 3.5	
84	2	.5 to 1.5	1.5 to 3
		0 to -1.5	-1.5 to -4
	1		2.5 to 3.5
			-2.5
9∆			1.5 to 3
	2	.5	5 to15
			-2 to -4
10	1		2 to 4
	2		4
			-4 to -1
	1		2 to 4.5
11	2		4
	2		-3 to -2
		$^{\Delta}$ Item 44 too difficult (substitution	on suggested)

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