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MEASURING ICT LITERACY AMONG GRADE 5-11 STUDENTS:

CONFIDENCE IN ACCESSING INFORMATION

THESES OF THE DISSERTATION

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INTRODUCTION AND THEORETICAL BACKGROUND

Our 21st century society witnesses a technological development, which has resulted in in the re-evaluation of knowledge. The importance of the ability to use knowledge to achieve certain purposes has been highlighted. The notion of literacy has been reconceptualized (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 conscious studying, working or responsible citizenship (Binkley et al., 2010; Griffin et al., 2012; UNESCO & Microsoft, 2011; NAGB, 2013). In the more and more computerized world of work the expectations of performance oriented employers towards employees now involve the ability of solving problems though efficient information search (Leu, Kinzer, Coiro, Castek, & Henry, 2017).

The new concept of literacy involves confident application of online search strategies (Leu et al., 2017). Without the elements of effective navigation in an Internet environment and further elements of digital literacy, our 21st century daily chores such as banking, investigating health care, travel or legal services, using the software applications at work, project and course registrations during our life-long learning or keeping contact might not be realized efficiently (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2015; Commission of the European Countries, 2005). Using ICT is an essential tool for responsible citizenship and decision making as well (Czirfusz, Habók, Lévai, & Papp-Danka, 2015; Commission of the European Countries, 2005). In our developed society millions of people use the internet both for communicating and as a source of information. Because of the exponential growth of the worldwide web (Nelliyullathil, 2013) the ability to handle the flow of information in a critical way has become an indispensable asset (Metzger & Flanagin, 2013).

Owing to the ever-accelerating technological development, the need for digital literacy has brought about changes in education and has triggered novel ways of assessing and developing 21st century skills (Molnár, 2011). Assessment and developing of ICT literacy 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). Research into both technology-based assessment (Csapó, Molnár, & R. Tóth, 2008), development and applicability have seen

a rapid improvement in national and international contexts as well – among many other examples – from computer game (Pásztor, 2014) and digital storytelling-based (Karakoyun & Kuzu, 2013; Lanszki & Papp-Danka, 2017; Tongori, 2017) development to the applicability of mlearning (Abonyi-Tóth & Turcsányi-Szabó, 2015), virtual reality (Ollé, 2012) or the implementation of technology in special education (Szili, 2014).

The theoretical basis for defining ICT literacy within digital literacy was provided by reviewing the literature. Within digital literacy, which partly involves information literacy, ICT literacy could be described as a construct having intersections with media and technological literacy (Molnár, Tongori, & Pluhár, 2015). When defining ICT or digital literacy, researchers and research groups have constantly extended its concept by adding further elements (Tongori, 2012). Summarising the diverse terminology, the notion of a complex construct is formed, where the seven components (of define, access, manage, integrate, evaluate, create and communicate) related to the steps of information handling (American Library Association, 2000; Association of College and Research Libraries, 2016) and based on the essential abilities of reading, writing, numeracy, technology use and thinking skills (Partnership for 21st Century Skills, 2008; Catts & Lau, 2008), are interwoven with further aspects of social competencies (Commission of the European Countries, 2005), health (Partnership for 21st Century Skills, 2008 related) and personal safety related (Aoyama, Barnard-Brak, & Talbert, 2011), legal (American Library Association, 2000) and ethical (Eurydice, 2002) aspects. Measuring this construct and especially its most essential component – from the perspective of everyday life management – accessing information has been chosen as the focus of our research.

Our literature review suggested that in terms of assessment instruments, from among the technology or computer based ones, third generation measurement instruments (Csapó, Ainley, Bennett, Latour, & Law, 2012; Molnár, Greiff, Wüstenberg, & Fischer, 2017) based on simulation of real software applications have proved to be the most authentic for gauging ICT literacy and its accessing information component. It is because the characteristics of the items in such tests are the closest to those of the dynamically changing, interactive applications encountered through online activities (Fu, Zapata & Mavronikolas, 2014). The fact that computers and technology play a central role in developing students' ICT literacy, justifies their involvement in ICT literacy performance assessment (Bennet et al., 2007 as cited in Csapó et al., 2012, p. 147).

Awareness of the factors discussed has led the most prominent, internationally recognized research groups carrying out educational assessment to apply simulation-based instruments to measure ICT literacy. Among such institutions internationally reputed for large scale educational assessment of ICT literacy using simulation-based tests, the Australian National Assessment Governing Board (ACARA, 2015; Fraillon, Schulz, Gebhardt, & Ainley, 2015), the International Association for the Evaluation of Educational Achievement (ICILS, 2014; Fraillon et al., 2015), the Centre for Information in Education (CITE) of the University of Hong Kong (Law et al., 2009), the American Educational Testing Service (ETS, Katz & Macklin, 2007), or the National Assessment Governing Board (NAGB, 2013; The Nation's Report Card, n.d.) must be mentioned. Regarding methods (in addition to the shared type of simulation-based assessment instrument), except for ETS – which focussed on ICT literacy assessment of students in higher education –, the subjects of the tests administered by these institutions were altogether between grades 5-10 students. Among their numerous results, some of the common ones noticeable in terms of our research goal setting are marking the period of a remarkable change in the development of ICT literacy between grades 8 and 10 (ACARA, 2012, 2015), detecting a significant diversion between girls' and boys' results (ACARA, 2015; ICILS, 2014; NAGB, 2013) and concluding from data analysis that self-reported frequency of ICT use is not correlated with ICT literacy performance test results (ACARA, 2012, 2015; Katz & Macklin, 2007). Further investigating these phenomena, useful information could be gained for education regarding the target groups.

AIMS AND HYPOTHESES

The overall objective of the whole research project was to devise and apply an instrument to assess those abilities of grades 5-11 students, which are necessary for confident information search in a digital environment. During the four-phase research project three pilot assessments and one large-scale assessment were carried out. To ensure that each phase is built upon the previous one and that there is a connection between them, all through the project the focus was on devising an assessment instrument to map grade 5-11 students' ICT literacy regarding a single component that is accessing information and to apply the instrument to assess the target group's respective ICT literacy component.

The first phase of the research project: a questionnaire

Our aim with the questionnaire devised in this phase was to map – from different perspectives – students' self-reported confidence in accessing information and on the other hand, to test the reliability of the questionnaire. Grade 7 and 10 students were asked about their confidence in, use of and attitudes towards computers and the internet – and within this their technology use – use. In addition, our aim was also to collect data about the frequency of students' computer and internet use, affective and socio-economic background variables, and besides, to compare the two genders' responses. Our hypotheses based on the literature were as follows:

(H1.1) Most of the students will report themselves as totally confident in using social network sites. Activity on social network sites will be reported as one the most time spent on compared with other online activities.

(H1.2) The number of students' totally confident in interpreting online visual and audial information in general, as opposed to printed information would be higher.

(H1.3) In general, the most frequented activity by grade 7 students wll be playing computer or online games, while 10th-graders are expected to report online socialising activities and school-related information seeking as their most frequently pursued ones.

(H1.4) Girls will report themselves more confident in digital reading and typing related activities, whereas boys are assumed to report more confidence in using technology for games.

(H1.5) Lower grade students and girls in general are 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.

(H1.6). Our questionnaire is expected to be reliable.

The second phase of the research project: a partly simulation-based performance assessment test

In the second phase of the research, a partly simulation-based online performance test was devised to gain direct information about students' activated abilities in the confident use of ICT literacy – mainly about one component of it, that is accessing information –, as opposed to questionnaires, whose data collection is executed indirectly. Students' online technology use

regarding information search was also to be mapped. As part of the test development process, testing the reliability, validity, the items regarding difficulty and discrimination and model fit of the assessment instrument were also among our aims as well as examining its feasibility and applicability in a public education setting. According to our hypotheses:

(H2.1) Based on the order of information handling processes (Bawden, 2008), task difficulty reflected by task mean scores will be at mostly identical with the sequence of tasks in the test administered.

(H2.2) There is a relationship between successful task completion – which is related to ability levels and task difficulty – and the time spent completing it across all grades and genders.

(H2.3) 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.

(H2.4) The set of tasks compose a reliable and valid assessment instrument to gauge the (tested) students' ICT literacy performance in the access dimension. The requirements of convergent and discriminant validity (to achieve construct validity) could be tested by analysing correlations between responses to those parts of the self-assessment questionnaire and the performance test which are expected to be related (Sommerville, Smith, & Macklin, 2008; Katz & Macklin, 2007).

(H2.5) In the access component of students' ICT literacy there will be significant differences between the genders and grades.

(H2.6) The items of the test will discriminate.

(H2.7) Task difficulty will cover most of the ability range of the students.

(H2.8) A high model fit is presumed with similar MNSQ values across selected items.

The third phase of the research project: a totally simulation-based performance assessment test

The primary goal of the third phase was achieving the highest possible level of authenticity by simulating navigation in a real, web-based environment. To achieve that, the simulated web environment of the simulation-based tasks of the previous phase were used to further develop the test into an explicitly information search focussed one. With the parallel development of eDia online platform (Molnár & Csapó, 2013; Molnár et al., 2015a), the test

could be reshaped to have an even more standardised, novel framework structure. This could also serve our aim to increase the internal consistency of the test. Empirical confirmation of validity by examining the model fit was also one of our goals. We aimed at mapping the confidence of grade 5, 6, 8 and 10 students in the information search component, examining how well the items discriminate the students according to their abilities and how well the items cover the ability range of the students. We also intended to investigate the time need across grades and the differences between the results across grades. We hypothesized that:

(H3.1) The internal consistency of the test will be higher than in the earlier version.

(H3.2) A 45-minute time frame to complete the performance assessment test will provide enough time for all levels.

(H3.3) The performance of the higher-grade students will be better than that of the lower grade students.

(H3.4) Higher grade students will complete both parts of the assessment (test and questionnaire) within a shorter time than lower grade students.

(H3.5) Validity will be confirmed by applying one dimensional structural equation modelling (SEM) using the Mplus software for a good model fit.

The fourth phase of the research project: a large-scale, totally simulation-based performance assessment

The aim of the fourth phase was to re-confirm that it is possible to devise an assessment instrument giving instant feedback for a wide age span in public school settings to gauge the efficiency of accessing information in a computer and simulation-based environment. We intended to examine the reliability of the test. One of our aims was to investigate how the different difficulty level items fit the ability level of the sample and how the data fit the theoretical model. In terms of model fit, we were interested in whether the data fit the one- or the two-dimensional model better. We wanted to check whether our further elaborated test development assumptions regarding the different abilities needed for finding easily and less easily accessible information could be empirically proven. A further goal of the phase was to collect information about the efficiency of accessing information of the two genders and grades 6 to 11. Ability levels within grades were to be examined as well. As a final goal, we planned to

analyse background variables and their relationships with the students' test results. Our hypotheses in this phase are as follows:

(H4.1) 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.

(H4.2) Item difficulty of the test items is suitable for the ability level of the age group examined.

(H4.3) The accessing information component of ICT literacy could be characterised by two dimensions rather than one. Distinct abilities operate finding primary information a short search path away and accessing information a longer a more complex path away or needing to visit different sources of primary information to retrieve the one needed.

(H4.4) Development to a significant extent could be detected from grade 6 to 11.

(H4.5) The development of the ability necessary for successful online information search could be described by a logistic curve.

(H4.6) There will be substantial differences between ability levels within the grades.

(H4.7) Girls' level of abilities necessary for confidence in and effectiveness of information seeking tasks will be significantly higher than that of boys'.

(H4.8) Different levels of performance will be detected across different types of school.

(H4.9) There will be significant relationships between students' academic achievements in information technology and test results (H9).

(H4.10) Further relationships will be found between students' test result and their respective questionnaire responses.

METHODS

Regarding samples, the large-scale assessment (N_4=10 064) in the fourth phase of the research was preceded by three small-scale, pilot assessments (N_1=65, N_2=106 and N_3=94). The aim of the whole research project was to assess the accessing information component of ICT literacy of grade 5-11 students. As a result, the grade range of the students was within this grade interval in each phase of the research. However, in each phase a greater number of

grades on a wider scale were involved. The representation of the genders was balanced except for the first pilot research where boys were overrepresented with their 61%. In the samples of phases 2, 3 and 4 the boys were represented by 46%, 52% and 48%.

All of our assessment instruments have been self-devised. Consequently, in each phase they had a binary role: the roles of means and end. Our aim was to assess the confidence of students in ICT literacy through its most essential *access* component. To achieve this goal, the means – the assessment instrument – had to be devised as well.

The self-reported questionnaire in the first phase, asked students about their confidence in carrying out related activities and using certain ICT related devices. Students also answered questions about the frequency of and attitudes towards such activities besides responding to demographical background questions.

In the second phase – besides repeatedly applying the questionnaire –, devising and testing a performance assessment instrument including imitated and simulated websites took place. Imitated websites were stative screenshots of web pages in eDia online platform (Molnár, Papp, Makay, & Ancsin, 2015a) with some opportunities of interactivity by having certain action buttons, clicking on which resulted in the changing of the content displayed, for example, another page of the website. The functioning of the simulated websites, however, was identical with that of real web pages; content was displayed in the form of – and could be reached by navigating – texts, images, tables, graphs and figures within the structure of menus and submenus. Students searched for the information by exiting the platform of the assessment instrument to navigate freely within the simulated websites. On finding the information needed, they returned to the platform of the assessment instrument to record their responses. Regarding themes, the scenario-based tasks were embedded in everyday situations the target grades were familiar with, for example, choosing hair gel, buying decoration material for school projects, printing information found or searching for information (such as the prices or opening hours of a spa) for family programmes.

In the third phase, by creating further items using only the virtual websites of the most authentic, simulation-based tasks of the performance assessment test in the previous phase of the research only, but at the same time restricting the focus strictly on the access component of ICT literacy, we moved toward a third-generation performance assessment with a higher internal consistency. During this phase of the test development, the simulation-based websites

were fully embedded in eDia online platform. This way the students no longer had to leave the platform of the assessment instrument to navigate on the simulated websites, which – as opposed to the earlier test version – provided a uniform framework for better consistency and the opportunity to log every movement made by students while navigating on the simulated websites.

In the fourth phase the assessment instrument was identical with the one applied in the previous phase. However, the items which had not proved to be appropriate – by using item-total correlation analysis – were deselected and omitted.

In terms of procedures, all phases shared the common features of data collection by the instruments (described) having a linear structure and being administered online (in case of the three performance assessment tests in phases 2-4, through eDia online platform), allowing students to access them entering a code using the school computers. Data were analysed by applying descriptive statistics and mathematical statistics (Mann-Whitney Test, ANOVA) in the first phase, and in addition, applying item response theory in the second and fourth, and methods of structural equation modelling in the third and fourth phases.

CONFIRMATION OF HYPOTHESES

In the *first phase of the research project*, *hypothesis 1.1* was 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 1.2* 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%. *Hypothesis 1.3* was confirmed: grade 7 students more frequently play computer games than grade 10 students, while the higher-grade ones are more frequently engaged in online social networking activities. *Hypothesis 1.4* was partly confirmed: 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 ($Z=-3.14$; $p<.01$). *Hypothesis 1.5* was confirmed: with the lower grade students and girls in general a notable number of students had 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. *Hypothesis 1.6* could be regarded as confirmed: the reliability coefficient of the questionnaire was acceptable (Cronbach's α=.85).

Hypothesis 2.1 of *the second phase of the research project* 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 functions of Item Response Theory, 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. *Hypothesis 2.2* was partly confirmed. 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 12). 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 result is lower results. However, further investigation is needed to reveal the causes. *Hypothesis 2.3* regarding the measurability of the access component of ICT literacy within 45 minutes was confirmed: the mean total time was roughly 10 minutes with approximately 25 minutes being the longest time spent in the test. Our *hypothesis 2.4* regarding the reliability and validity of the test was partly confirmed. Internal consistencies of the questionnaire were high (Cronbach's α= .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; by using the item-total correlations analyses as a first step, 16 items – whose

discrimination parameter was also below .2 – were selected which resulted in a reliability measure of Cronbach's α= .74. The items filtered also had a low point biserial index showing the correlation between the students' test result and the result on task. At the same time on these deselected items the mean ability parameter (WLE Avg.) of students giving the wrong answer hardly differed from that of those giving the correct answer, which also suggested the wrong functioning of the items. As a conclusion, further development of the existing items in addition to creating new ones might increase internal consistency of the test. Regarding validity, although construct validity (by confirming convergent and discriminant validity) by detecting correlations between the respective responses to the test and the questionnaire could not be confirmed, the validity of the instrument was proven by empirically confirming model fit presupposed in *hypothesis 2.8*. Our *hypothesis 2.5* regarding achievement differences between genders and grades was partly confirmed. The mean achievement of girls was higher than that of boys in most tasks, however, no significant difference could be detected. In the routine information searching tasks little difference could be detected across grades. *Hypothesis 2.6* was confirmed: the discrimination parameter of all the 16 selected items reached .2 with 14 out of 16 describable with the label (*low-)moderate* regarding their discrimination power. *Hypothesis 2.7* in terms of task difficulty was partly confirmed: 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. Further items need to be developed to cover lower and higher ability levels. Our *hypothesis 2.8* regarding a good model fit was confirmed: MNSQ fit indices of all items were within the confidence interval and varied between the values of .8 and 1.2, which was expected because of the small sample size.

Hypothesis 3.1 of *the third phase of the research project* was confirmed: by further item development and standardization of the framework of the test, internal consistency became higher than in the previous phase. By repeated item-total correlation analysis, reducing the number of the new items from 61 to 45, reliability coefficient was high (Chronbach's α= .92). The time need presumed in *hypothesis 3.2* was partly confirmed. It was hypothesized that two 45-minute sessions for completion of both parts would provide enough time for all levels. 90% of the students in each grade spent less than 90 minutes completing the two parts of the test (performance assessment test and questionnaire) altogether. Hypothesis 3.3 regarding the advantage of higher grades over the lower ones in terms of achievement was confirmed: the

mean achievement 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 component of efficient information search within the construct of ICT literacy, in terms of the sample examined. The advantage of higher graders over the lower ones was also hypothesized (*hypothesis 3.4*) regarding a shorter time to complete the whole – both parts of the – test, which was confirmed. The time on task for the whole test on average varied across grades between 72 and 88 minutes with the higher graders completing the test in a shorter time. In *hypothesis 5* of this phase of the research project we had assumed that a one-dimensional model fit should be confirmed. Validity measures proved to certify, as expected, a good, one dimensional model fit the RMSEA estimate .028 (C.I. .001, .040; Probability RMSEA<= .05; CFI 0,970; TLI 0,969).

In *the fourth phase of the research project* our *hypothesis 4.1* expressing the confirmation of the possibility to devise reliable, third generation online test giving instant feedback on the effectiveness of grade 6 to 11 students' browsing activities was re-confirmed. The whole test had a reliability coefficient Cronbach's α= .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 indicated by the mean performance (achievement) measure and standard deviation per grade. *Hypothesis 4.2* regarding the appropriacy of item difficulty for the ability levels of students was partly confirmed. 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 considering the major differences across the grades ($\chi 2=33353.63$; df=5, $p<0.001$). Regarding *hypothesis 4.3*, in this phase of the research project re-examination of the dimensionality of the accessing information component of ICT literacy was carried out presuming 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). Dimensionality analysis showed a good model fit in cases of both the one- (CFI=.936, TLI=.933, RMSEA=.037) and the two-dimensional model (CFI=.939, TLI=.935,

RMSEA=.037). Consequently, a special $\chi 2$ difference test comparing nested models was carried out, which showed the two-dimensional model fit significantly better than the one-dimensional one (Tongori & Molnár, 2018). According to the assumption made in *hypothesis 4.4*, significant development could be detected between grades 6 to 11. The hypothesis was confirmed: ability levels grew 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%. In *hypothesis 4.5* the logistic curve typical of describing the characteristic development of numerous other abilities 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, confirming our hypothesis. Notable differences between ability levels within the grades were hypothesized (*hypothesis 4.6*), which was confirmed: the rate of ability level difference detected within the grades was equivalent to several year's difference. In *hypothesis 4.7* significantly higher achievement was expected from girls in the field of efficient and confident online information search than from boys. Regarding the entire sample, girls' achievements were significantly higher than boys' ($M_{girl}=53.97$, $SD_{girl}=19.58$, $M_{boy}=48.71$, $SD_{boy}=20.20$; $t=-13.19$, $p<.001$) with a greater variability in boys' results. In *hypothesis 4.8* it was expressed that the results – deriving from ability levels – of the students of different types of school will show divergence. Indirect confirmation was given when examining the change in the development of grades 9-10 students: as no significant difference could be detected in the results of the secondary grammar school ('gimnazium') students ($t=.517$, $p>.05$), the change in the whole sample was caused by the ability differences between the secondary technical school ('szakgimnázium') grades. Significant relationships were hypothesized (*hypothesis 4.9*) between students' academic achievements in information technology and test results, which was confirmed: 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 (*hypothesis 4.10*) relationships between them. Identical variables explain the highest percentage of all known effects in grades 6-8 with the highest

explanatory power in grade 8 (31.5%). The most significant predictors of success in online information searching (within ICT literacy) 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.

CONCLUSION

Technological development and consequently, the necessity of digital literacy has posed challenges for education, which it answered by defining the 21st century skills and abilities as well as by devising novel methods and instruments appropriate for development and assessment and evaluation. Regarding definition, 21st century literacy – considering the terminological diversity – involves digital, and within it ICT literacy, which is a construct including components related to the steps of information handling (define, access, manage, integrate, evaluate, create and communicate) together with their technological, social, responsibility related and cognitive aspects all built on the basic abilities of reading, writing, numeracy and thinking. In terms of assessment instruments, among technology and computer-based ones, third generation ones simulating real software applications have proved to be the most authentic for measurement of the ICT construct and its online information searching component.

In our information society, from the perspective of lifelong learning, acquiring and maintaining 21st century literacy, the most essential component of ICT literacy is accessing information. This component – approaching from a different angle, digital information search – is in the focus of several researches itself. Those researches also establish a close link across the information handling stages.

In international context, educational assessment of ICT literacy today is typically conducted regarding the whole construct of ICT literacy applying simulation-based tasks widely, resulting in the most authentic assessment methods. Simulation-based instruments are original-looking software applications embedded in an assessment platform suitable for data collection and recording.

While testing grade 5-10 students, educational assessment conducted by the most prominent assessment and research centres has found that in the field of ICT literacy, the greatest development takes place between grade 8-10. Overall results shared by several

assessments include the girls' advantage over boys in their overall achievement and the conclusion that the frequency of ICT use does not necessarily predict higher achievements in ICT literacy. These results carry considerable messages for education in terms of the literacy areas and target age groups. That is why our research was focussed on measurement of the digital information search component of ICT literacy.

Overall, all hypotheses were confirmed. With only 10 of the 28 hypotheses only partly confirmed, our results indicate realistic goal setting and substantiated and verifiable hypotheses based on the related literature. 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, within a 45-minute session in public education settings in a national context.

The originality of the research – in a national context – lies in the unprecedented development of a simulation-based performance assessment instrument, which is suitable for mapping students' confidence in the most fundamental information searching component of ICT literacy in a wide age spectrum. Consequently, no large-scale assessment of the component in a national public educational has been conducted. In line with assessment in an international context typically marking the period of change in the development of ICT literacy between grades 8 and 10, our research narrowed the interval to between grades 8 and 9 as the most intensive period of development of the abilities needed for the efficient and confident online information search component of ICT literacy. In terms of the ICT literacy component investigated, a further example of originality of the research both national and international context is that it empirically confirmed, that accessing online information could be described by a two-dimensional model. It means that distinct abilities are mobilised for finding easily accessible, primary information with a short search path (only one or two mouse clicks away) or for less easily accessible, more complex information with a longer or more complex search path (three or more mouse clicks away or involving visiting several websites and comparing information found there). A further significance of the research bearing practical relevance for education is that by applying an authentic assessment instrument, educators might have feedback on the ability levels of their students in a key literacy component of the 21st century.

One of the limitations of the generalizability of the results is that due to the constraints of the accidental (as opposed to random) sampling method used, which was convenience

sampling based on availability – despite the considerably large sample size of over ten thousand students –, no representativeness regarding gender, type of school, type of settlement or region was achieved. The fact that the research into ICT literacy assessment was restricted to one component, that is accessing information online, could also be seen as a limitation.

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