

TOWARDS MEASURING THE ACCESS DIMENSION OF DIGITAL LITERACY USING SIMULATION

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This paper focuses on the access dimension of digital literacy (from among the seven: identifying, finding, storing, integrating, evaluating, creating and sharing information). The objective of the study is to introduce a pilot assessment using a new measurement instrument devised in Hungary. The test administered in May to June, 2014 in four different state schools in a major city in Hungary drew its sample (N=106) from grades 5, 8 and 10 students, whose tasks varied from simple multiple choice - on imitated online surfaces - to complex, simulated website search. The test (duration 45 minutes) was delivered through eDia online platform. With a total score of 20, the mean was 8.41 (SD=3.26). Significant correlations were found between the time allotted and the score achieved ($r=.240$; $p=.013$) indicating that a thorough understanding of the task and its proper completion are related to noticeable cognitive processes taking place rather than technological proficiency even for the Z generation.

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 ($F=1.395$; $p=.253$). This together with the comparatively low results might suggest that development in the field of accessing digital information might commence at a further stage of confident use of ICTs at a higher age. This study is to provide evidence that the pilot test introduced serves as a solid basis of an assessment instrument being developed to gauge students' confidence in accessing information in digital environments and with further elaboration an effective means of assessment could be devised.

Keywords: ICT, digital literacy, public education, research

The development of the concept of ICT literacy

From the 1980s, when computer literacy was the term mostly used meaning the capability of using the computer, through the 1990s, when the term information literacy (Bawden, 2001) referred to what is called ICT literacy or digital literacy today, a constant extension of the concept could be seen.

The spread of computers as well as mobile devices has brought about one-to-one computer policies in many schools all around the world which broadened the concept with new components (Fraillon, Schulz & Ainley, 2013). ICT literacy is no longer regarded simply as a set of information and digital device handling skills, but rather as construct involving the confident use of info-communicational tools and networks to retrieve, handle, create and share information so as to be a conscious citizen in society who is aware of the necessity of technology use, and who can make decisions responsibly in every-day life and is capable of effective communication (Tongori, 2013).

Measurement of ICT literacy

ICT literacy is a complex construct composed of interrelated skills, abilities and competencies. Similarly to the measurement of one specific thinking skill, which is always embedded in certain content, and thus requires the application of general mental processes (Molnár, Greiff & Csapó, 2013), measurement of any one dimension of ICT literacy is also delivered in some context and besides the related ICT literacy components, it necessarily requires the activation of the related cognitive, technological, social or responsibility-determined (legal, ethical, health and personal safety) aspects (Tongori, 2012, 2013).

Measurement of all dimensions of ICT literacy

Assessment of such a complex construct as ICT literacy faces a twofold hardship. On the one hand, sophisticated technological background and human resources – especially in terms of time consuming software development — are necessary for assessment instrument development, and on the other hand, it is difficult to measure the different ICT literacy components and aspects separately. The largest post-millennium ICT literacy assessment projects in an international context, for example the ones administered by IEA (Fraillon, Schulz & Ainley, 2013), ETS (Katz & Macklin, 2007), NCES (National..., 2013), ACARA (Australian..., 2012), the joint project of ACER, NIER and ETS (OECD, 2003) and CITE (Law, Lee & Yuen, 2010), developed novel assessment tools to gauge students' ICT literacy performance by using simulation software delivered digitally in order to administer large scale assessment [with the PISA Feasibility Study (OECD, 2003) being a small scale one]. Having evolved from the theoretical framework of information handling steps by the American Association of School Librarians (Eisenberg & Johnson, 1996), confidence of information retrieval, management and integration, ability to decide on the appropriacy and relevance of the information found, confidence of creating and sharing information (Katz & Macklin, 2007) have been assessed acknowledging that technological and cognitive skills as well as social competencies (Whyte & Overton, 2001) and a responsible attitude in the use of ICT (Ainley, Fraillon & Freeman, 2007) are also integrated in ICT literacy, which is based on the core literacies of reading, writing and numeracy (Catts & Lau, 2008).

Measurement of the access dimension of ICT literacy

To our knowledge, no research has yet been conducted analysing differences solely in the access dimension of students' ICT literacy performance with regard to gender and grade using simulation software embedded in an online assessment tool. The rationale behind the choice to focus on one of the seven components is that the restricted focus could result in a more detailed analysis of students' achievement in that one component of ICT literacy and the underlying processes. The reason why the choice fell on the access component (information retrieval) is that it seemed wise to begin ICT literacy assessment instrument development and piloting with a focus on a lower order activity based on receptive skills rather than a higher order activity requiring productive skills (Fraillon & Ainley, 2013). Also, compared with the 90 to 165-minute time allotment of major whole-scale ICT literacy assessment projects in international context – with the exception of the 50-minute NAEP pilot —, a reduced focus on one dimension of ICT literacy seemed more feasible for a pilot test within the 45-minute lessons in Hungarian schools.

Aims and research questions

1. What is the order of difficulty of tasks in the light of student achievement and time spent completing the tasks?
2. Is there a relationship between successful task completion and the time spent completing it?
3. Can students' performance in the access dimension of ICT literacy (using the Confidence in Accessing Information Performance Test – CAIPT) be tested in 45 minutes, which is the time allotment of a regular lesson in the Hungarian educational setting?
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?
5. What variations exist between grades, and between male and female students' achievements within the grades in the access dimension of students' ICT literacy?

Hypothesis

H1: We expect that task difficulty reflected by task mean scores will be at least 70 per cent identical with the sequence of tasks in the test administered.

H2: We expect that there is a relationship between successful task completion and the time spent completing it across all grades and genders.

H3: We expect that students' performance in the access dimension of ICT literacy can be tested in 45 minutes applying the set of tasks in the pilot test administered across all grades and genders. However, an advantage of the higher graders over the lower graders is also expected in terms of speed.

H4: We expect that the set of tasks compose a reliable and valid assessment instrument to gauge at least two subsets' (grades 5 to 8 or 8 to 10 students') ICT literacy performance in the access dimension bearing in mind that reliability measures can be affected by sample size and that the requirements of convergent and discriminant validity can only be tested by analysing correlations between the self-assessment questionnaire (Confidence in Accessing Information Questionnaire — CAIQ) and the

Confidence in Accessing Information Performance Test (CAIPT), which is beyond the scope of this paper.

H5: We expect that the access dimension of students' ICT literacy is measured invariant across gender but we expect variations across grades.

Methods

Sample

The sample of the study consisted of grades 5, 8 and 10 students in four Hungarian primary and secondary schools. There were 123 students with different numbers in each cohort: grade 5 (n=57), 8 (n=40) and 10 (n=26). The two sexes were represented in approximately the same proportion. Due to technical problems during online testing, a data loss of the results of 17 grade 10 students occurred.

The final sample contained data from (N=106) grade 5 (n=57), 8 (n=40) and 10 (n=9) students.

Design

The test used for the study is a linear one and covers confidence in the accessing information component of ICT literacy. All students in all grades completed the same set of tasks. The test could be divided into two types of tasks. From task 1 to task 10 student were faced with imitated online surfaces on the screen represented by print screen shots embedded in the 'slides' or 'screens' of the assessment instrument. From task 11 to task 14 students exited the assessment tool to search simulated websites for information as response to tasks, which they could then record when re-entering the assessment tool. To support students with possible reading difficulties, and exclude testing reading comprehension instead of ICT literacy, all instructions had been recorded and the students could listen to or stop them unlimited times by clicking on a button. All instructions in the test are given within the assessment tool. In case of simulated websites, when students exit the platform of the assessment tool, a reminder button is provided on the home page of each website, clicking on which reveals the scenario and the instruction. This way no memory test but pure ICT test is administered. Besides, in order 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 individually.

Materials

The test is comprised of scenario-based open-ended and multiple-choice tasks both in the imitated and the simulated task-set.

Procedure 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). In the CAIPT test full credit was given for each correct answer (20 items in 14 tasks), whereas no credit was given if the answer was incorrect. The students were allowed.

Results and discussion

Descriptive statistics

Internal consistencies of the CAIQ were high (Cronbach $\alpha = .91$), but the reliability coefficient of the CAIPT proved to be low due to the comparatively low number of (only 14) administered tasks, and limited sample size (Cronbach $\alpha = .68$). Consequently, contrary to our assumption, *hypothesis 4* could only be confirmed in case of the CAIQ, but not in case of the CAIPT. Further development of the test is 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.

In terms of frequencies, girls' mean scores outnumbered boys' mean scores in 9 out of the 14 tasks, and the two genders' mean scores were identical in one task (See Table 1). Taking into account that one gender was represented in the sample at nearly the same proportion as the other, it could be said that *hypothesis 5* did not prove to be right, as the girls' overall performance shown by their mean scores was higher than that of the boys.

In *hypothesis 1* the assumption that task difficulty order reflected by task mean scores will be at least 70 per cent identical with the sequence of tasks in the test administered was expressed. However, analysis revealed variations in task difficulty order both across genders and as compared with the sequence of tasks in the test administered (See Table 2). Regarding both genders the first six places in the task difficulty order are taken by tasks 1-3, 7, 9 and 10. These are followed by tasks 5 and 6 according to the performance of both genders. The tasks using simulation had been assumed to be the most complex and thus most complicated ones. The difficulty level of these simulation tasks was found similarly high by the boys (with variations in the order). The girls' performance rendered each of these four simulation tasks to one of the places among the last five, indicating that complex web search activities aimed at accessing information require the mobilisation of multiple skills, which not all the students are equipped with. Nevertheless, the fact that tasks 1-3 and 11-14 proved to match the intended difficulty level and tasks 5 and 6 were found nearly as complicated as they were meant to be allow for the conclusion that the direction of the test development is correct.

Correlations

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 correlation in Grade 5 ($r = -.269$; $p < .05$) and no significant correlation in Grade 10 (See Table 3). 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 4).

Hypothesis 3 proved to be confirmed. We expected that students' performance in the access dimension of ICT literacy can 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 and 21 seconds being the shortest time. Taking into account that the mean total score was 8.41 (SD 3.265) from 20 points, the data on the comparatively short time taken in the CAIPT raises the question whether the students made serious effort to complete the test in the best possible way.

Conclusion

Limitations on the interpretation of the results of the pilot research are to be imposed owing to sampling and reliability measures. 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.

Further development of the test is 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.

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Appendix

Table 1. Mean scale scores (SD) for boys and girls

	Task	Boys' mean (SD)		Girls' mean (SD)	
Imitation	1. Jeweller's	.76	(.43)	.83	(.40)
	2. Navigate back	.69	(.47)	.79	(.41)
	3. Project	.71	(.46)	.71	(.46)
	4. Type search term	.35	(.48)	.42	(.50)
	5. Netgift	.63	(.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	.78	(.80)	.81	(.80)
Simulation	11. Wingsuit	1.06*	(.56)	.98*	(.46)
	12. Decoration	.43**	(.80)	.71**	(1.14)
	13. Aqualand	.02	(.14)	.08	(.27)
	14. Skiing	.67*	(.72)	.54*	(.70)

*Maximum score = 2 points

** Maximum score = 3 points

Table 2. Comparison of intended and actual order of task difficulty demonstrated by performance across gender

Intended order of difficulty of tasks in CAIPT	Boys' task difficulty order	Boys' mean performance (%)	Girls' task difficulty order	Girls' mean performance (%)
1. Jeweller's	7.	78	1.	83
2. Navigate back	10.	78	9.	83
3. Project	1.	76	10.	81
4. Type search term	9.	73	2.	79
5. Netgift	3.	71	7.	79
6. Presentation	2.	69	3.	71
7. Wiki	5.	63	6.	5
8. Hairgel	6.	45	5.	46
9. Local paper1	8.	39	4.	42
10. Local paper2	4.	35	12.	36
11. Wingsuit	11.	35	11.	33
12. Decoration	14.	34	8.	27
13. Aqualand	12.	22	14.	27
14. Skiing	13.	2	13.	8

Table 3. Correlations between mean times and mean scores in imitated online surface tasks 1-10 across grades

Grade			Mean time	Mean score
5	Meantime	Pearson Correlations	1	-.269*
		Sig (2 tailed)		.045
		N	56	56
	Mean score	Pearson Correlations	-.269*	1
		Sig (2 tailed)	.045	
		N	56	56
8	Meantime	Pearson Correlations	1	.775**
		Sig (2 tailed)		.000
		N	39	39
	Mean score	Pearson Correlations	.775**	1
		Sig (2 tailed)	.000	
		N	39	39
10	Meantime	Pearson Correlations	1	-.232
		Sig (2 tailed)		.548
		N	9	9
	Mean score	Pearson Correlations	-.232	1
		Sig (2 tailed)	.548	
		N	9	9

*. p= .05

** . p<.01

Table 4. Multiple Comparisons of successful task completion of tasks 1-10 (imitated online surfaces)

	(I) Grade	(J) Grade	Mean Difference (I-J)	SD	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Dunnett T3	5	8	.90018	.57865	.327	-.5199	2.3202
		10	-1.66071	.74469	.138	-3.7948	.4734
	8	5	-.90018	.57865	.327	-2.3202	.5199
		10	-2.56090*	.86029	.026	-4.8439	-.2779
	10	5	1.66071	.74469	.138	-.4734	3.7948
		8	2.56090*	.86029	.026	.2779	4.8439
*p= .026							