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DEVELOPING AN UNDERSTANDING OF DIGITAL INTELLIGENCE AS A PREREQUISITE OF DIGITAL COMPETENCE

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Abstract

Although the interest of academics and practitioners is focused on concepts, such as digital competence, literacy, and skills, digital intelligence has its own distinct importance. Whilst the former concepts are related to knowledge and learning outcomes, digital intelligence is about the new way of thinking (particularly visible to young people) that is developing in the continuously expanding digital environment. Understanding and further investigating digital intelligence will help to establish better and more appropriate, for the demands of the digital era, frameworks of digital competence. This study proposes that measuring digital intelligence should comprise computational thinking tests, as well as tests that could be used to assess digital use and behaviour. In the context of that, a number of students at senior high schools of the Regional Unit of Thessaloniki, Greece, were tested regarding their computational thinking and their digital use and behaviour. The most interesting results are: (i) the average score of students increases as the level of education of their parents increases, and (ii) there is a statistically significant positive relationship of the students' aggregate performance between computational thinking and digital use & behaviour, implying that they are correctly considered components of the construct of digital intelligence.

Keywords: Digital intelligence, Digital competence, Digital literacy, Digital skills.

1 Introduction

This paper aims to shed light on a new construct that has emerged in the literature, i.e. '*digital intelligence*', also referred to as '*digital quotient*' (DQ Institute, 2019). To the best of our knowledge, Adams (2004) was the first author to introduce digital intelligence as a type of intelligence, although without providing any evidence. Digital intelligence is the new way of thinking in the digital era. In other words, it is about how people have started to think differently trying to adapt themselves in the expanding digital environment. What we will attempt to do is to show that digital intelligence differs from other related concepts, such as digital competence, digital literacy, and digital skills, which are mostly acquired by means of education, learning programs, practice, and experiences. We believe that analyzing the characteristics of digital intelligence and being able to measure it through appropriate tests will enable the building of digital competence to a much greater extent. It should be pointed out that we focus on digital competence since it is nowadays the most mentioned concept in the related conceptual frameworks (e.g. the European Digital Competence framework).

The structure of the paper is as follows: the main characteristics of digital intelligence and some significant related concepts are outlined in Section 2. The methodological approach of the study is presented in Section 3, while the results are given in Section 4. Finally, the discussion and conclusions of the study are summarized in Sections 5 and 6, respectively.

2 Digital Intelligence and Related Concepts

2.1 Digital literacy, digital skills, and digital competence

Digital literacy includes a large variety of skills that are necessary in executing tasks effectively in a digital environment, such as searching in databases, playing digital games, creating and sharing content on the Web, etc. Digital literacy is much more than a matter of learning how to use digital devices; it is also related to communication, information evaluation, problem solving, gaining experiences, and understanding of risks, given that all these take place in digital environments. Digital literacy is a key component of 21st-century skills, i.e. the digital skills that people should acquire to enter the workforce of 21st century (van Laar, van Deursen, van Dijk, and de Haan, 2017).

Among the various frameworks that have been proposed to measure digital skills, the following three are noteworthy to mention: firstly, the framework of Eshet (2012), in which digital literacy is a set of six skills: (i) photo-visual, i.e. understanding of messages in visual-graphical representations, (ii) reproduction, i.e. using digital media to create new work from pre-existing elements, (iii) branching, i.e. orientating properly while navigating through complex knowledge domains, (iv) information, i.e. assessing information effectively, (v) socio-emotional, i.e. sharing data and knowledge, and identifying threats and risks; finally, (vi) real-time thinking, i.e. high speed processing of numerous simultaneous stimuli of different kinds (sound, text, images, etc.). Secondly, the framework proposed by van Dijk and van Deursen (2014) comprises the following skills: (a) operational, i.e. the skills to operate digital media, (b) formal, for using the formal characteristics of digital media, (c) information, in order to search, select, process, and evaluate information, (d) strategic, i.e. the skills to employ digital media as a means for personal or professional goals, (e) communication, the ability to encode and decode messages, and (f) content creation, i.e. the skills to create digital content of acceptable quality. The third approach introduces the concept of competence, which is comprised of knowledge, skills, and attitudes; it is the European Digital Competence framework (known as DigComp), that has been proposed by the Joint Research Centre (JRC) of the European Commission (Carretero, Vuorikari, and Punie, 2017). This framework is a set of 21 competences to use digital technologies and media, which are grouped into five discrete areas: (1) information and data literacy, (2) communication and collaboration, (3) digital content creation, (4) safety, and (5) problem solving. It is worth mentioning that digital competence is recognized as one of the eight key competences for lifelong learning by the European Union.

2.2 The construct of digital intelligence

Although the research interest on the aforementioned concepts still remains intense, digital intelligence has started to attract the attention of academics and practitioners. There are many references in the literature (see Table 1) indicating significant differences in specific cognitive abilities between the digital and the physical (tangible) environment. This implies that a new way of thinking is developing in the digital environment, i.e. digital intelligence. It could be considered as the outcome of people's need and their effort to adapt themselves to the continuously expanding digital environment. And, as more complicated digital technologies will appear in the future, digital intelligence could probably evolve into the most necessary type of intelligence for success in the digital era. Digital competence is very important, but it can only result from education, learning programs, practice, and experiences. On the other hand, digital intelligence is a set of inherent abilities which can be possibly improved to some extent. It could be said that digital competence is much more important for adults and professionals, who have already acquired the appropriate skills, while the measurement of digital intelligence has a particular importance for young people who have not developed these skills. The outstanding value of digital intelligence is apparent for the selection, evaluation, and allocation of human resources. For instance, it is quite possible that a software development company will prefer to hire a programmer who has the ability to understand the logic of creating a software program instead of someone else who knows a greater number of programming languages.

Physical (tangible) environment	Digital environment	Reference
In-depth reading of printed documents	One-time reading of electronic documents, selective reading	Carr (2008); Liu (2005)
It is possible to pay sustained attention on reading	Possible distraction of attention on reading	Carr (2010, 2008); Liu (2005)
Serial access to information of a text	Random access through hypertext links and browser functions	Kress (2003); Prensky (2001)
	Multimodality of electronic documents (image, audio, video, text) changes the way that readers perceive and understand such a document	Kress (2003)
Reading via print media, along with audio media, improve critical thinking and imagination		Greenfield (2009)
	Video games improve visual-spatial skills	Greenfield (2009)
	Video games improve high school students' executive functions	Homer, Plass, Raffaele, Ober, and Ali (2018)
	Video games improve many cognitive abilities, such as reasoning, receptive vocabulary, visual short-term memory, and processing speed	Gnambs and Appel (2017); Dobrowolski, Hanusz, Sobczyk, Skorko, and Wiatrow (2015)
Writing by hand: the visual attention is strongly concentrated onto the point of character input (e.g. the tip of the pen)	Writing with digital devices: the visual attention is detached from the input of characters (continuously oscillates among the screen, the keyboard, the mouse, etc.)	Mangen and Velay (2010)
	The visual memory capacity and writing skills of primary school students are positively affected by digital storytelling	Sarıca and Usluel (2016)
Writing movements of the hand facilitate letter memorization	The movements involved in type-writing have little contribution to visual recognition of letters	Mangen and Velay (2010)
	Receiving information really fast from many sources at the same time	Prensky (2001)
	Real-time thinking, in sense of processing a large number of simultaneous stimuli of different kinds (e.g. sound, text, images)	Eshet (2012)
Information seeking is the first step for knowledge creation	Information seeking is a continuous process	Nicholas, Huntington, Williams, and Dobrowolski (2004)
	"Knowing together": children want to seek information in groups and they like to share it with others	Dresang (2005)

In face to face communication, the participants respond immediately and spontaneously	In instant messaging and other digital media (e.g. email, blogs, fora), the users have the time to compose and revise their responses, thus getting more control over their communication	Madell and Muncer (2007); Bowman, Levine, Waite, and Gendron (2010)
Usually performing one task at a time	Usually multitasking (doing different things simultaneously, as for instance, during a video game)	Eshet-Alkalai (2004); Wolf and Barzillai (2009); Greenfield (2009)
	Divided attention is enhanced by playing action video games	Greenfield (2009)
	It is possible for the user of digital media to externalize a particular form of thinking, namely algorithmic thinking	Williamson Shaffer and Clinton (2006)
	New ways of learning to do things (e.g. through computer games, simulation)	Prensky (2001); Tapscott (2008)

Table 1. Differences in specific cognitive abilities between the digital and the physical (tangible) environment

Today’s world demands higher levels of intelligence due to the continuously rising complexity and information overflow. People, particularly in developed nations, could not cope with the challenges and the rapid variations of their environment if they did not have higher intelligence (compared to earlier times). Over the past century, there was a rise in the average IQ in developed countries (around 3 IQ points per decade), based on comparisons of IQ test scores of successive generations. That issue, known as the “Flynn effect” (Flynn, 1994), implies that people in our era are getting smarter (Gottfredson, 2011). This intelligence rise may be due to many reasons, such as mixing of populations, more educational opportunities, better diet, as well as great changes of the environment in which people grow up and live (Gobet, Campitelli, and Waters, 2002). One of the greatest changes is apparently the emergence and development of the Internet and the digital environment (Miranda and Lima, 2012). Nowadays, the digital environment, being composed of digital technologies, media, devices, etc., is at home, workplaces, public areas, everywhere.

2.3 Analyzing digital intelligence

Although digital intelligence needs to be further investigated, from our point of view it is composed of two main parts: (i) computational thinking and (ii) digital use and behaviour. Computational thinking is the sort of thinking that should characterize computer scientists and software developers. Also, computational thinking is about dealing with a problem in a way that a computer can help us to solve it (Wing, 2006). According to the National Curriculum in England: Computing Programmes of Study (Department for Education UK, 2013), “*a high-quality computing education equips pupils to use computational thinking and creativity to understand and change the world.... Computing also ensures that pupils become digitally literate – able to use, and express themselves and develop their ideas through, information and communication technology – at a level suitable for the future workplace and as active participants in a digital world*”. Computational thinking involves the following 6 mental processes (Department for Education UK, 2013):

- *logical reasoning*: predicting the behaviour of a computer program (e.g. what will happen when playing a computer game or using a simple program) – explaining how the program works

- *algorithms*: realising how algorithms are used in computer programs – writing down the algorithm for a program (e.g. using pseudocode or flow charts) – finding the quickest way to achieve the goal of the program
- *decomposition*: breaking down a problem into smaller manageable parts – thinking about how these parts are inter-related
- *abstraction*: capturing key information and removing unnecessary detail from the system or problem under study
- *patterns and generalisation*: identifying patterns in a problem – looking for a general approach to solve a number of problems
- *evaluation*: assessment of data and information – making judgements for the most effective and efficient solution.

According to DQ Institute (2019), "*digital intelligence is a comprehensive set of technical, cognitive, meta-cognitive, and socio-emotional competencies that are grounded in universal moral values and that enable individuals to face the challenges and harness the opportunities of digital life*". DQ Institute identifies 8 digital competencies, all of which are relevant to digital use and behaviour:

- *digital identity*: the ability to build and manage a 'healthy' online and offline identity
- *digital use*: the ability to use technology in a balanced, healthy, and civic way
- *digital safety*: the ability to understand, mitigate, and manage various cyber risks through safe, responsible, and ethical use of technology
- *digital security*: the ability to detect, avoid, and manage different levels of cyber threats to protect data, devices, networks, and systems
- *digital emotional intelligence*: the ability to recognize, navigate, and express emotions in one's digital intra and interpersonal interactions
- *digital communication*: the ability to communicate and collaborate with others using digital technology
- *digital literacy*: the ability to find, read, evaluate, synthesize, create, adapt, and share information, media, and technology
- *digital rights*: the ability to understand and uphold human rights and legal rights when using technology.

3 Methodology

In order to answer the research questions of our study (given at the end of this section), a survey was conducted at public senior high schools (lyceums), targeting to students at the age of 15-16 years old (attending the first class of a senior high school according to the Greek educational system). For the purposes of this survey, a permission was requested and given from the Institute of Educational Policy (belonging to the Greek Ministry of Education, Research and Religious Affairs), i.e. the competent agency for providing relevant permissions. Our sample is composed of public senior high schools in the Regional Unit of Thessaloniki (to which our university also belongs), i.e. the second biggest Regional Unit in Greece in terms of population. It should be mentioned that the Regional Unit of Thessaloniki is subdivided into 14 municipalities: (i) Ampelokipoi-Menemeni, (ii) Chalkidona, (iii) Delta, (iv) Kalamaria, (v) Kordelio-Evosmos, (vi) Langadas, (vii) Neapoli-Sykies, (viii) Oraiokastro, (ix) Pavlos Melas, (x) Pylaia-Chortiatis, (xi) Thermaikos, (xii) Thermi, (xiii) Thessaloniki, and (xiv) Volvi. Our effort was to have in the sample the schools which have been chosen to participate in the Programme for International Student Assessment (PISA), an educational survey that has been conducted every 3 years since 2000 by the Organisation for Economic Co-operation and Development (OECD). For all the municipalities, we tried to have a greater or at least equal sample than the sample used in the PISA survey. In that way, 35 senior high schools (27 general and 8 vocational) were selected to participate in the sample of our survey. At the end of the survey, 21 senior high schools (14 general and 7 vocational) responded to the survey. It should be pointed out that we intend to expand the survey to all the Regional Units of the country by the new academic year. Data for the selection of the schools participating in the sample are presented in Table 2. The survey was conducted at the time period 1/4/2019 – 17/5/2019 and the sample size in terms of the number of respondent students was 971 (after removing few problematic cases, the final sample size was 956 students).

No	Municipality	Population	Senior high schools	PISA survey (data for 2018)	Sample %	Proposed schools in our sample	Sample %	Respondent schools to the survey	Sample %
1	Ampelokipoi-Menemeni	52,127	6	0	0%	1	16.7%	1	16.7%
2	Chalkidona	33,673	8	1	12.5%	2	25%	0	0%
3	Delta	45,839	7	0	0%	2	28.6%	2	28.6%
4	Kalamaria	91,518	8	1	12.5%	2	25%	2	25%
5	Kordelio-Evosmos	101,753	9	3	33.3%	3	33.3%	0	0%
6	Langadas	41,103	6	1	16.7%	1	16.7%	0	0%
7	Neapoli-Sykies	84,741	7	1	14.3%	3	42.9%	1	14.3%
8	Oraiokastro	38,317	4	1	25%	2	50%	2	50%
9	Pavlos Melas	99,245	11	1	9.1%	3	27.3%	3	27.3%
10	Pylaia-Chortiatis	70,110	6	2	33.3%	3	50%	1	16.7%
11	Thermaikos	50,264	5	1	20%	2	40%	1	20%
12	Thermi	53,201	6	1	16.7%	2	33.3%	0	0%
13	Thessaloniki	325,182	30	4	13.3%	7	23.3%	6	20%
14	Volvi	23,478	4	0	0	2	50%	2	50%
	Total	*1,110,551*	*117*	*17*	*14.8%*	*35*	*33%*	*21*	*19.2%*

Table 2. Data for the sample of the survey

The questionnaire, used in the survey, included three parts: part (A) was about demographic data of the participant students, i.e. gender, municipality of residence, education level of parents, usage of digital devices, navigation time on the Internet, social media accounts, as well as questions about their perceptions: (i) the courses the students think that they have the highest performance and (ii) self-assessment of students' relationship to ICTs. Part B was about 8 tests to assess computational thinking and part C 8 tests to assess digital use and behaviour (the tests of part B and part C were mixed up). A concise description of the 16 tests of the questionnaire follows:

1. Navigating a new website, a window appears showing objects that represent computer functions. The students had to match objects with functions (it is test of computational thinking concerning abstraction).
2. Selecting six elements from a given list which are not required in order a 2-D electronic ping-pong game to be accomplished (it is a test of computational thinking concerning decomposition & abstraction).
3. Selecting the safest check-in on a social networking site (it is a test of digital use and behaviour concerning digital rights & digital communication).

4. Finding out the shortest route from a list of selections for an ambulance transporting a patient to a hospital (it is a test of computational thinking concerning evaluation).
5. Selecting the information that is not required in order to go by car from one place to another (it is a test of computational thinking concerning decomposition & evaluation).
6. Selecting the e-shop that you would register depending on the data required to fill out the registration form (it is a test of digital use and behaviour concerning digital identity).
7. Finding out the outcome of a number of commands, given to the students graphically (it is a test of computational thinking concerning patterns and generalisation).
8. Prioritizing the personal goals of using a hypothetical social networking site (it is a test of digital use and behaviour concerning digital use).
9. Finding out the outcome of running an algorithm by using pseudocode (it is a test of computational thinking concerning logical reasoning).
10. Reacting to a bad personal comment on a social networking site (it is a test of digital use and behaviour concerning digital safety & digital emotional intelligence).
11. Detecting the mistakes in the flow chart of a contest process (it is a test of computational thinking concerning logical reasoning & algorithms).
12. Finding out the outcome of applying a set of instructions (it is a test of computational thinking concerning algorithms).
13. Selecting the safest password when creating an account on a website (it is a test of digital use and behaviour concerning digital security & digital rights).
14. Deciding on messages in a social networking site that could be cyberbullying cases (it is a test of digital use and behaviour concerning digital emotional intelligence & digital communication).
15. Recognizing fake news (it is a test of digital use and behavior concerning digital literacy).
16. Understanding the emotions of people who are sending emojis (it is a test of digital use and behaviour concerning digital emotional intelligence).

It should be mentioned that digital intelligence score (DQ score) was calculated by giving 1 point to each correct answer (all the tests were considered to have the same level of difficulty). In four questions, where each test was composed of 6 elements, the answer was considered correct if the respondents had at least 5 out of 6 correct choices. The research questions are formulated as follows:

- Is there a relationship of DQ score with the place of residence of the students (in terms of its wealth)?
- Is there a relationship of DQ score with the education level of parents?
- Is there a relationship of DQ score with the usage time of digital devices?
- Is there a relationship of DQ score with the navigation time on the Internet?
- Is there a relationship of DQ score with specific courses at the senior high school?
- Is there a relationship of DQ score in computational thinking with DQ score in digital use and behaviour?

4 Results

In Figure 1, the average DQ score of the respondent students in relation to their parents' educational level is presented. Firstly, it should be mentioned that the main levels of the Greek education system are (from the lowest to the highest): (i) elementary school certificate, (ii) lower secondary school certificate (high school), (iii) upper secondary school certificate (senior high school), (iv) vocational training diploma (v) bachelor degree (by universities or technological educational institutes), (vi) master's degree, and (vii) doctorate. The average DQ score of students increases as the level of education of their parents increases. Figures 2 and 3 depict the average DQ score depending on the usage time of digital devices (desktop, laptop, tablet, smartphone, video games console, etc.) and the navigation time on the Internet, respectively. We can see that DQ score increases proportionally with the usage time, although more slightly when the time increases significantly. On the other hand, it is very interesting that when the navigation time is more than 4 hours, DQ score decreases.

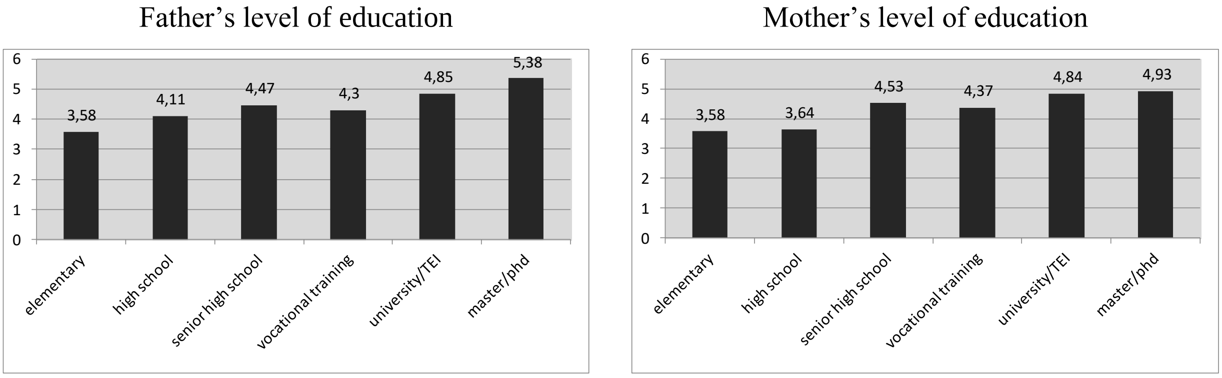

Figure 1. Average DQ score in relation to parents' educational level

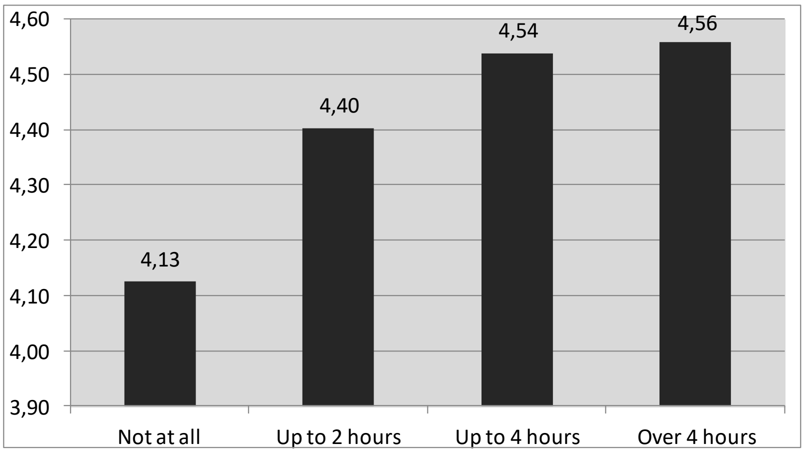

Figure 2. Average DQ score in relation to usage time of digital devices

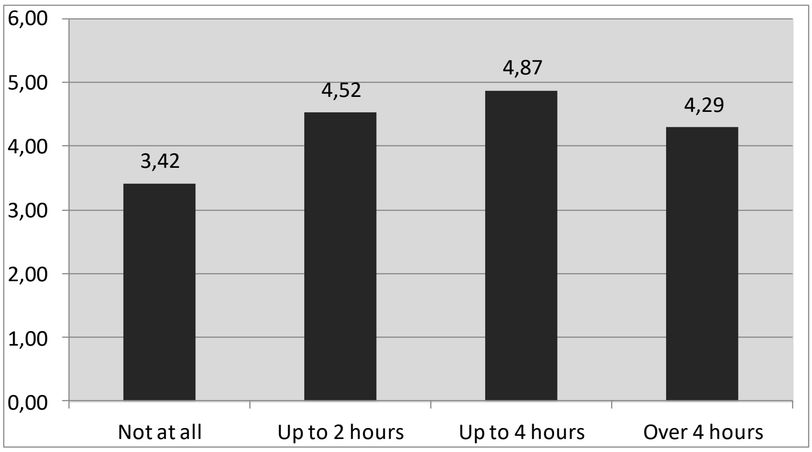

Figure 3. Average DQ score in relation to navigation time on the Internet

In order to relate the average DQ score with the place of residence of the students, we divided the 14 municipalities of the Regional Unit of Thessaloniki into three zones according to the average objective value of property in each municipality. The zones resulting from that division are: (i) the wealthier areas, (ii) the areas at a medium level, and (iii) the poorer areas. The division is given in Table 3.

Zones	Municipalities	Average Objective Value of Property (€/m^2)
Wealthier areas	Kalamaria	1750
	Thessaloniki	1625
	Pylaia-Chortiatis	1121
Areas at a medium level	Neapoli-Sykies	1008
	Oraiokastro	1000
	Thermi	903
	Volvi	900
	Thermaikos	850
Poorer areas	Ampelokipoi-Menemeni	800
	Langadas	800
	Pavlos Melas	775
	Kordelio-Evosmos	758
	Delta	608
	Chalkidona	600

Table 3. Division of the 14 municipalities of the Regional Unit of Thessaloniki into 3 zones

The average DQ score in relation to the municipality of residence of the respondent students is illustrated in Figure 4. The wealthier areas are represented with white colour, the areas at a medium level with grey colour, and the poorer areas with black colour. The figure shows 11 municipalities, since the respondent students who reside in each of the three municipalities excluded, i.e. Chalkidona, Kordelio-Evosmos, and Langadas, are very few (it is reminded that the sample was selected based on the schools to which the students belong and not based on the place of their residence).

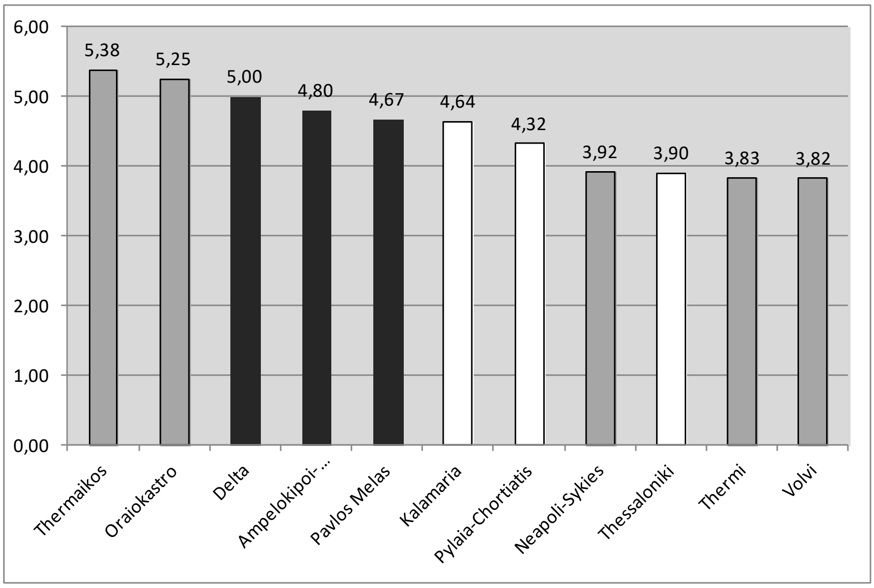

Figure 4. Average DQ score in relation to municipality of residence

The interpretation of Figure 4 is really interesting as the wealthier municipalities indicate rather low DQ scores. Although we do not claim that this finding does not make sense, we believe that other reasons should also be considered in 'reading' Figure 4. The high scores in the municipalities 'Thermaikos' and 'Oraiokastro' are mainly due to the high education level of parents, as presented in Table 4. Concerning the municipality 'Delta', which has the third highest DQ score, the students mostly come from vocational senior high schools, where the course of Informatics (including the development of digital skills), at the age we are targeting, is included in the curriculum.

Municipality	Master/ PhD	University/TEI	Vocational training	Senior high school	High school	Elementary	Not aware
Thermaikos	14.5%	30.3%	6.6%	28.3%	5.3%	3.9%	11.1%
Oraiokastro	11.5%	39.8%	11%	25.9%	2.5%	0.4%	8.9%
Delta	0%	10.3%	8.7%	25.9%	24.1%	8.6%	22.4%
Ampelokipoi-Menemeni	5.4%	20.3%	7.4%	43.9%	8.8%	3.4%	10.8%
Pavlos Melas	6.9%	27.9%	9.5%	29.4%	10.3%	0.8%	15.2%
Kalamaria	5%	30.6%	4.1%	30.6%	6.6%	3.7%	19.4%
Pylaia-Chortiatis	14.7%	30.8%	5.9%	32.4%	3.7%	1.5%	11%
Neapoli-Sykies	10.3%	20.6%	13.1%	28%	5.6%	7.5%	14.9%
Thessaloniki	8.5%	23.9%	4%	31.3%	13.2%	1.8%	17.3%
Thermi	4.5%	27.3%	4.6%	54.5%	0%	0%	9.1%
Volvi	3.9%	6.6%	6.5%	38.2%	17.1%	13.2%	14.5%

Table 4. Parents' (both father's and mother) educational level per municipality

Another relationship that needs further investigation is between the average DQ score and the course (belonging to the school curriculum) the students think they have their best performance. There were many different answers but only the five shown in Figure 5 received, each of them, a sufficient number of replies. The students who selected Science and Mathematics had higher DQ scores, while the students who had their best performance in Physical Education scored much lower in DQ.

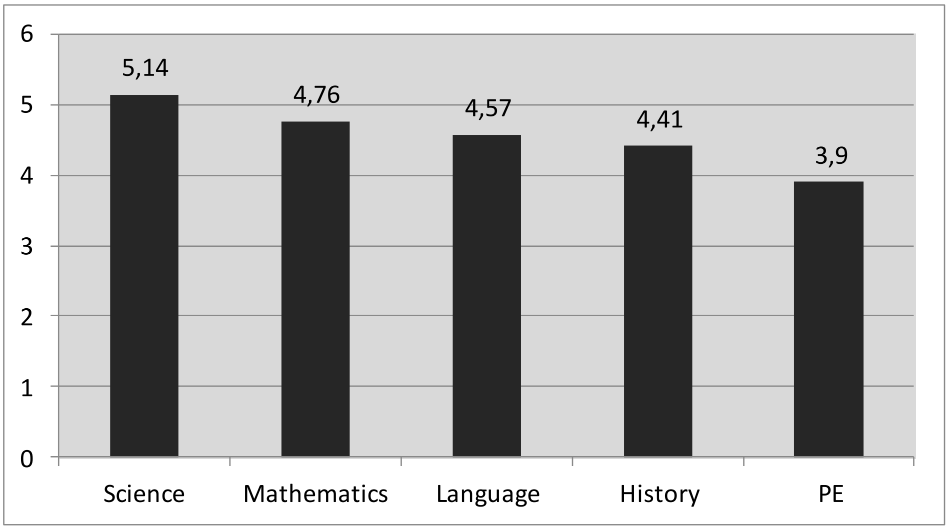

Figure 5. Average DQ score in relation to the course with the best performance

The correct answers (in a total of 956 students) in each of the computational thinking (CT) tests and digital use & behaviour (DUB) tests are illustrated in Figure 6. Also, the distribution of correct answers for the two categories of tests is given in Figure 7. It can be easily deduced that the students had much better performance in the tests that were used for the assessment of digital use and behaviour. This is probably due to the fact that young people at the age of 15-16 years old are nowadays familiar with the use of digital devices, mostly with smartphones. On the other hand, their performance in computational thinking can be considered quite poor. Generally, the overall low assessment of the respondent students in such kind of tests, i.e. designed to measure intelligence and not skills, reveals that teachers should focus their attention not only on the development of digital skills, but also on identifying digitally intelligent students and further improving their distinctive abilities.

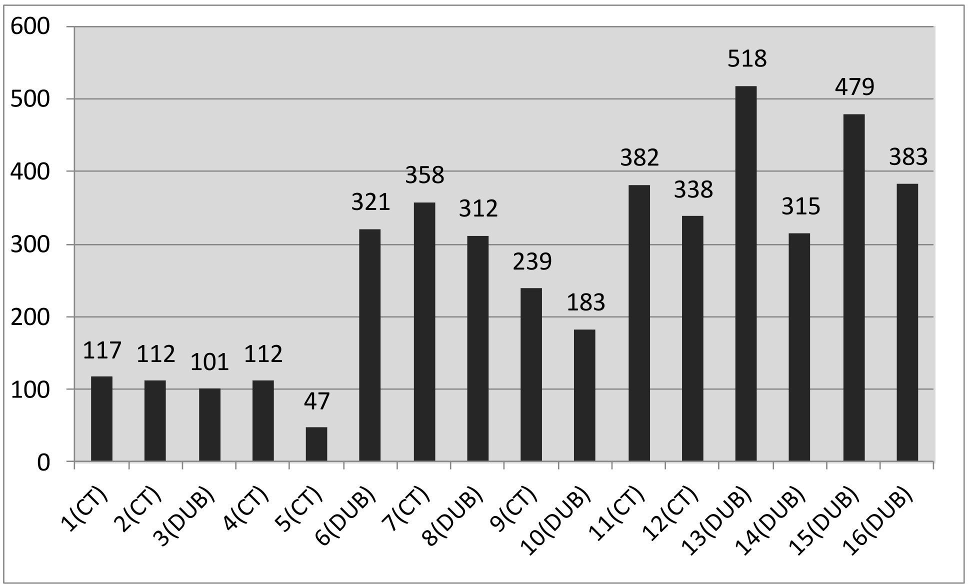

Figure 6. Correct answers in each of the 16 tests

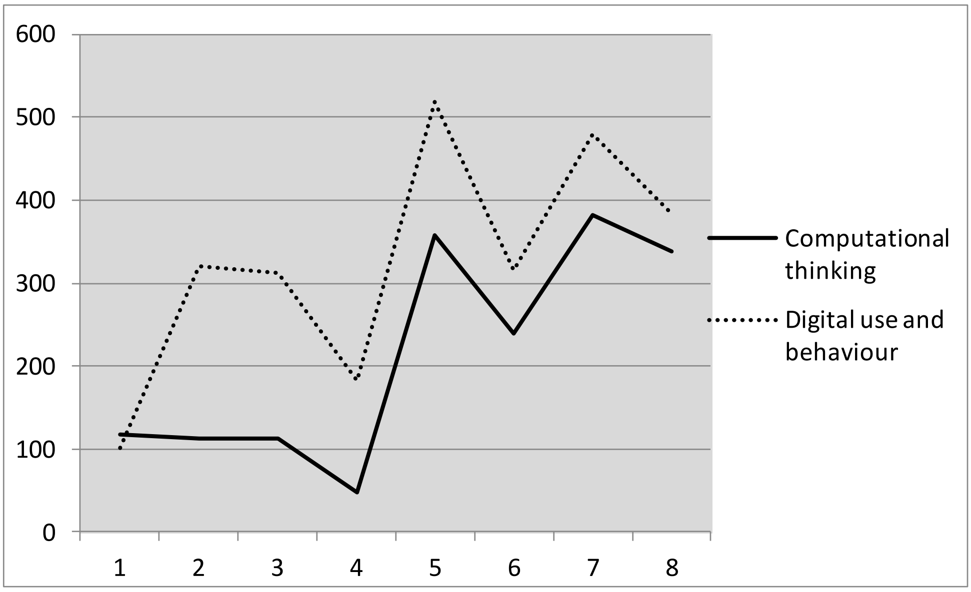

Figure 7. The distribution of correct answers for CT tests and for DUB tests

In order to correlate the aggregate performance of the students on computational thinking with the aggregate performance on digital use and behaviour, Spearman's coefficient is used because performance was measured by using an ordinal variable (getting values from 0 to 8). It was found that there is a statistically significant positive relationship of medium intensity with regards to aggregate performance between the two parts of digital intelligence (Table 5). This implies that a student who is capable of thinking computationally is also capable of using properly digital technology.

		CT	DUB
CT	Spearman's rho	1	,313**
	Sig. (2-tailed)		,000
	N	956	956
DUB	Spearman's rho	,313**	1
	Sig. (2-tailed)	,000	
	N	956	956

** Correlation is significant at the 0.01 level (2-tailed).

Table 5. Correlation result of the aggregate performance between CT and DUB

5 Discussion

It is true that the European Union (EU) gives particular emphasis on the development of digital competence to its citizens. This is obvious taking into consideration the European Digital Competence framework (known as DigComp), especially its current version, 2.1. However, emphasis should also be given to a related concept having been recently under investigation, i.e. digital intelligence. Identifying at schools the digitally intelligent students and working for their quick and effective integration in the highly demanding labour market nowadays is of great interest for our society and economy. Digital intelligence is very important, mainly for young people who have not built their digital competence yet; understanding and measuring digital intelligence in young people is a prerequisite for the development of digital competence in adult citizens. More specifically, if we know the principal characteristics of digital intelligence and we are able to measure it through valid tests, then we can better comprehend what digital competence is and what should be done to build digital competence in the future. Giving an example, if a young person is not so digitally intelligent and cannot be protected against digital threats (e.g. having access to inappropriate digital content, talking to strangers online, etc.) on their own, then we have to develop protection mechanisms, such as software labelling, training tools, information platforms, etc. In that way, we know that protection against digital threats (in other words, safety) should be a crucial component of digital competence, as well as the actions that should be accomplished in order to make the young person a digitally competent adult.

6 Conclusions

In this paper, we highlighted the differences in certain cognitive abilities between the digital and the physical (tangible) environment, which can be considered as 'signs' of a new, digital way of thinking. From our perspective, digital intelligence is composed of (i) computational thinking and (ii) digital use and behaviour, which in their turn are subdivided into specific abilities. In the research part of this study, 956 students were tested in terms of their computational thinking and their digital use and behaviour, and a DQ score was calculated. It should be mentioned that to the best of our knowledge, it is the first survey conducted in Greece concerning this topic. Its main findings are: as the parents' level of education increases, DQ score also increases. DQ score is proportional to the usage time of digital devices and depends on the navigation time on the Internet, as well. Another finding is that the students, who have their best school performance in Science and Mathematics, achieved higher DQ scores. Relationship between DQ score and the wealth of the municipality of residence was not found. Performance in computational thinking was correlated to performance in digital use and behaviour, leading to the conclusion that the two parts of digital intelligence are interrelated. However, the overall performance in digital intelligence was low, also indicating that the respondent students were not used to tests that aim to assess mental abilities rather than skills. Digital intelligence is a construct that has not been attracting the interest in the Greek education system and it is believed that surveys like ours will help to the accomplishment of that aim.

This study has a few limitations that should be briefly mentioned. Our analysis led to the inference that all the tests had the same level of difficulty, but the findings showed that the students had trouble answering some tests. However, the lack of a precise identification of the difficulty level of each test is a limitation that holds for all the respondents. Another issue is that students need motivation to participate in a survey like that, since it is questionable if they try with all their might to answer the tests.

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