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Digital competence assessment across generations: Study of a Finnish sample

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Abstract

Digital technologies along with the free navigation of internet is rapidly changing our lives. Considering the importance of digital technologies for socio economic success, acquiring digital competences have become important in knowledge societies. In addition, the European Commission presents a framework of digital competence for citizens by means of combination of knowledge, skills and attitudes, through technology, to perform tasks, solve problems, communicate, manage information, collaborate, create and share content effectively, appropriately, securely, critically, creatively, independently and ethically. Based on the European Framework (DigComp) a self-assessment tool Digital competency wheel is used for this quantitative study to measure the individuals' perceptions toward digital competence. With a sample of 197 individuals from different generations in Finland, this study aims to provide empirical evidence that the generational technological abilities are diverse. The data in this study show that "Net generation" also coined as Digital natives, have obtained the highest level of digital competence; nevertheless, when looking at the performance of all the investigated groups, slight inter-generational difference has been found in the case of problem solving, whereas programming has been found as the least developed competency among these groups. Considering the usefulness and importance of digital competence for learning, this difference is minimal, with no universal applicability. Based on the results, the study concludes that digital competence is very much distributed across generations; this also contribute to intergenerational learning that may enhance technological skills across generations. Therefore, the research in this field needs to be strengthen and the digital competence should be assessed more deeply on a large scale.

Keywords: Digital competence, Digital competency wheel, digital society, connectivism, Digital natives.

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[Fawad Khan]

Contents

1 Introduction

Over the last few decades, information and communications technologies (ICT) have affected our lives in many ways. In particular, technologies with the free navigation of internet have changed the current trends in almost every aspect of our society. Today, people are learning, reading, writing and thinking, with the aid of new technologies (Kirschner & Stoyanov, 2018). Moreover, it is a fact that, moving from a nineteenth to a twenty first century imaginary, skills such as problem solving, critical thinking, computational thinking, creativity, ability to cooperate and self-regulation, are more essential than ever. In addition, these basic realities become even more important when society deals with the challenges to bridge the gap between the digital and the real world (e.g., insecure future employment, lack of future skills, and invention of the new and unforeseen jobs) (Kirschner & Stoyanov, 2018).

Nowadays, people almost every day use technologies for personal and professional purpose, this also affects their level of knowledge in local and global aspects. Although their responses towards the information processed by these technologies are individual, people tend to be aware of their deep connection with the society, where information flows and knowledge evolve (Dunaway, 2011). Further, the digital technologies with the free navigation of internet makes individuals life more meaning-intensive, as the digital means provide almost a constant access to the information as well as assist in sharing culture and ideas through active participation within a society (Martin, & Grudziecki, 2006). Furthermore, the effective use of ICT for socio economic wellbeing necessitates the development of critical thinking and the increased awareness of individuals to use such components with a sufficient degree of autonomy (Hozjan, 2009). Accordingly, new literacies and competencies are required for individuals to use the technologies in their ongoing lives in order to fully participate in the digital age (Hozjan, 2009). In addition, to meet the challenges in a society where the creation, dissemination, and utilization of information and knowledge has become the most important factor of production, individuals also need to be digitally competent to understand digital cultures and being a digital native to be able to navigate and work in the digital environments (Ilomäki & Lakkala, 2011).

As such, it should come as little surprise that digital literacy in the digital age has an important role, specifically, in defining the society's intellectual and socio-economic well-being

(Kiili, 2012). Moreover, nowadays the countries are constantly committed in looking for ways to equip their citizens, from this point of view: in particular they focus on the increasing digital transformation of societies where the creation of knowledge is highly affected by technologies and the social networks have become real tools in the construction of social knowledge towards building a knowledge society (Kluzer & Priego, 2018). In this sense, an important attention in the development of the notion of digital literacy, drawn by the European Commission, extended the concept of digital literacy towards the digital competence. Since then, digital competence became a key concept in the discussion of what kind of skills and understanding people should have in the knowledge society (Ilomäki & Lakkala, 2011). The digital competence that involves the confident and critical use of ICTs for work, leisure and communication, has been central to many academic and policy debates (Ala-Mutka, Punie, & Redecker, 2008).

Further, in the current era of digitalization, it is essential to look into the individuals' ability of using ICT in a safe, responsible and effective way in a society where ICTs are excessively use to communicate with others and to read, learn and share knowledge. Furthermore, with the continuing development of ICTs, it has become crucial to deeper understanding individuals' digital competence in the society. As a matter of fact, technologies and internet provide access resources, and means for the individuals to follow, interact, create and share content on both local and global level. Moreover, it is noteworthy to say that, individuals belonging to different age groups use the digital technologies with the free navigation of internet, and participate in various digital activities that support their work and improve learning to strive in a digital society (Ala-Mutka et al., 2008).

The present study aims to explore the digital competence of individuals from different generations in a knowledge society. Further, the study looks into the intergenerational digital competence in the ICT enabled environment, specifically in Finland. Furthermore, this study explores the digital competence framework for citizens in knowledge societies presented by the European commission (Ferrari, 2013). As such, the study introduces a tool for the assessment of digital competence of individuals belonging to different age groups, while using digital technologies for personal or professional purposes.

By doing so, the present study aims to contribute to the growing area of research on digital competence that is being acknowledge in many national and international policies. Today it is true to say that, in most of the European countries as well as in many other parts of the world,

life is permeated by the use of digital tools, that individuals use frequently to mediate their actions; analogously, the tools that individual encounter and deal with, are often shaped by digital intervention (Martin, & Grudziecki, 2006). Thus, the questions about the digital competence characterizing people of different generations is of major concern in almost every digital society.

In this sense, the Finnish vision of digitalization is in line with these international trends. Recently, Finland ranked first among European countries at the digital economy and society Index (DESI; 2019). In addition, according to DESI country report (2019) Finnish policies have improved their score in the integration of digital technologies in social sectors (DESI; 2019). Given this importance, the concept of digital competence is part of the Finnish new core curriculum, Finnish National Board of Education (2016). In view of that, Mannila (2018) claims that Finnish curriculum covers the key competencies presented in EU framework for lifelong learning.

2 Theoretical framework

For this study, I used constructivism learning theory based on social constructivism (Kim, 2001) and connectivism learning theory of the digital age (Siemen, 2004) to understand how individuals access information and construct knowledge through networks. The above mentioned theories are used as a theoretical approach to explore the perception of individuals' digital competence within the digital sphere, and to investigate how information is processed across different generations.

2.1 Constructivism and social constructivism in digital age

Although there is no universal definition of constructivism (Amineh & Asl, 2015), it can be defined as an epistemological learning theory that refers to learning and thinking (Kim, 2001). In a digital age where technology is used for learning, the individualistic view of constructivism emphasizes on the understanding that an individual develops by using its own knowledge to increase and change the level of thinking in light of its past experiences (Kalina, & Powell, 2009). Furthermore, in the context of technologies, the individualistic view of constructivism sees an individual's approach in constructing knowledge as limited to a single strategic process of learning and thinking on itself. On the contrary, social constructivism emphasizes the importance of culture and context in the development of understanding that occurs in society, whereas the knowledge construction by an individual is made within the process of exploration (Amineh & Asl, 2015). Further, social constructivists see knowledge construction as a shared process rather than an individual experience (Prawat & Floden, 1994). Furthermore, the social constructivist considers the use of digital technologies as a new learning opportunity and in-strument of change in the society, where the learner stands at the center (Amarin & Ghishan, 2013).

2.2 Connectivism view of learning in digital sphere

Kop & Hill (2008) suggest that in the epoch of technology, the theory of connectivism (Siemens, 2004) presents a theoretical framework for understanding and learning in the digital sphere. In connectivism learning theory, learning is established through various connections in the form of networks that contributes to organizational and societal change (Sittia, Sopeerak & Sompong, 2013). It is a collaborative epistemology in which knowledge is con-

structed by a group and distributed across the nodes as a cognitive system (Downes, 2007). The connectiv-ism model posits that learning takes place within the networks where the learners place them-selves in online or virtual learning environments, in order to share their interests, knowledge, perspectives, expertise, and opinions (Kop & Hill, 2008). Next, the information is processed from an individual's learning network, then recognized by other connections that may access through the navigation of Internet and use of technologies, such as databases, search engines, and online information resources (Dunaway, 2011).

Moreover, in connectivism learning, the knowledge is constructed through various connections and distributed across information networks and thus, the process of learning works through the principles of a network. Siemens (2004) explains that learning occurs through a process where cognition and emotions together contribute to construct knowledge. By extensions, an individual's ability to understand and learn about a subject continues to change over time. In this context, connectivism emphasizes on two abilities that contribute to learning process: the first one is the ability to seek information, while the second one is the use of critical lens to filter the information in a specific network (Siemens, 2004).

"The capacity to know is more critical than what is actually known" (Siemens, 2004).

In terms of a knowledge society, connectivism is characterized as the reflection of a society that is changing rapidly (Siemens, 2004). The social aspects in society, from a local to a global level, are more complex and mediated by increasing advancements in technology. Connectivism in the context of a knowledge society offers a combination of ideas from a diversity of opinions networked to specific information sets, where the individual does not have complete control. Furthermore, connectivism offers the ability to share and collaborate between the connections, to reach the source of information as well as to maintain that connection, to facilitate continual learning.

In everyday context, the process of learning in social interactions builds connections that also strengthen links between concepts and ideas across social technological networks. In addition, the free navigation of the internet enables learners to engage with the source of information, i.e. libraries, databases, journals etc. In backing connectivism-learning theory, Siemens (2004) presents the views that the increasing influence of information communication technologies have affected learning personally and socially. Thus, an external connection of information and communication technologies upon human cognition is established.

Connectivism learning theory offers a network learning approach, and from the information literacy perspectives, it highlights the impact of information communication technology in educational and literacy settings (Dunaway, 2011). Further, with the ongoing development of technologies, the shift from the print to digital culture have raised the concerns in different areas of society, especially in the field of education. The digital technologies and the free navigation of internet enable the users to create and disseminate contents and to transform them into text-based knowledge. Thus, the digitalization of knowledge necessitates digitally equipped individuals, able to acquire a critical information literacy, to reflect acknowledgement of the centrality of technology.

In addition, connectivism theory has gained momentum in particular to the digital environments, and researchers and policy makers are highly focused in exploring the learning opportunities presented by emerging technologies. Thus, the connectivism learning theory does not only provides a theoretical support for this study but, also, puts into practice the research methodology. The methodology section in this study discusses much of the research design, including the online survey instrument developed for this study; are based on the connectivism theory. In later sections, the study discusses digital competence of digital citizens in a knowledge society (i.e., Finland) belonging to different generations.

2.3 Development of the Digital competence framework

ICT enabled learning spaces, constitute intergenerational learning as a continuing activity (Ala-Mutka, et al. 2008). These learning spaces enable a self-directed learning in formal and informal settings, such as in educational institutions, at work, at home, and in leisure activities. In this view, the learner is at the center according to its learning needs where the learner is also the co-producers of the outcome (Ala-Mutka, et al. 2008). In general, the digital technologies along with the free navigation of internet, affect the learning at all ages. These technologies support flexibility and openness that enable learners of all ages to experience learning in open, pleasant and reflective environment. However, it would be noteworthy to say that the appropriate and effective use of digital technologies in everyday practices may significantly improve achievements, inspire creative thinking and encourage the development of skills in the real world (Kluzer & Priego, 2018). To this end, in the technologically developed societies where 21st century skills are particularly crucial, the preparation and continuous professional development of average citizens are essential, to enable them to be digitally competent

and thus, improve the quality of their life for progress and success (Kirschner & Stoyanov, 2018).

To increase the role and use of ICT and to develop a common understanding between the world of education and the world of work, there seems to be a shift from a content based (and knowledge based) approach towards a competence-based approach. New suggestions for developing qualification frameworks have been frame towards the technological advancement required for a knowledge society. In the same vein, many international organizations initiated projects in order to better understand the needs to fulfil the requirements of the technological advancements on a global and local level.

Considering this, the European Parliament and the Council first, adopted the recommendations on the European Qualifications Framework for Lifelong Learning (EQF) in European commission (2008). The European Union (2009) then, created a framework for key competences for lifelong learning in a knowledge society where digital competence is added as one of the core competencies of the framework that focus on the basic ICT skills. At that point, other skills, such as critical thinking, safety, responsibility, risk awareness, and ethical and legal considerations while using digital technologies were not that explicitly addressed. However, in 2013, European Commission launched a project Digital Competence (DIGCOMP), to identify the key components of digital competence, and to develop descriptions in order to support a European-level framework (Ferrari, 2013).

Since then, the concept of Digital competence has been used in many policy debates with the aim to improve and increase the computing skills and to develop critical thinking among the citizens (Ala-Mukta, et al. 2008). Further, the concept Digital Competence has been used in many academic studies for exploring its various dimensions (Hatlevik & Christophersen, 2013). Furthermore, it has been prominent in the field of education and has been widely used by teach-ers, school leaders while many instruments and tools are developed to improve their compe-tencies to strive in the digital age (Cartelli, 2010). In addition, digital competence focuses on improving and increasing the computing skills and critical thinking to communicate and share information with digital tools or media. Eventually, European Commission develop a framework for the digital competence for citizens to increase the interest and engagement of governments to equip the citizens with digital skills and to enable them to use digital technologies in appropriate-ate and effective way in everyday practices (Ferrari, 2013).

Based on the skill-oriented aspects of the technology, digital competence framework, identifies five broad areas of digital competence: (1) information and data processing, (2) communication, (3) content creation, (4) safety and (5) problem-solving (Ferrari, 2013). More recently, in 2017 the framework was upgraded under the name of DigComp 2.1 (Carretero, Vuorikari & Punie, 2017), with the aim to recognize the digital competence as a key in contributing to personal fulfilment and development, active citizenship, social inclusion and employment in a knowledge society. Likely, digital competence involves the confident and critical use of Information Society Technology (IST) for work, leisure, communication, and participation in collaborative networks via the Internet (Røkenes & Krumsvik, 2014).

Moreover, the OECD (2015) also acknowledged the digital competence as a key factor, contributing towards socio economic productivity, and therefore, they encouraged member states to develop framework for digital competence. In the same vein, governments have shown worries to provide digital competence framework for educators, social partners, and learners and, along with that, to support other related areas, such as employment, health, education and policies affecting youth (Fraile, Vélez & Lacambra, 2018). In addition, while acknowledging the importance of digital technologies for socio economic success, also the attention has drawn to the 21st century skills in educational context (OECD, 2015). Therefore, this would be noteworthy to say that, the digital competence has received attention in national and global context and in many policies and research studies that are often aim for preparing citizens to thrive in an increasingly digitalized society.

2.4 Earlier studies on generational differences in digital competence.

Due to the fact that nowadays the digital world is rapidly changing, individuals from all ages are quite exposed to information communication technologies. The digital environment in influences an individual's perception and way of thinking (Oblinger & Oblinger, 2005). The priorities and necessities of the individuals from different generations may differ from each other in terms of their diverse capabilities and dealing with technological developments. Parry & Urwin (2017) notes that the presence of generational diverse capabilities are increasingly reported by researchers in the academic literature. In the same vein, Giancola (2006) presents the notion of a "generation gap: more myth than reality", while Lyons, Duxbury, and Higgins (2007) notes the lack of empirical evidence investigating popular generational differences in terms of value such as self-enhancement and openness to Change (see also Parry & Urwin,

2017). On the contrary, Tolbize (2008) provides the empirical evidence about variations of attidue and behavior throughout an individual´ life; in such a way that, an individual have different values thought, reaction, and behaviors to external stimuli that are also shared across generations.

Yet, one important consideration that has been often neglected in discussions about digital tech-nologies is the changing technological landscape that has influenced a series of generations (Oblinger & Oblinger, 2005). In line with this view, Strauss & Howe (2003) as well as Oblinger & Oblinger (2005) classify generations in to matures, born in 1900–1946, baby Boomers, born in 1946–1964, generation X, born in 1965–1982 and Net Generation (millennials), born in 1982–1996. However, some differences and different viewpoints can be detectable in the literature regarding such classification: Cole, Napier & Marcum (2015), for example, consider 1994 as the starting point for Generation Z, thus proposing the existence of an additional category. Furthermore, according to Dimock, M. (2019), 1996 is the last birth year for Millennials. Taking into consideration the different classifications available in the literature, the present study recognizes mid 90s as the last years for millennials, and the birth year for Generation Z.

2.5 Mapping digital competence

To provide a better understanding of the digital competence, the study map the digital competence by adopting the digital competence framework Digcomp 2.0 (Vuorikari Punie, Carretero, Gomez, & Van den Brande, 2016) as a guidance document for the assessment of digital compe-tence. The Digcomp 2.0 identifies five competence areas: information, communication, con-tent creation, safety and problem solving. These areas are identified as core competencies in order to assess the digital competence of the target population.

In addition, the study adopt the scale for assessing low/high level proficiency to measures the overall digital competence by using the Digital competence framework-Digcomp2.1 (Carretero, Vuorikari, & Punie, 2017). It presents eight levels of achievement (ranging from 1 to 8) for each of the competence area presented in Digcomp 2.0 (Vuorikari et al., 2016).

Table 1 and 2 provide a more detailed description of the competence areas and proficiency levels used as reference for the assessment of digital competence across generations. In addition, these tables include a general description of competences and sub-competencies that are

mentioned in Digcomp 2.0 and 2.1 (Vuorikari et al., 2016; Carretero, Vuorikari, & Punie, 2017).

Table 1. Description of competence areas reporting the title, the description and the sub-competencies, defined according to The Common Digital Competence Framework 2.1 (DigComp 2.0, Vuorikari, Riina, et al., 2016; DigComp 2.1, Carretero, Vuorikari, & Punie, 2017).

Competence areas (Dimension 1)	General description of Competence areas	Sub Competences (Dimension 2)
1. Information and data literacy	Ability to identify, locate, retrieve, store, organize and analyses digital information, judging its relevance and purpose.	1.1 Browsing, searching and filtering data, information and digital content 1.2 Evaluating data, information and digital content 1.3 Managing data, information and digital Content.
2. Communication and collaboration	Ability to communicate in digital environments, share resources through online tools, link with others and collaborate through digital tools, interact with and participate in communities and networks, cross-cultural awareness	2.1 Interacting through digital technologies 2.2 Sharing through digital technologies 2.3 Engaging in citizenship through digital technologies 2.4 Collaborating through digital technologies 2.5 Netiquette 2.6 Managing digital identity

3. Digital content creation	Ability to create and edit new content (from word processing to images and video), integrate and re elaborate previous knowledge and content, produce creative expressions, media outputs and programming and deal with and apply intellectual property rights and licenses.	3.1 Developing digital content 3.2 Integrating and re-elaborating digital content 3.3 Copyright and licenses 3.4 Programming
4. Safety	Ability to personal protection, data protection digital identity protection, security measures, safe and sustainable use.	4.1 Protecting devices 4.2 Protecting personal data and privacy 4.3 Protecting health and well-being 4.4 Protecting the environment
5. Problem solving	Ability to identify digital needs and resources, make informed decisions as to which are the most appropriate digital tools according to the purpose or need, solve conceptual problems through digital means, creatively use technologies, solve technical problems and update one's own and others' competences.	5.1 Solving technical problems 5.2 Identifying needs and technological responses 5.3 Creatively using digital technologies 5.4 Identifying digital competence gaps

Table 1. Eight proficiency levels (Dimension 3) for each of the 21 competences provided in The Common Digital Competence Framework 2.1(DigComp 2.0; Vuorikari et al., 2016; DigComp 2.1, Carretero, Vuorikari, & Punie, 2017).

Proficiency level (Dimension 3)	Foundation	Intermediate	Advanced	Highly specialized
Simple tasks with guidance	1. I can solve simple task with guidance	3. I can solve well-defined and routine tasks, and straightforward problems on my own	5. I can solve many different tasks and problems and help guide others	7. I can resolve complex problems with limited solutions and contribute to the professional practice
	2. I can solve simple tasks with autonomy and guidance where needed.	4. I can solve tasks and deal with non-routine problems independent and according to my need.	6. I can solve many different tasks and problems and help guide others	8. I can resolve complex problems with many interacting factors and propose new ideas and processes to the field

2.6 Aim and research questions

The aim of the study is to explore the digital competence in a sample of individuals that belong to different age groups.

More specifically, the present study aims to identify:

1. What is the digital competence proficiency levels of different age groups by following the Digcomp framework 2.1?

2. What are the strongest and the weakest competence areas in overall Finnish sample?

3. What are the highest and lowest digital competencies in overall Finnish sample?

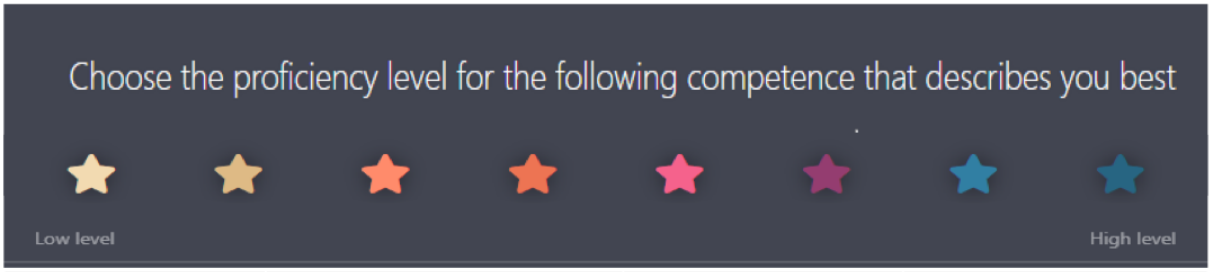
3 Methodology

3.1 Digital competency wheel

This study uses an online tool called *Digital competency wheel*, in order to assess the digital competence proficiency level among individuals from all ages. In order to use the tool for a research study, the developers provided an admin access. A detailed research was carried out before selecting the tool for data collecting, which revealed that the tool is theoretically based on three elements i.e., knowledge, ability, and attitude of the digital competence framework DigComp (Ferrari, 2013) Moreover, it is in line with the core competencies of European Commission framework for digital competence Digcomp 2.0 (Vuorikari et al., 2016). In addition, it follows DigComp 2.1 (Carretero, Vuorikari, & Punie, 2017) framework as a reference to assess proficiency level at a scale of 10 to 100, for the assessment of the digital competence of the adopted sample in this study. Moreover, the tool is theoretically based on digital competence frameworks (Ferrari, 2013; Vuorikari Punie, Carretero, Gomez, & Van den Brande, 2016, & Carretero, Vuorikari, & Punie, 2017). Also, it is based on the premise that, an individual can easily reflect on their own understanding of digital technologies by taking into account their own level of digital competence with a sense of improvement (McNicol, Lewin, Keune, & Toikkanen, 2014).

3.2 The Questionnaire

The digital competency wheel generates the questionnaire adopted in this study. In total 21 questions in the form of statements are embedded in the online survey. Further, the online survey solicits participants to self-assess the specific competencies in Table 1. Further, the respondents are asked to assess their own digital competence by choosing the score best representing their own abilities. In detail, they are asked to choose their level of proficiency on a Likert scale ranging from 1 (Low Level) to 8 (High level). Graphically speaking, the questionnaire in the survey provides a star of different colors representing the specific level on each scale. See Figure 1. As a result, the Digital competency wheel formulates the overall mapping of a respondent's ability on each of the digital competence area.



Foundation		Intermediate		Advanced		Highly specialized	
I can resolve simple task with guidance	I can resolve simple task with autonomy and guidance where needed	I can solve well-defined routine tasks and deal with straightforward problems on my own.	I can solve the task and deal with non-routine problems independent and according to my needs	I can solve many different tasks and problems and help guide others	I can select the most appropriate task and am able to adapt solutions to others in a complex context	I can resolve complex problems with limited solution and contribute to the professional practice	I can resolve complex problems with many interacting factors and propose new ideas and processes to the field

Figure 1. Example of a question with the proficiency level presented by Digital competency wheel.

3.3 Respondents' background

The participants of the study responded based on their digital attributes, and ability to take part in the online survey. In total, 197 individuals, irrespective of the gender, ranging in age from 16 to 89, responded to the online survey designed for this study. Moreover, their responses were organized into four groups are as follows: (a) Baby boomers (b) Net generation (c) Generation X (d) Generation Z. Notably, no one from the age group of Matures responded to the survey. Therefore, Matures are not taken into consideration for this study. The distribution of the participants according to their age groups is displayed in Table 3.

Table 3. The distribution of the age groups in the sample.

Generation	Year of Birth	N
Matures	1900–1946	0
Baby Boomers	1946–1964	33
Generation X	1965–1982	97
Net-Generation (Millennials)	1982–1994	56
Generation Z	1995-2003	11

4 Data analysis and procedure

The digital competence of each age group is examined through quantitative research model and the data is obtained by using snowball sampling method through a virtual network. In addition, a snowball-sampling method adopted in this study; as it is a useful methodology for exploratory, quantitative and descriptive research, especially in the studies, where a high degree of trust is required to initiate the contact (Baltar & Brunet, 2012). The quantitative research method in this study emphasizes on the objectivity reliability and validity of the data. Given the need to assess the individuals' perception of their own proficiency in the digital sphere and considering the digital competence framework, the study used the descriptive design to employ a survey methodology (Edward, 2001). A survey methodology helps to clarify the ideas that a researcher usually considers in providing thorough descriptions and interpretations of the data including its meaning to those who experience it (Dey, 2003). Further, a descriptive study provides the basic features for the data description with statistics, such as mean, median, mode and standard deviation (Frankel & Wallen, 2000). For its part, numeric data collected in this study are analyzed quantitatively using descriptive statistical analysis that are represented by graphs, with the distribution-based percentage. Further, going deep into the generational diverse technological abilities to explore the perception of digital competence across generations, the graphs provided in the study represents the performance scores of the individuals in response to the questions. Further, to obtain a more meaningful assessment of the respondent reactivity in a reasonably short time, internet as a medium to interact is used. Firstly, by using Digital competency wheel, the links for the online survey are generated with the short description of the aim of the research, for each age group. Secondly, these links are shared via email and on social media platform "LinkedIn". By doing so, this led the participants to the Digital competency wheel where they assessed their own digital competence in the form of a filling a questionnaire.

The study examines separately, the average score for five competency areas and 21 sub competencies in each group displayed in Table 1 are separately examined. Subsequent to this, participants' proficiency levels are measured on a scale from 10 to 100 points; the obtained scores are displayed, converted in percentages by each group in Table 2). Altogether, in this way, the average score for each group in all competencies is used to examine the overall digital competence score. In detail, respondents are asked to examine their proficiency level of digital competence. Their own perceptions of digital competence on each statement are rec-

orded and analyzed in order to examine their overall proficiency level. From all their responses, the highest and lowest sub competencies are identified, indicating the strongest and weakest competence area.

4.1 Results

The results for each of the research question of this study are given below:

4.1.1 What is the digital competence proficiency levels of different age groups, following the Digcomp framework 2.1?.

Overall, the participants in all the age groups placed themselves at the advance level of 5 and 6 on a scale of 1 to 8 (Table 2), with a total average score of 69%. In regard to digital competence framework, Digcomp 2.0 (Vuorikari et al., 2016) and DigComp 2.1 (Carretero, Vuorikari, & Punie, 2017), these generations are able to perform different tasks, solve problems and help others.

Regarding the digital competence proficiency level of different age groups, the *Net Generation* gained the highest score with an average of 73%, whereas G*eneration Z* had the lowest score with an average 64%. As can be seen in Figure 2, however, there seems to be a difference in the percentage score for each group in terms of proficiency level; no clear indication of a considerable gap between the *Baby boomers* and the *Generation X* was detected.

The overall digital competence score obtained by each ager group is displayed in Figure 2.

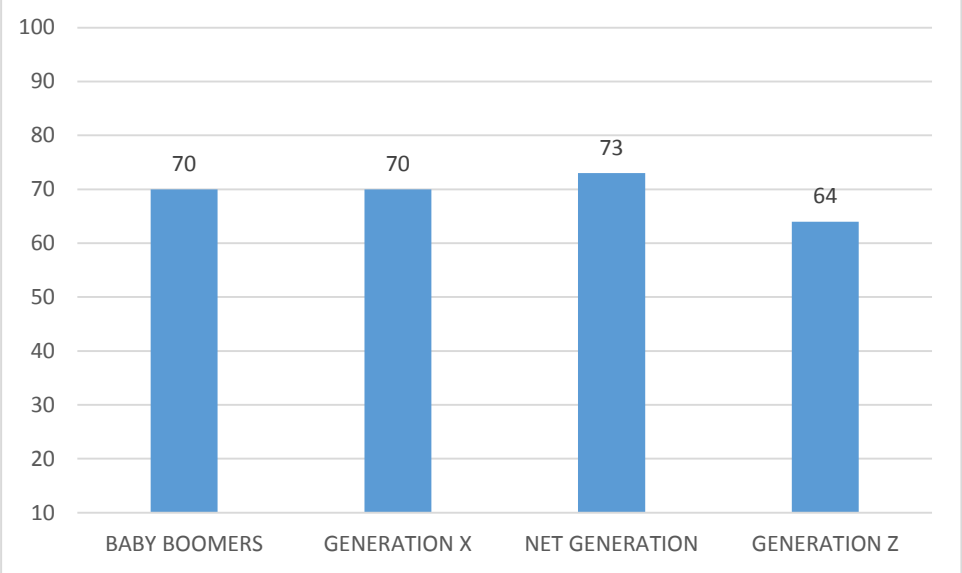


Figure 2. Digital competence percentage score for each age group.

4.1.2 . What are the strongest and the weakest competence areas in overall Finnish sample?

In order to go deep into the analysis of the results, the average score of all the groups in each competence area (Table 1 and Dimension 1) assessed by the Digital competency wheel is examined. As can be seen in Figure 3, *information and data literacy* is the highest core competency with the mean of 76 scored by each group. This shows that the individuals from all the groups are able to identify, locate, retrieve, store and organize digital information. Also, in the case of *communication and collaboration*, almost the same ratio of respondents is able to communicate, collaborate, interact and participate in virtual teams and networks. As can be seen in Figure 3 *safety* is the least developed competency with a mean score of 63. This means that the respondents report the ability to create, configure and edit digital content as well as solve digital issues by exploring and learning new ways to take advantage of technology. As for its part, *problem solving* is the least developed area of competence, as only 61 percent of the respondents are able to identify technical problems (software and hardware), solve them and configure applications and devices on personal preference. In this sense, these generations are less dominant in the identification of digital needs and resources, and in making informed decisions and solving conceptual problems through digital means.

The score in five competence areas, by each age group, is displayed in Figure 3.

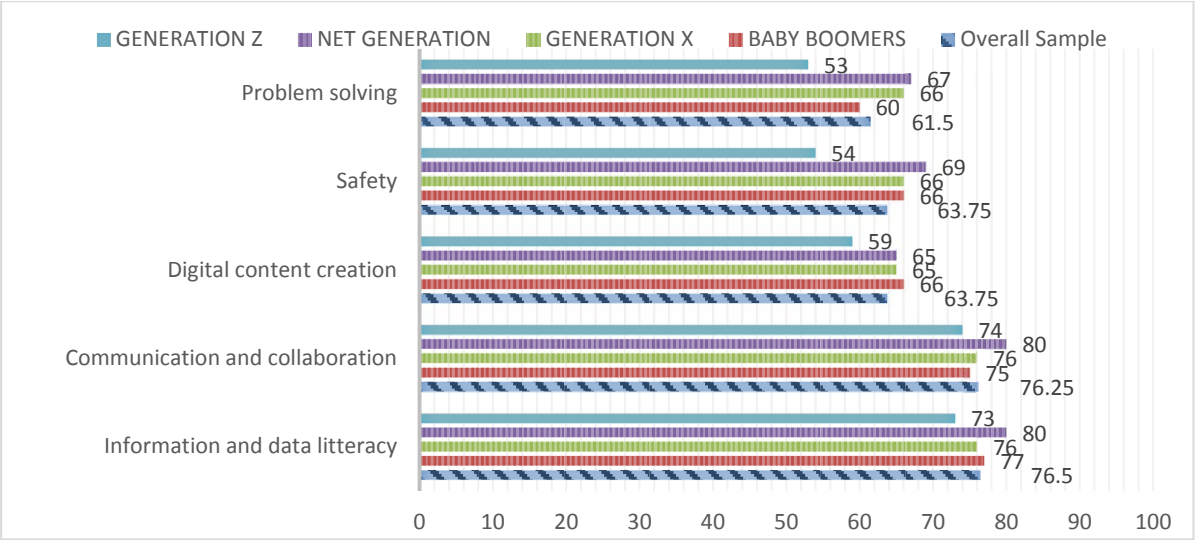


Figure 3. The proficiency level obtained by each age group in five competence areas including the mean score by all groups (Dimension 1)

4.1.3 What are the highest and lowest digital competencies in overall Finnish sample?

As for the identification of highest and lowest competency among groups, the performance scores obtained by the different age groups in each single sub-competency of the five-competence area (Table 2 and Dimension 1 & 2) is examined. This revealed that, in overall sample, the highest competency turned out to be *Netiquette* whereas the lowest was Programming Further, the respondents are highly awared of behavioural norms while using digital technologies and interacting in digital environments. However, they have less ability in planning and developing a instruction, in computing to solve a given problem or in performing a special task.

The score of each sub competency, in percentage, is displayed in Figure 4.

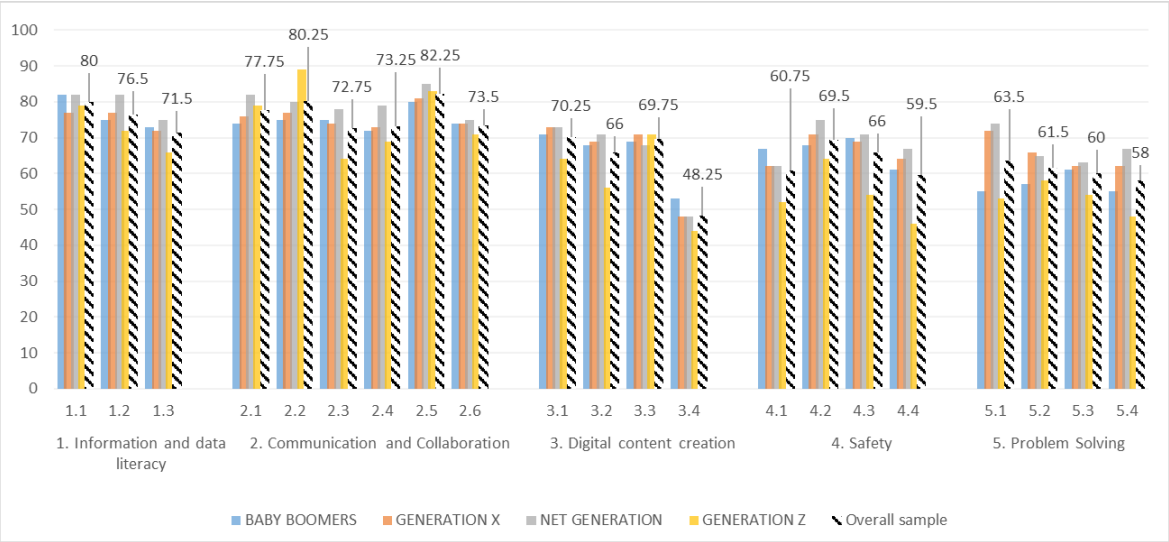


Figure 4. Level of proficiency of each age group for each sub competencies, including the mean score of the participants despite the generation

5 Discussion and conclusions

The study analyzes the digital competence level in a sample of individuals belonging to different age groups, by using a self-assessment tool, Digital competency wheel, which is based on the digital competence framework as research lens. To the best of our knowledge, this study is a pioneer in Finland as it focuses for the first time on the assessment of digital competence of individuals belonging to different generations.

The findings of the study provide the evidences for the level of five core competencies among different generations in a knowledge society. The main objective of the research is to explore the digitally competent generation and their proficient digital competencies in a knowledge society, such a Finland. More specifically, while measuring the digital competence with the three dimensions of the Digital competence framework, it is revealed that individuals from different generations are able to perform tasks and solve technical problems, as well as provide guidance to others about their own experiences. These individuals may, indeed, play a significant role in guiding others and helping them to acquire and enhance their technological skills. These results confirm the idea that individuals have the ability to share and collaborate between the connections, to reach the source of information as well as to maintain that connection, therefore facilitating continual learning (Seimens, 2004).

Specifically, the data in the study show that among different generations, the individuals of the so-called Net generation, also labeled as Digital natives, have obtained the highest level of digital competence. Net generation individuals are able to resolve complex problems with many interacting factors, and propose new ideas and processes them to any required field. Such finding is not surprising and is consistent with the available literature; Net Generation individuals are born and grown in a digital age, where internet has become a major source of the information in their learning preferences (Coombes, 2009; see also Oblinger & Oblinger, 2005).

By extension, the empirical results show that all these generations were the most competent in areas such as information and data literacy, communication and collaboration, digital content creation and safety; that are also often considered as cognitive skills and the abilities for the appropriation of technologies and the digital practices presented by Vuorikari et al., (2016). This highlights that they possess the ability to express oneself through digital means, with respect the security measures such as reliability and privacy. However, the same skills were

not observed regarding problem solving (an individual's capacity to understand and resolve problem situations), which has been found as the least developed area of in terms of digital competence.

More specifically, by identifying the highest and lowest competency, it was found that all the generations show a high proficiency in the "Netiquette; that refers to the awareness of behavioral norms, online, cultural and generational diversity in digital environments. Whereas, the finding revealed that the lowest competency is Programming; that is the ability to plan and develop a sequence of understandable instructions for a computing system to solve a given problem or perform a specific task. It is now evident from the findings of the study that individual`s responses towards the information produced processed by these technologies are unique however, they are aware of their deep connection with the society where information flows and the knowledge evolve (Dunaway, 2011).

One of the major contributions of this study is its comparison of the age cohort with the level of digital competence. The findings line up with the theory and research on digital natives regarding their birth in a digital age, and even more important. the use of internet as a major source of information in their learning preferences; therefore, their technological skills and preferences are different from previous generations (Barbara Coombes,2009) see also Oblinger & Oblinger, 2005).

In addition, , it should be noted that, this does not lead us to a conclusion that all the generations have developed a same level of technological abilities (Lyons, Duxbury, & Higgins 2007). In contrast, the digital natives show higher levels of digital competence than digital immigrants as presented by Giancola (2006), no considerable gap is evident in generations, in particular in Finland, as it has been ranked the first country among other European countries in the integration of digital technologies in social sectors (DESI; 2019)

Moreover, Bennett, Maton & Kervin (2008) extended this same idea, suggesting that generations approach several things while they use digital technologies, it influences their behavioral tendencies in acquiring new competences At this regard, Rasi & Kilpeläinen (2015) present the socio-demographic view of technology driven by behavior that remains a fundamental method for coping social and societal pressure in digital societies. This assertion is consistent with the results of this study, as it develops the key idea that that digital competence is a distributed competence in formal and informal networks across generations and it should not, therefore, be assessed solely as an individual characteristic (Rasi, & Kilpeläinen, 2015).

Ethical Considerations

This study adopted a free and informed consent that enable participants to exercise the free power of choice. In order to participate the study, a short introduction of the research and its purpose, as well as an explanation about the selection of the research subjects was provided. The data collected for this study is used only for the research purposes and the rules are followed accordingly to the provided ethical guidelines by Finland National Advisory Board on Research Ethics (2009). The research supervisor was asked to see and evaluate the tool before the final data collection was carried out and, also, a test run of the complete process was run with some of colleagues in order to double check the correctness of the procedures..

Limitations of the study and future studies

Nevertheless, this research represents the first attempt to highlight the issue of digital competence in Finland. The results provided will allow to increase the academic debates about the digital competence, with the possibility to include in the discussion the potential differences among different generations in all the dimensions investigated in the present study.

The study was conducted in a specific context of Finland. Nevertheless, the digital competence framework in other European countries might be of great interest, as the issued covered, as well as the implications may be different in other counties, for example depending on different socio-economical status.

As noted earlier, the interests in knowledge societies have been increasing lately, specifically in digitally equipped citizens; yet, the frameworks and tools available for this kind of assessment are subject to the changes over time and quite limited. Therefore, future research should focus on assessment of digital competence in in different kinds of societies, in order to achieve better results to develop skill and abilities to use digital tools and technology with a sufficient degree of autonomy.

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