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Digital Competences for Virtual/Hybrid Hackathons: DigComp 2.1 in Municipal Organization

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Abstract: This paper addresses the digital competences necessary for virtual hackathon participation. Specifically, it focuses on the digital competences and their training utilizing DigComp 2.1.-framework as reference. It presents a case study in a Swedish municipality carrying out multi-disciplinary and intra-organizational, hackathons in virtual and hybrid collocation for public sector innovation. The results of performance-based assessment of digital competence areas, competences, and proficiency levels of virtual and hybrid hackathon hacker participants are illustrated. Furthermore, the activities to train those digital competences in two hackathons are portrayed. The results clarify the 17 digital competences necessary for virtual hackathon participation, needed to be verified or trained before the event. Moreover, the results clarify that some of the digital competences are also context dependent, thus affecting the hackathon design. The paper contributes to the literature on digital competence as well as hackathons particularly in virtual and hybrid collocations in municipal organization context.

Keywords: innovation contest; hackathon; virtual hackathon; hybrid hackathon digital competence; DigComp 2.1; competence training; innovation training; performance-based assessment; public sector innovation

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1 Introduction

The Covid-19 Pandemic has affected innovation management by shifting the innovation endeavours into digital environments (Almeida, 2021). However, innovating in digital environments requires levels of digital competences, which pre-pandemic were not normally required in, for example, public sector employees daily work. Ferrari et al (2013) emphasizes that digital competence is a transversal key competence that renders possible to adopt other key competences and is associated to many of the 21st Century skills. As such, possessing digital competence is a necessity for all citizens to participate in modern society and economy.

Alongside digital services literacy, hackathons are highlighted as one of most utilized innovative response initiatives in the EU to mitigate the effects of Covid-19 (Almeida, 2021). Hackathons as innovation contests have been studied to some extent (Medina Angarita and Nolte, 2020). Arranged in three types of collocations: radical, virtual and hybrid (Halvari et al., 2020), hackathons have three phases: pre-hackathon, hackathon event and post-hackathon (Pe-Than et al., 2019; Pe-Than and Herbsleb, 2019) Virtual hackathons are arranged with information and communication technology (ICT) (Jussila et al., 2020). Virtual or hybrid hackathons require digital competences from their participants (Jonsson et al., 2021). Hackathons are applied by both national public entities and private entities, yet their focus is on the development of innovative solutions and solving specific problems through technology, not in the training or competence building potential during the hackathon journey(Almeida, 2021). Thus, there is a need to study those digital competences in the context of virtual or hybrid hackathon, and more specifically, for value-creating public sector innovation (Suominen et al., 2021). The goal of our research is to clarify the digital competences necessary for participation in virtual and hybrid hackathons by utilizing the digital competence DigComp 2.1. -framework (Commission et al., 2018) as reference. As those digital competences are needed for participation, they also have to, either be verified or trained, prior to the hackathon event. Our case organization is a Swedish municipality adopting hackathon methodology by arranging hackathons in virtual and hybrid collocations. Therefore, our research focuses on digital competences and competence building for hackers in a virtual or hybrid hackathon in a municipal organization. By utilizing performance-based assessment (Stefano and Pujol Priego, 2018), the aim is to present the identified competence areas, as well as competences, and their necessary competence proficiency levels for virtual hackathon participation. Our research question is: *"How the needed digital competences to participate in virtual hackathon of DigComp 2.1. framework can be trained with the help of information technology-enabled innovation methods in a municipal organization?"*

The article is composed as follows: First, in the introduction, we give background regarding our research problem and present the research question, second, we briefly describe the aspects of digital competence and DigComp 2.1. -framework as reference model. Third, we portray the methodological choices of our study. Fourth, we illustrate our research results and fifth we present the conclusions and practical implications together with further research suggestions.

2 Digital competence and DigComp 2.1

Digital competence is a relatively novel and multifaceted concept without a single generally accepted definition. As a term it has originated from a societal need for defining and describing core competences in a digitalized knowledge society, particularly in Europe (e.g. Ilomäki et al., 2016; Pettersson, 2018). Despite its comprehensive nature, the research is currently limited and carried out in Scandinavia, (for example From, 2017; Ilomäki et al., 2016, 2011; Krumsvik, 2014, 2011, 2008; Lakkala et al., 2011; Røkenes and Krumsvik, 2016, 2014; Tømte et al., 2015). Most of the international research on digital competence focuses on the specific competences required of teachers or teacher educators (Pettersson, 2018), and in digital competence teaching context as a side-effect of digital technology. (Ilomäki et al., 2016; Pettersson, 2018; Spante et al., 2018)

Digital competence as a concept is still emerging (Ilomäki et al., 2016; Spante et al., 2018). With the aim of clarifying the concept, a few systematic literature reviews have been carried out, such as those of Ilomäki et al. (2016), (Spante et al., 2018), and (Pettersson, 2018), all producing slightly different views. These literature reviews revealed that digital competence and digital literacy are closely linked and often used synonymously; however, they do have distinct origins and meanings (Ilomäki et al., 2016; Spante et al., 2018). In general, there has been an increase in the use of both terms. Additionally, digital competence is regarded as being similar to the concept of 21st century skills (Ilomäki et al., 2016).

Janssen et al. (2013) argued that digital competence should be understood as a pluralistic concept*: "a concept that describes a network of intricately connected purposes, domains, and levels of ICT use"* (Janssen et al., 2013, p. 480) with areas partially overlapping, yet also complementary. Digital competence extends beyond technology use to encompass communication and information management skills as well as knowledge and attitudes regarding legal and ethical factors, privacy and security, understanding the role of ICT in society, and an individual's balanced attitude toward technology. (Janssen et al., 2013) Ilomäki et al. (2016) suggested that *"digital competence is defined as consisting of (1) technical competence, (2) the ability to use digital technologies in a meaningful way for working, studying and in everyday life, (3) the ability to evaluate digital technologies critically, and (4) motivation to participate and commit in the digital culture"* (Ilomäki et al., 2016, p. 655), and, proposed the following definition:

> *Digital competence consists of the skills and practices required to use new technologies in a meaningful way and as a tool for learning, working and leisure time, understanding the essential phenomena of digital technologies in society as well as in one's own life, and the motivation to participate in the digital world as an active and responsible actor. (Ilomäki et al., 2016, p. 670–670)*

European Commission (2018) consider digital competence as a multifaceted concept that encompasses a variety of skills, such as problem-solving, communication and collaboration, and knowledge creation, particularly co-creation. In Europe, the digital competence framework (DigComp) has been developed since 2005. The aim of the DigComp -framework was to provide a tool through which to improve individuals' digital competence (Ferrari et al., 2012). Since the first DigComp -framework (Ferrari, 2013), it has been updated with two versions: 2.0 by (Vuorikari et al., 2016) and 2.1 by (Carretero et al., 2017)**.**

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Today, DigComp 2.1-framework contains five competence areas: 1. information and data literacy, 2. communication and collaboration, 3. digital content creation, 4. safety, and 5. problem solving (Table 1), each entailing eight proficiency levels (Table 2) defined though learning outcomes according to Bloom's taxonomy (Commission et al., 2018). An individual may have a varying set of these competences, and the level of each may also differ. Thus, in order to master the future digital society, the set of digital competences of each individual should be as extensive and high-level as possible; however, survival in digitalized society does not require expert level competences (e.g., in programming competence included in competence area 3. digital content creation in DigComp 2.0). (Vuorikari et al., 2016).

Table 1 Summary of DigComp 2.1 Competence areas and competences in two dimensions (Carretero et al., 2017)

Competence areas, Dimension 1	*Competences, Dimension 2*
1. Information and data literacy	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	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 To use digital tools and technologies for collaborative processes, and for co-construction and co-creation of resources and knowledge 2.5 Netiquette 2.6 Managing digital identity
3. Digital content creation	3.1 Developing digital content 3.2 Integrating and re-elaborating digital content 3.3 Copyright and licences 3.4 Programming
4. Safety	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	5.1 Solving technical problems 5.2 Identifying needs and technological responses 5.3 Creatively using digital technologies 5.4 Identifying digital competence gaps

Source: DigComp 2.1.

The aforementioned proficiency levels can be summarised as in Table 2. Some examples of *simple tasks* are: "with help from a teacher finding identifying how to update a previously created digitally animated presentation with text and images to be shown to others" **or** "in the classroom where I can consult my teacher whenever needed I can identify an app in my tablet to organize, store and retrieve links related to a topic I am preparing a report for". Examples of *well-defined and routine tasks, and straightforward problems*:

"By myself I can add or delete members from a chat group" **or "**By myself I can send calendar invitations to an event I am planning". Examples of *Tasks, and well-defined and non-routine problems* are: "Independently I can use a cloud-based storage system to share material with other members of my group" **or "**I can show my colleagues on their smartphones how to access and share an agenda, using our digital storage system, for an event I am organising." Examples of *Different tasks and problems* are: "I can help my colleagues to detect risks and threats while using a specific social media platform" **or "**I can propose and use different micro-blogs, blogs and wikis, for a public consultation regarding social inclusion of a target group in my neighbourhood to collect proposals on what work should be done."

Table 2 Summary of DigComp 2.1 Proficiency levels (Carretero et al., 2017)

Levels in DigComp 1.0	*Levels in DigComp 2.1*	*Complexity of tasks*	*Autonomy*
Foundation	1	Simple tasks	With guidance
	2	Simple tasks	Autonomy and with guidance where needed
Intermediate	3	Well-defined and routine tasks, and straightforward problems	On my own
	4	Tasks, and well-defined and non-routine problems	Independent and according to my needs
Advanced	5	Different tasks and problems	Guiding others
	6	Most appropriate tasks	Able to adapt to others in a complex context
Highly Specialised	7	Resolve complex problems with limited solutions	Integrate to contribute to the professional practice and to guide others
	8	Resolve complex problems with many interacting factors	Propose new ideas and processes to the field

Source: DigComp 2.1.

In research, the most recent version DigComp 2.1. -framework has been utilized e.g., in Finland to evaluate the digital competence across generations (Khan and Vuopala, 2019). (Bartolomé et al., 2021) results confirmed that DigComp is the most appropriate reference when considering the transversality of digital competence. However, they highlight, that researchers should have well-defined clear criteria. According to Stefano and Pujol Priego (2018), digital competence assessment tools contain: a) self-assessment, subjective evaluations which may not really reflect an individual's competence, due to the cognitive bias of Dunning-Kruger effect (Dunning et al., 2003); b) knowledge-based assessment, which measures the knowledge of an individual in a certain subject or field; c) performance-based assessment, where an individual has to demonstrate their ability performing certain tasks; and d) secondary data-gathering and analysis, which provides information related to a group but not at the individual level. Performance-based assessments represent a set of strategies for evaluating knowledge, skills and work habits

through the performance of tasks that are meaningful and attractive to users (Bartolomé et al., 2021). The performance-based assessment of digital competence means that**,** *"users are requested to actually solve digital challenges, reflecting real situations that they may face and entailing the use of tools such as browsers, word processors, spreadsheets etc."* (Stefano and Pujol Priego, 2018, p. 35). In other words, users have to access to materials, interact with programs and services, create new contents, search and evaluate the information found, and communicate and share information. As an assessment approach, performance-based analysis is considered the most accurate, since it is 'knowledge in action", yet it is regarded very demanding. (Stefano and Pujol Priego, 2018). Furthermore, Ilomäki et al., (2016) proposes that the methods for **learning these skills** require practice through complex, challenging, and "authentic" activities to ensure that the skills related to using technology are viewed from broad perspective.

Hackathon an authentic activity in a virtual and hybrid collocation

Hackathons as innovation contests have been studied to some extent (Medina Angarita and Nolte, 2020). Hackathons are arranged in three types of collocations: radical, virtual and hybrid collocations (Halvari et al., 2020). Hackathon has three phases: pre-hackathon, hackathon event and post-hackathon (Pe-Than et al., 2019; Pe-Than and Herbsleb, 2019). The event itself include creation process and celebration process (Halvari et al., 2020) Utilized as one of the most popular for innovative response initiatives in EU to mitigate the effects of Covid-19, hackathons are used in national public entities and private entities for developing innovative solutions and solving specific problems though technology (Almeida, 2021) Virtual hackathons are arranged with the help of Information and Communication technology (ICT) (Jussila et al., 2020), thus hybrid hackathons have also the virtual element (Halvari et al., 2020). Hackathon in virtual collocation require digital competences for participation (Jonsson et al., 2021). Pe-Than et al. (2020) highlight, that hackathons presented in the literature typically exist outside any stable organizational context and bring together people who generally have not worked together or even met each other before.

3 Methodology

Hackathon, particularly in virtual and hybrid collocation, is a novel concept, and especially the digital competences needed for their successful outcome are under-researched, the nature of this research is exploratory (Saunders et al., 2008). The aim of this study is further clarify the digital competences that are required and thus need to be verified or trained for the participant to take part in a virtual or hybrid hackathon, thus philosophical program of this study is pragmatism (Morgan, 2014). The research strategy of the study draws from a combination of intensive case study approach and action research (Eriksson and Kovalainen, 2008). The study is carried out in the case organization (e.g. Siggelkow, 2007). The research data collection has been carried out with the participatory action research method with both physical and virtual participation. Specifically, the virtual collocation of hackathon has been designed to enable communication and collaboration with the available information technology in the case organization needed for innovation contest. The assessment of the participants and their teams' digital competence is performance-based with DigComp 2.1. as reference framework (Bartolomé et al., 2021; Stefano and Pujol

Priego, 2018) DigComp-framework was chosen, as it is considered the most appropriate reference when considering the transversality of digital competence (Bartolomé et al., 2021). The performance-based assessment was chosen as e.g. self-evaluation is affected by the cognitive bias of Dunning-Kruger effect (Dunning et al., 2003) The performance-based assessment has been carried out by observing the hacker participants within the systems, the multiple objects that they were utilizing, as well as the documents' logs. The discovered digital competences applicable and necessary for hackathon participation are then mapped to the competences of DigComp 2.1.-framework five competence areas and if applicable for hackathon, their eight proficiency levels.

The case organization under research is a municipal organization in Sweden, Knivsta. Knivsta has been the second-fastest-growing municipalities in Sweden during the 2010s (Sveriges Radio, 2019), and the growth rate will persist for the foreseeable future. Knivsta pursues to meet the challenges of growth with, for example, innovation management; thus having a longitudinal three-year project 'Mosaic' that aims to develop the organization's innovation culture by adopting hackathon methodology. Therefore, Knivsta has been selected as a case due to its idiosyncrasy (van Maanen et al., 2007). Mosaic project has arranged three intra-organizational hackathon events for employees of multiple municipal departments in February 2020, November 2020 and October 2021. All events, one in radical, one in virtual and one in hybrid collocation, have included pre- and post-hackathon phase activities for participants. Under case study, and reported in this paper is the two hackathons carried out in virtual and hybrid collocations in November 2020 and October 2021. To improve the validity of this research, the multidisciplinary research group entails both innovation management and the subject matter experts from the public sector. Moreover, the case study analysis has been carried out in researcher triangulation.

As an innovation contest, at the core of hackathon methodology are communication and collaboration of the innovating teams (Halvari et al., 2021). In a virtual or hybrid hackathon, the virtual environment must be designed in a manner, that information and communication technology (ICT) enables the integration between the members and teams (Jussila et al., 2020). Moreover, it's role is to facilitate participants interaction both as a whole group and in smaller groups, with the possibility to change the virtual location if needed. For collaboration, the virtual environment should support co-creation and sharing digital documents for ideation and voting. With current and constantly evolving ICT, there are alternative solutions or combinations of versatile tools to fulfil those requirements.

The performance-based assessment of the digital competences of the hacker participants was analysed by observing the participants (Table 3) in all activities in the pre-hackathon and the hackathon event phases (Table 4) in the pre-design hackathon specific information technology enabled virtual environment in regards to their:

- attendance and ability to perform the pre-defined exercises
- collaboration in the teams' collaboration channels e.g. by making use of the pre-defined templates of innovation methods or hackathon progress aid
- both verbal and written communication in the teams' communication channels

The numbers of people observed in various activities of pre hackathon and hackathon event phases are presented in Table 3. The observed activities and their outputs in pre-hackathon and hackathon event phases are presented in Table 4a and Table 4b.

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Table 3 The observed hacker participants in pre-hackathon and hackathon events

Activities in pre- and hackathon event phases	*Participation of hackers*					
	Virtual hackathon			*Hybrid hackathon*		
	Total	**Virtual**	**Radical also*)**	**Total**	**Virtual**	**Radical**
Enrolled total	**27**			**48**		
Trained total	**26**			**44**		
Training 1	5	5	5	14	14	7
Training 2	7	7	7	16	16	7
Training 3	9	9	6	14	14	
Training 4	5	5	4			
Voluntary extra				11	6	5
T&I WS 1	17	17		33	3	30
T&I WS 2	19	19		34	6	28
Hack event total	**21**	21		**36**	2	34
Teams	**4**			**8**		
Team compilations	3 of 5 1 of 6			1 of 3 3 of 4 3 of 5 1 of 6		

*) Also: hackers had a possibility to be present at municipal office during virtual training while still participating fully virtual

Table 4a The observed activities and their outputs in pre-hackathon and hackathon event

Hackathon phase	*Hackathon collocation types*	
	Virtual	**Hybrid**
Pre-Hackathon		
Trainings for hackers	**Quantity, collocation and length**	
	4 virtual training à 6h - participation in municipal office premises was allowed	**3 mandatory virtual trainings à 4h** **1 voluntary additional virtual training á 3,5 h** - participation in municipal office premises was allowed
Team and ideation - workshops	**2 virtual workshops à 3h:** 1. 9 pitches 2. 13 pitches no participation in municipal office premises was allowed	**2 hybrid workshops à 4,5h** in the municipal office premises - virtual participation was enabled 1. 22 pitches 2 pitches

Table 4b The observed activities and their outputs in pre-hackathon and hackathon event

Hackathon phase	*Hackathon collocation types*	
	Virtual	**Hybrid**
Hackathon event		
Hackathon event	1-day virtual Hackathon event from 8-18	1-day hybrid Hackathon event from 8-18
Collaboration in creation phase	**Synchronous, continuous** collaboration of all participants during the event hours	**Synchronous, continuous** collaboration of all participants during the event hours
Mentoring sessions	Mentoring in dedicated Zoom Breakout-rooms each session 15 min*2 pcs/team - Progress mentoring - Presentation mentoring	Mentoring in dedicated rooms in municipal office, with virtual participants in Zoom each session 15 min*2 pcs/team - Progress mentoring - Presentation mentoring
Ceremony phase	4 Pitches of 180 seconds by the teams in Zoom Social event: Mingle and award ceremony in Zoom General room and Breakout rooms	8 Pitches of 180 seconds by the teams in municipal offices conference room and virtual audience via Zoom Social event: Mingle and award ceremony in conference room and Zoom General and Breakout rooms

4 Results

Designed platforms for hackathons that need digital competence for usage

The technological design for virtual hackathon implemented in April 2020 (Table 5) was based on two sets of parameters. First, at the time no one solution existed that could provide all the needed features for the various phases of the hackathon process. Second, the risks involved in the challenges associated with developing or introducing completely new software to a large organisation in short time frame were to be avoided. Therefore, as a compromise result, the virtual environment was built using the municipality's already licensed, used, and supported software. By combining Zoom ('Zoom', 2021) for synchronous video and voice communication purposes with the needed amount of breakout rooms, and Microsoft Teams ('Teams', 2021) for storing, sharing and co-creation of materials. In summer–fall 2021, when the collocation type for the upcoming hackathon in October 2021 was not definitive, a decision was made to utilize the identical virtual environment with some small adjustments. In November 2020 a Teams "Planner board" was utilized for writing down the pitched ideas to task cards and voting and unvoting of one's own interest was carried out with assigning/unassigning oneself into an idea card. In October 2021, that function was replaced with virtual post-it-notes in a Miro ('Miro', 2021) board linked to Teams. That event also featured integrated Miro boards for all teams in their Teams workspaces.

Table 5 Technological design of virtual and hybrid collocation hackathons

Design choices	**Virtual collocation hackathon**	**Hybrid collocation hackathon**
Platform for virtual collaboration	Hackathon-specific Zoom with Breakout rooms and Teams with team channels Color-coded individualized participant Zoom backgrounds for roles of hacker, coach, jury	Hackathon-specific Zoom with Breakout rooms and Teams with team channels Color-coded individualized participant Zoom backgrounds for roles of hacker, coach, jury
Physical collocation	Physical collocation when allowed in Knivsta municipal office	Physical collocation: Knivsta municipal office
Communication design	*Verbal interaction:* Virtual in Zoom with stand-by technical support in place *Written interaction:* Virtual in Teams with documents e.g. PowerPoint, Word, Excel	*Verbal interaction:* Virtual in Zoom with stand-by technical support in place *Written interaction:* Virtual in Teams with documents e.g. PowerPoint, Word, Excel
Designed communication support	Support of pre-prepared 1st-hour materials and material package uploaded in Teams	Support of pre-prepared 1st-hour materials and material package uploaded in Teams
Designed collaboration support	Pre-prepared innovation method templates in Teams (6 thinking hats, Lotus flower)	Pre-prepared innovation method templates in Teams (6 thinking hats, Lotus flower)

Designed trainings to provide that need digital competence to communicate and collaborate in hackathons in virtual or hybrid collocations

The utilization of a virtual environment for communication and collaboration requires digital competences. Therefore, the recruited employees either need to possess the required digital competences or have the ability to learn them in a limited time. The Mosaic-hackathon model for radical collocation includes innovation training in pre-hackathon phase before the Team and ideation -workshops and hackathon event. Therefore, the training for virtual collocation was adjusted to accommodate the digital competence requirements of the built virtual hackathon environment. Thus, in addition to the innovation themes, the training was added with exercises of the virtual environment use in Zoom, Teams, Excel or Miro linked to Teams (Table 6) with technical support personnel.

Results of performance-based assessment of digital competence necessary for hackathons in virtual and hybrid collocation

The result of the performance-based assessment of the digital competences carried out by observing the participants in all the pre-hackathon and hackathon event phases in the pre-design information technology enabled virtual hackathon environment was as follows:

1. **The participation and ability to carry out the pre-defined exercises in virtual trainings or hackathon event**

   During the virtual and hybrid collocation hackathons all the hackers were able to

   - access the Zoom and Teams systems with instructions, yet some needed additional technical support time to time.
   - carry out the pre-prepared exercises e.g. finding and applying individual Zoom backgrounds, carrying out their introductions in the form of association exercise, utilizing SCAMPER (Eberle, 1977), 6 Thinking hats (De Bono, 1985) and Lotus-blossom (Michalko, 1991) in Excel or Miro boards, and pitch exercise with NABC-model (Carlson and Wilmot, 2006).

   The association exercise comprised multiple activities:

   - sharing your screen in Zoom
   - tagging and writing to a chat box under the picture of a selected fruit in General channel discussion
   - introducing oneself verbally by associating to a fruit microphone on
   - stopping the sharing and turning microphone off

2. **Collaboration in the teams' collaboration channels**

   - All teams, thus their team members, collaborated with the joint documents on their dedicated team channel by making use of the prepared Excel tables or Miro boards and producing own documents e.g. Powerpoint presentations or word documents. As well downloading documents from the internet and storing and sharing in in their channel.

3. **Both verbal and written communication in the teams' communication channels**

   - All teams and their team members communicated by discussing, posting and chatting.

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Table 6 Performance of hackers in virtual hackathon environment

Hackathon activities	*Utilized exercises, templates, communication or collaboration*	*Hackathon collocation types*		*DigComp Competences*
Pre-hackathon phase		**Virtual**	**Hybrid**	
Training	Entering and working in virtual environment	Teams, Zoom	Teams, Zoom	2.6, 4.1, 4.2, 4.3. 5.1, 5.2, 5.3, 5.4.
	Association exercise	Teams	Teams	1.1 2.1. 2.2
	Performance	*All*	*All*	
	Lotus-blossom group exercise	Excel[1]	Miro [1]	2.2, 2.4
	Performance	*All*	*All*	
	6 thinking hats & Scamper	Excel [1]	Miro [1]	2.2, 2.4
	Performance	*All*	*Voluntary training*	
	Pitch training	Zoom	Zoom	2.1, 2.2, 2.3
	Performance	*28*	*26*	
Idea and Team WS 1&2	Pitching hackathon ideas	Zoom	Zoom	2.1, 2.2, 2.3
	Performance	*22*	*24*	
Idea and Team WS 2	Voting ideas by tagging to the idea one wants to collaborate with	Teams Planner	Miro notes	1.1, 1.2.
	Performance	*All*	*All*	
Hackathon event				
Entering virtual event	Entering and working in virtual environment	Teams, Zoom	Teams, Zoom	2.6, 4.1, 4.2, 4.3. 5.1, 5.2, 5.3, 5.4.
	Performance	*All*	*Virtual*	
	Browsing and setting up color-coded individual Zoom backgrounds	Teams, Zoom	Teams, Zoom	1.1, 1.3, 2.6
Start collaboration	1st hour template	Power Point [1]	Miro[1]	1.1, 1.3 (1.2 if for analysis)
	Performance	4 teams	8 teams	
Creation phase	Lotus-flower	Excel[1]	Miro[1] *)	2.2, 2.4
	Performance	2/4 teams	4/8 teams	
Written communication	Posting messages or chatting in channels, collaborating with documents	Teams	Teams	2.1, 2,2, 2.3, 2.4, 2.5. 3.1, 3.2,
	Performance	4 teams	8 teams	
Verbal communication	Pitching ideas in mentor sessions and ceremony with presentation	Zoom	Zoom	2.1, 2,2, 2.3, 2.4, 3.1, 3.2.
	Performance	4 teams	8 teams	

[1] in Teams channel *) Not utilized by all teams

Results in Table 7 present the incorporation of the performance assessment of the hackers to the DigComp 2.1.-framework in terms of the competences and the proficiency levels. The Individual proficiency levels (Individual) illustrate the performance of the individuals have shown at minimum necessary level for all members of a team. The team proficiency levels (Team) portray the performance the teams have presented at a minimum necessary level possessed by one person in the team.

Table 7 DigComp 2.1 competences and proficiency levels necessary to participate

Competence areas *Dimension 1*	*Competences* *Dimension 2*	*Performance Results*	*Necessary competence proficiency level*	
			Team	Indi-vidual
1. Information and data literacy	1.1 Browsing, searching and filtering data, information and digital content	Teams, Miro 1.1, 1.3 1.2	4	2
	1.2 Evaluating data, information and digital content		2	2
	1.3 Managing data, information and digital content		4	2
2. Communi-cation and collabo-ration	2.1 Interacting through digital technologies	Zoom (verbal), Teams (written), Miro 2.1, 2,2, 2.3, 2.4, 2.5, 2.6	3	3
	2.2 Sharing through digital technologies		5	2
	2.3 Engaging in citizenship through digital technologies		4*)	1*)
	2.4 Collaborating through digital technologies		3	3
	2.5 Netiquette		1	1
	2.6 Managing digital identity		1	1
3. Digital content creation	3.1 Developing digital content	Teams 3.1, 3.2.	4	2
	3.2 Integrating and re-elaborating digital content		4	2
	3.3 Copyright and licences			N/A
	3.4 Programming			N/A
4. Safety	4.1 Protecting devices	Zoom, Teams 4.1, 4.2, 4.3	1	1
	4.2 Protecting personal data and privacy		1	1
	4.3 Protecting health and well-being		1	1
	4.4 Protecting the environment			N/A
5. Problem solving	5.1 Solving technical problems	Teams, Zoom, Excel, Miro 5.1, 5.2, 5.3, 5.4	2	1
	5.2 Identifying needs and technological responses		4	2
	5.3 Creatively using digital technologies		4	3
	5.4 Identifying digital competence gaps		2	2

Source: DigComp 2.1. for DigComp Dimensions.
*) necessary for our hackathon case organization context

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5 Discussion

As the main result this article clarifies the digital competence areas and competences needed to participate in virtual or hybrid hackathon with DigComp 2.1.-framework as reference. Having digital competences is not necessarily required in all work profiles, therefore the needed digital competence has to be either verified or built, i.e. trained prior to virtual innovation contest. By lightening up the use of IT-enabled innovation methods utilized in the training to build the digital competences, this article makes several contributions to the innovation management theory, particularly regarding virtual hackathons as one type of innovation contests. First, it contributes to literature regarding the digital competences (Commission et al., 2018), by bringing new information on the required digital competences to participate in virtual hackathon with performance-based assessment (Stefano and Pujol Priego, 2018), as well as the training of those competences. Second, it contributes to the concept of virtual hackathon and especially its design (Halvari et al., 2020; Jussila et al., 2020) by portraying a vivid case of building digital competence in multi-disciplinary municipal setting with the help of IT-enabled innovation methods. Third, it contributes to the hackathon studies in the municipal organization context since most of the hackathon studies have been conducted outside any stable organizational context. Moreover, most of the intra-organizational hackathon studies and descriptions have been in the corporate context (e.g. Granados and Pareja-Eastaway, 2019; Pe-Than et al., 2020). Yet, public sector organizations have an increasing need to utilize innovation management methods, such as hackathon methodology for their innovation practice and culture development needs. Fourth, the results also make contribution to public sector innovation literature (Tidd, 2005).

Our results of the case organization's two hackathons in virtual and hybrid collocations with performance-based assessment showed that, 17 of DigComp 2.1. framework's 21 digital competences are necessary for participation in virtual hackathons, yet their proficiency levels vary depending on the competence in question. Furthermore, our results showed that the digital competences can be built by training. As in the core of virtual hackathon as a concept is the communication and collaboration in virtual environment for innovation creation, the competence areas, where the digital competence performance manifested most were 2. Communication and collaboration, and 5. Problem solving, and 1. Information and data literacy. Additionally, the competences of areas 3. Digital content creation manifested to some extent. In 3. Digital content creations area the competence *3.3. Copyright and licences* did not manifest as a performance, as those are not necessarily idea generation phase issues, yet have to be taken care of later in the innovation process. Furthermore, licences are taken care of at organization level, thus do not manifest in individual hacker or even team performance in hackathon – even though especially SW licences are required to arrange virtual hackathons. Moreover, people familiar with hackathons in IT branch might be surprised that *3.4. Programming* competence did not manifest as performance in our case. Similarly, competence *4.4. Protecting the environment* did not manifest with performance in our case. Whereas the competence *2.3 Engaging in citizenship through digital technologies* did manifest. These manifestations or lacks of them in performance are due to the hackathon type and design and context (Halvari et al., 2021). Programming or protecting the environment might be required competences in hackathons, when those are declared with the hackathon theme, contest criteria, challenge and/or desired output artefact (Suominen et al., 2021). Engaging in citizenship through digital technologies is inherent digital competence in municipal, public sector

innovation context, as citizenship participation is the very essence of the municipality as an organization. With that comes the conclusion that participation to virtual hackathon requires at minimum digital competences in the areas of 1. Information and data, 2. Communication and collaboration, 3. Digital content creation and 5. Problem solving, as well as additional competences context dependently. Furthermore, the required proficiency levels vary according to the competence. As certain competences are required in the virtual hackathon participation, those competences have to be either verified or trained prior to the hackathon event. The result of our case showed that the training of virtual competences can be integrated to the training of innovation competences by utilizing the communication and collaboration features of the available information technology and enhance them with pre-prepared virtual templates of innovation methods.

Our case description brings new detailed information on hackathon concept in terms of the virtual hackathon design (Halvari et al., 2021, 2020; Medina Angarita and Nolte, 2020), and more specifically the digital competence requirements that affect the design (Suominen et al., 2021). The virtual environment designed in our case is just one option, thus each virtual hackathon organizer must consider the available systems, risks, and – the digital competences the hackers might or might not possess.

Our case study was carried out in multi-disciplinary municipal organization, thus adding to the hackathon studies in the municipal organization context and public sector innovation. Integrating the learning of transversal key competence of digital competence on the job, benefits the municipal employee in public sector also as a citizen of modern post-pandemic society.

As practical implications, those aiming at enhancing their innovation endeavours with virtual hackathons or other virtual innovation contests we provide the view on the digital competence needs for participation as well as details of building those competences in pre-hackathon phase as part of on-job innovation training.

These results benefit those studying innovation contests especially in virtual environments, as well as those having interest in digital competence building. For further research we suggest studying the digital competences, their assessment and training needed in various types of virtual hackathon contexts.

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