Measuring the levels of 21st-century digital skills among professionals working within the creative industries: A performance-based approach

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\textbf{ABSTRACT}

The main aim of this study was to measure the actual levels of digital skills among professionals in the creative industries. Therefore, the levels of the following four types of digital skills were examined by means of a performance test: information, critical-thinking, creativity, and problem-solving skills. Authentic tasks were developed for each skill and were performed by professionals working within the creative industries (N = 87). As a result, one observational test directly measured a refined set of indices for each skill. The results reveal that the participants have most difficulties with digital information evaluation and problem-solving skills. For example, the participants rarely checked their answers on another website or provided multiple solutions with an explanation. The results contribute to determining detailed skill indices related to the differences in working professionals’ digital skill levels.

1. Introduction

As a result of the rapid integration of new information communication technologies (ICTs) in the workplace, working professionals need to adapt to changing job requirements and organizational practices related to new skill-intensive technologies (Leahy & Wilson, 2014). Previous research concerning digital skills has tended to focus on technical operations, but many scholars have moved toward considering higher-order or content-related skills (Claro et al., 2012; Janssen et al., 2013). Main cognitive competences for the 21st century are critical thinking, creativity, and problem solving (Wechsler et al., 2018). The 21st-century workforce requires workers who can search for relevant information, justify their choices, generate innovative and worthwhile ideas for their fields, and find solutions to the problem in digital environments (e.g., Şendağ & Odabaşı, 2009; Yang, 2015). The current contribution focuses specifically on the following 21st-century digital skills: information, critical-thinking, creativity, and problem-solving skills. These skills are considered highly important, as work is increasingly knowledge-based and performed in digital environments (e.g., Ananiadou & Claro, 2009; Silva, 2009; Voogt & Roblin, 2012). The main contributions of this article are that (1) the study involves the measurement of a broader range of 21st-century digital skills and (2) the skills are actually performed by professionals working within the creative industries.

The creative industries are strongly linked to knowledge-intensive activities (Bontje, Musterd, Kovács, & Murie, 2011), where ideas or knowledge function as commodities (Anderson, 2008). The creative process is often described in terms of cognitive processes such as generating, selecting, assessing, elaborating, and transforming ideas (Chan, Bruce, & Gonsalves, 2015, p. 21).
developments, knowledge creation and innovation are at the core of their work activities (Müller, Rammer, & Trüby, 2009), and the four types of 21st-century digital skills (information, critical-thinking, creativity, and problem-solving skills) are important assets for professionals working within the creative industries. Nevertheless, the individual level is often neglected in terms of how working professionals' digital skills must be developed to cope with future industry changes (Kamprath & Mietzner, 2015). Especially the creative industries rely heavily on the skills of human resources. Therefore, it is necessary to measure workers' level of digital skills and to understand what they need to reach their full potential.

To accurately assess the levels of digital information, critical-thinking, creativity, and problem-solving skills among workers in the creative industries, objective measurements are needed. Most studies measure digital skills by using large-scale surveys in which respondents must estimate their own skill levels. Self-reports have significant validity problems (Merritt, Smith, & Renzo, 2005). Ideally, the levels of digital skills should be derived from actions performed online. The question then is how to obtain a direct observation of performance on digital information, critical-thinking, creativity, and problem-solving skills with tasks or assessments. Especially creative and critical-thinking digital skills are seldom measured in performance tests (Van Laar, Van Deursen, Van Dijk, & De Haan, 2020). This study explores measures by means of a performance test with a task-based approach. The following research question was addressed:

*How to measure the level of digital information, critical-thinking, creativity, and problem-solving skills among professionals working within the creative industries by means of a performance test?*

2. Theoretical background

2.1. 21st-century digital skills

The skills needed for education and the workplace in contemporary society are often labeled as 21st-century skills (Griffin, McGaw, & Care, 2012). Although this concept emphasizes a broad spectrum of skills, the digital component is often considered as a separate skill within the range of 21st-century skills, for example under the label of technical skills. However, as skills are inevitably interwoven with ICT in a knowledge society (De Haan, 2010), we consider the digital component as an integral part of the skills that a professional must possess. The connectivity to people and information is increasingly being supported and mediated by digital technology (Mangematin, Sapsed, & Schuessler, 2014). A technology-rich society requires individuals to acquire a new set of skills related to the use of ICT or digital technologies. With the increasing digitization, the labor market has quickly evolved, requiring a workforce that possesses extensive digital skills. Against this background, we use the term 21st-century digital skills to understand the consequences of digitalization in terms of individual workers' skills. This section provides an in-depth discussion of information, critical thinking, creativity, and problem solving, which can be considered core 21st-century digital skills for working professionals (Van Laar, Van Deursen, Van Dijk, & De Haan, 2017). The aim is to provide more details about the specific indices that each skill contains.

2.1.1. Information digital skills

Working professionals in a variety of domains rely upon information retrieval systems to gather information necessary to formulate policy, impart advice, and make important decisions (Russell-Rose, Chamberlain, & Azzopardi, 2018). Today, it is possible to access many resources on any subject through the Internet, which has created the need for information digital skills. Information digital skills consist of the skills to search, select, and evaluate information online (Katz, 2007). Once the search system is chosen, workers need the skills to formulate search queries matching the information need. Defining the information need represents an awareness of the features of the required information (Çoklar, Yaman, & Yurdakul, 2017; Zhang, Majid, & Foo, 2010). A person must be able to formulate the correct search terms derived from a task or question (Aesaert & Van Braak, 2015; Aesaert et al., 2015). The quality of the search terms directly affects the quality of the generated search results (Van Deursen & Van Dijk, 2009). As today's knowledge society challenges people with overabundant information available on the Internet, it is also important for a person to be able to limit the amount of search results when accessing information. The use of advanced search operators or Boolean searches can improve the precision of search results (Eastman & Jansen, 2003; Willoughby, Anderson, Wood, Mueller, & Ross, 2009). Furthermore, workers need the skills to select relevant websites from the result list (Willoughby et al., 2009) and subsequently read the requested information effectively. Finally, workers need the skills to evaluate whether information satisfies or fulfills the information need (Katz, 2007). The ability to identify subjective, biased, or even false information has become a key issue (Eshet-Alkalai & Chajut, 2009). Thus, the skills to check retrieved information on a different website is a key component of this skill. Altogether, the indices considered are (1) defining search queries, (2) selecting a website to seek information, (3) selecting information on websites or in search results, and (4) evaluating the information found. The skill indices are inspired by several scholars who conducted a performance test on information digital skills (Aesaert & Van Braak, 2015; Eshet-Alkalai & Amichai-Hamburger, 2004; Hargittai, 2002; Katz, 2007; Van Deursen & Van Dijk, 2009).

2.1.2. Critical-thinking digital skills

In a digital age in which anyone may publish anything online, higher-order thinking skills such as critical thinking become especially important. The ability to present one's own point of view supported by arguments requires critical-thinking skills (Mulnix, 2012). Critical thinking includes self-disciplined thinking, during which an individual assesses, synthesizes, and interprets relevant information that is associated with a situation (Hyytinen, Toom, & Postareff, 2018). A worker needs the skills to see both sides of an
issue and to reason independently of prior beliefs (West, Toplak, & Stanovich, 2008; Willingham, 2008). One way to justify arguments is through the use of examples. The Internet provides people with opportunities to engage in critical-thinking processes, such as seeking alternatives and considering other points of view. Furthermore, a person can demonstrate critical thinking by being able to perceive a situation from a new perspective (Choy & Cheah, 2009). A worker needs the skills to assess the strength of argumentation and the reasons that are relevant to the particular context. Finally, critical thinking involves the careful acquisition and interpretation of information to reach a sound conclusion or answer. Ennis (1993) argues that reflective thinking is an essential component; critical thinking is about “reasonable, reflective thinking that is focused on what to believe or do” (p. 180). Thinking critically is defined as a process that enables an individual to make an informed decision about conflicting claims (Ennis, 1991). One needs to carefully and deliberately determine whether to accept, reject, or suspend judgment about a claim (Moore & Parker, 2007). In addition, Nussbaum and Schraw (2007) emphasize that effective argumentation includes not only considering counterarguments but also weighing and combining the arguments to support a final conclusion. Therefore, effective argumentation involves the analysis of alternatives in relation to one’s aims and the justification of a conclusion. In this study, the scoring criteria of Newman, Webb, and Cochrane (1995) are used to assess critical thinking skills. In line with the above-stated research, the indices considered are (1) justification, (2) breadth of understanding, and (3) critical reflection.

2.1.3. Creative digital skills

Workers’ digital creativity is considered key to success in today’s competitive and dynamic environment. Creative digital skills are defined as the use of information technology to encourage the creative process by looking at tasks from a new perspective or by forming new combinations of existing ideas (Chung, Lee, & Choi, 2015). The growth and diversification of online participatory platforms has led to a significant proliferation of creative activity in the digital context (Littrat & Glaveanu, 2018). Workers can use the Internet as a participatory platform to directly engage the public in the creation of work (Henriksen, Mishra, & Fisser, 2016; Littrat, 2012). The use of digital technology provides an appealing means of creative self-expression (Hoffmann, Ivcevic, & Brackett, 2016). Digital environments support creativity at two different levels, namely, the generation of creative ideas and the design of creative products, processes or services (Greene, 2002). In the era of wikis, social networks, and user-generated content platforms, workers can easily access external ideas (Füller, Hutter, & Faullant, 2011). Access to new and diverse online information as a source of creativity may enhance employees’ generation of ideas (Oldham & Da Silva, 2015). Workers who have access to a variety of alternatives or examples of potentially relevant ideas are more likely to make connections that could lead to creativity (Amabile, Conti, Coon, Lazenby, & Herron, 1996). Moreover, technological change is driven by individual creativity and in turn provides new contexts and tools for creative output (Henriksen et al., 2016). Individuals may extend the available opportunities offered by digital tools to further broaden the design space. Here, the main focus is on generating ideas rather than, for example, designing software tools. The skill of generating ideas is valued across a variety of occupations and industries. Idea generation - also referred to as divergent thinking, refers to the process of generating numerous original ideas for a given topic or problem (Guilford, 1967; Pásztor, Molnár, & Csapó, 2015). As originality is often defined in terms of unusualness or infrequency, an idea is original if it is proposed by one or very few individuals (Runco, 1993). In the context of creativity at work, novelty is not enough; ideas must also be useful to be considered creative (Zhou & George, 2003). As measure of creativity, we have used the Torrance test of creative thinking in which four aspects of creativity are assessed: fluency, originality, flexibility, and elaboration (Torrance, 1966). In this study, creativity is assessed in terms of (1) fluency (the number of ideas) and (2) originality (the infrequency of ideas). A precondition is that the developed ideas are useful and thereby apply to a particular context. Due to the set time limit, the number of different categories (flexibility) and the amount of detail in ideas (elaboration) were not included as assessment criteria.

2.1.4. Problem-solving digital skills

Problem-solving skills help individuals and teams acquire and apply knowledge that is needed to solve complex problems at work (Mainert, Niepel, Murphy, & Greiff, 2018). Given an increase in the number of jobs that require employees to solve complex problems in real time and a corresponding decrease in the number of jobs that involve executing well-defined organizational practices and routines, problem-solving skills are likely to grow in importance (Autor, Levy, & Murnane, 2003; Neubert, Mainert, Kretzschmar, & Greiff, 2015). In light of the widespread reliance upon the Internet as an information repository, the effective use of online information is crucial to generating valid solutions for the problem (Laxman, 2010). Problem-solving digital skills consist of the skills to use ICTs to analyze a problem situation and the use of this knowledge in finding a solution to the problem. Solving problems involves both the acquisition and the application of new knowledge in situations that must be actively explored to find and apply a solution (Mainert et al., 2018). Workers need the skills to represent the problem, explore potential solutions to the problem, and justify the solutions to decide which best fits their goals (Çevik, 2015). The ease with which a problem can be solved often depends on the quality of the available problem representations (Slof, Erkens, Kirschner, & Helms-Lorenz, 2013). Therefore, the skill to generate meaningful problem representations by integrating the information in a given situation is of decisive importance. Furthermore, successfully solving complex problems involves actively engaging in a process of making sense of the knowledge domain in question by considering multiple perspectives of the problem (Slof, Erkens, Kirschner, Jaspers, & Janssen, 2010). The opportunity to exchange or combine knowledge from multiple online sources can foster the problem-solving process. Finally, since problem solvers select the solution(s) from a group of many possible solutions, they must justify the selected solution by defending it against other alternatives (Chen, 2010). In line with the above stated, the indices of problem-solving skills refer to the extent to which someone is able to identify, provide, and explain possible solutions (Kauffman, Ge, Xie, & Chen, 2008). In this study, the assessment is focused on (1) the identification of the problem, (2) the provision of appropriate solutions, and (3) the explanation of solutions.
2.2. Digital skills for the creative industries

The above stated 21st-century digital skills are tested among professionals working within the creative industries. The creative industries are of considerable interest because they embody knowledge-intensive work characteristics such as flexible organizing, advanced use of technologies in the creative process, and extensive employment of creative and technical talent (Lampel & Germain, 2016). Creative products and services are complex and, therefore, it is often impossible to determine the exact final result in advance (Steiner & Prettenthaler, 2015). Work activities are defined by active cognitive processes such as creating, evaluating, problem solving, and reasoning (Shuaib & Enoch, 2013). A large part of the organizations within the creative industries are developing new ideas, knowledge, and methods for a product or service with the purpose of their commercial and practical use. Many jobs bring together a combination of creative content and ICT skills (Bakhshi, Freeman, & Higgs, 2012). Improvements in ICTs, leading to growth in digital creative production, distribution, and consumption (Munro, 2017). Digitalization plays a key role in the generation and filtering of multiple heuristics or options to pursue as well as in the way to connect with customers and stakeholders in developing products and how these products are consumed (Mangematin et al., 2014). According to Greene (2002), digital environments support creative workers’ knowledge gathering, knowledge sharing, and knowledge integration. As a result, the use of technology is considered as a means to foster individual empowerment (Bridges, 2018), and technology development inevitably shapes the ways to perceive and define digital skills.

2.3. Measuring digital skills

The most commonly employed method to measure digital skills is a survey. In surveys, measurements are mostly directed toward self-reported measures of ICT self-efficacy and digital skills (Hargittai, 2005; Van Deursen & Van Dijk, 2011). Self-efficacy is an individual’s belief in his or her capacity to perform certain Internet actions to produce a given goal (Eastin & LaRose, 2000). Self-efficacy is not a measure of skill; rather, this type of question captures what individuals believe they can do with the skills they possess. To measure digital skills, in most cases, people are presented with a list of skills and are asked to evaluate how well they perform in them. The advantages of self-reported surveys are the ability to present a large number of questions on a wide range of skills in a short time, simple scoring, and cost effectiveness (Kuhlemeier & Hemker, 2007). Although these measures are useful for investigating self-perceived skills within large samples, they are less appropriate for measuring actual digital skill levels. It is well known that measures that are based on people’s own judgment have significant problems of validity because of the misalignment between perceived and actual skills (e.g., Bunz, Curry, & Voon, 2007; Hargittai, 2005; Merritt et al., 2005; Litt, 2013). For example, men and younger people tend to overestimate their skill levels (Van Deursen & Van Dijk, 2011). Overall, authors agree that self-reports are insufficient (for a lengthy discussion see Hargittai, 2005; Helsper & Van Deursen, 2015).

For this reason, a few scholars have incorporated observational or performance-based assessments of Internet users’ skills. For example, Hargittai (2002) conducted one of the first performance-based studies in which she observed participants’ abilities to find several types of information online. Eshet-Alkalai and Amichai-Hamburger (2004) carried out another pioneering performance-based study. They designed tasks for various age groups aimed at testing digital literacy skills. The authors argued that digital literacy skills involve more than the ability to use software or operate a digital device. They conducted a task-based assessment in which each task assessed one of the following digital skills dimensions: photovisual literacy, reproduction literacy, information literacy, branching literacy, and socioemotional literacy. Comparably, Van Deursen and Van Dijk (2009) developed performance tests of operational, formal, information, and strategic Internet skills. Moreover, research often has been conducted to measure the actual level of digital skills possessed by pupils or students. For example, Aesaert, Van Nijlen, Vanderlinde, and Van Braak (2014) used a performance-based ICT competence test to measure pupils’ actual proficiency in digital information processing and communication. Although observations and performance-based measures have higher validity, they are also time consuming, expensive, and difficult to conduct with large samples (Aesaert & Van Braak, 2015). To overcome some of these limitations, scenario-based performance tasks have been established in which students solve information problems using simulated software such as email, web browser, or presentation software (Katz, 2007). Scenario-based performance tasks can be completed online by a larger sample. However, a characteristic of this approach is that it requires questions with one answer or solution; therefore, skills such as critical thinking and creativity are inappropriate for this method.

Performance-based tests using authentic tasks are considered the most valid method of measuring digital skills. Although the above-stated performance-based studies have great scientific value, they primarily focused on pupils, students, or citizens. Furthermore, the available performance tests mainly address basic technical, information, and problem-solving skills. Our study contributes to the existing literature by conducting a detailed performance test aimed at measuring a broader range of digital skills among professionals working within the creative industries. A unique combination of the levels of four digital skills (information, critical thinking, creativity, and problem solving) were measured in the labor context. An authentic performance test with a refined set of indices per skill was developed to provide a detailed analysis of the skill levels.

3. Method

3.1. Assignments

A test was created with two parts. The first part consisted of tasks with the topic of crowdfunding. Four tasks measured information skills and one task measured problem-solving skills. In the information tasks, the participants were asked to search for fact-
based information with one correct answer. They were asked to search for (1) a specific type of crowdfunding, (2) a regulation for crowdfunding platforms that applies when companies can obtain a loan, (3) a tool for crowdfunding platforms to check whether a consumer’s investment is justified, and (4) an investment rule for crowdfunding platforms. In the problem-solving assignment, a scenario was presented to the participants in which they had invested in a successful crowdfunding project but were faced with a payment default. The participants were asked to use the Internet to determine what actions they could have taken to prevent this situation. For successful completion, the task required several actions and an explanation. In the first part of the test, no time limits were imposed.

The second part of the test consisted of online tasks about the Internet of Things. One task measured creativity skills and one task measured critical-thinking skills. In the creativity task, the participants were asked to use the Internet to generate as many ideas as possible concerning Internet of Things applications that improve productivity at work. They had to mention the device and the corresponding application. The participants were given 10 min to complete this assignment. The creative task was adapted from Torrance test of creative thinking, primarily used to examine divergent thinking (Torrance, 1968). In the critical-thinking task, participants had to reflect on the statement: “The Internet of things makes life easier, healthier, and safer”. The idea was for the participants to argue their own points of view with the help of information online. The participants were given 15 min to finish this critical-thinking assignment. They could finish early if they considered the assignment completed. For the second part of the test, large time limits (determined in the pilot test) were imposed to ensure participants had enough time to complete each task. At the same time, the maximum time for completion gave them an inclination of how much time they should spend on a task. For each task, participants had to start a new search query. All tasks were pilot tested with nine participants to ensure comprehensibility and applicability. See Appendix A for a complete overview.

3.2. Participants

The study was conducted among professionals working within the creative industries in the Netherlands. The participants were recruited by approaching respondents who had previously participated in a large-scale survey about the Internet at work. Professionals who are directly involved in creative work processes (e.g., designers, engineers, and project managers) were included in this study. If they agreed to participate, they were contacted by phone to schedule a date and time for the research session. In total, 87 respondents participated in the performance tests. The participants represented a large variety of professions, ranging from directors, project managers, and producers to artists, designers, and engineers. The sample characteristics are displayed in Table 1.

3.3. Procedure

The performance tests were conducted from April 1 through August 15, 2018. Before the start of the assignments, informed consent was obtained from each participant. The participants had to accomplish assignments on the Internet. TeamViewer was used

<p>| Table 1 |
| Sample characteristics (N = 87). |</p>
<table>
<thead>
<tr>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>45</td>
</tr>
<tr>
<td>Female</td>
<td>42</td>
</tr>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>18–30</td>
<td>32</td>
</tr>
<tr>
<td>31–45</td>
<td>33</td>
</tr>
<tr>
<td>46–60</td>
<td>21</td>
</tr>
<tr>
<td>60+</td>
<td>1</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>5</td>
</tr>
<tr>
<td>High</td>
<td>82</td>
</tr>
<tr>
<td>Branch organization</td>
<td></td>
</tr>
<tr>
<td>Advertising/marketing</td>
<td>10</td>
</tr>
<tr>
<td>Radio/television</td>
<td>10</td>
</tr>
<tr>
<td>Visual art/photography</td>
<td>10</td>
</tr>
<tr>
<td>Architecture</td>
<td>7</td>
</tr>
<tr>
<td>Graphic design</td>
<td>7</td>
</tr>
<tr>
<td>Industrial design</td>
<td>6</td>
</tr>
<tr>
<td>Journalism</td>
<td>6</td>
</tr>
<tr>
<td>Performing art</td>
<td>6</td>
</tr>
<tr>
<td>Museum</td>
<td>6</td>
</tr>
<tr>
<td>New media/software</td>
<td>5</td>
</tr>
<tr>
<td>Film</td>
<td>4</td>
</tr>
<tr>
<td>Gaming</td>
<td>3</td>
</tr>
<tr>
<td>Fashion/textile design</td>
<td>3</td>
</tr>
<tr>
<td>Publishing/media</td>
<td>2</td>
</tr>
<tr>
<td>Books/magazines</td>
<td>2</td>
</tr>
</tbody>
</table>
to view and record the participant’s actions on the Internet remotely. The participants were asked to install TeamViewer on their computers before their scheduled appointments. On the date of the test, the participants were asked over the phone whether they had questions about the procedure. During the session, the researcher and participant stayed connected by phone or TeamViewer’s chat function. If any problems or concerns arose, the participants had the option to contact the researcher directly. No questions related to the tasks were allowed. The tests took approximately 1 h, and participants received an incentive of 20 Euros.

3.4. Data analysis

A coding scheme was developed based on the skill components as discussed in the theoretical background section. All components were double-checked by the researcher during the video recording analyses. See Appendix B.

4. Results

4.1. Information digital skills

Table 2 provides an overview of the information-related skill indices divided by participants who provided correct/incorrect answers.

Table 2
Overview of the information-related skill indices divided by participants who provided correct/incorrect answers.

<table>
<thead>
<tr>
<th>Skill Indices</th>
<th>Task 1</th>
<th>Task 2</th>
<th>Task 3</th>
<th>Task 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Correct</td>
<td>Incorrect</td>
<td>Correct</td>
<td>Incorrect</td>
</tr>
<tr>
<td>N (%)</td>
<td>13 (14.9%)</td>
<td>74 (85.1%)</td>
<td>22 (25.3%)</td>
<td>65 (74.7%)</td>
</tr>
<tr>
<td>Average time spent on the task in minutes</td>
<td>6:37</td>
<td>6:12</td>
<td>5:22</td>
<td>7:18</td>
</tr>
<tr>
<td>Average number of search queries</td>
<td>2.5</td>
<td>2.7</td>
<td>2.3</td>
<td>2.9</td>
</tr>
<tr>
<td>Average number of search words per search query</td>
<td>2.4</td>
<td>2.6</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>Directly using a search query emergent</td>
<td>3 (23.1%)</td>
<td>20 (27.0%)</td>
<td>12 (54.5%)</td>
<td>25 (38.5%)</td>
</tr>
<tr>
<td>Using Boolean operators (e.g., AND, OR, “”)</td>
<td>0 (0%)</td>
<td>1 (1.4%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Average number of relevant websites selected</td>
<td>2.2</td>
<td>1.4</td>
<td>1.7</td>
<td>1.4</td>
</tr>
<tr>
<td>Average number of irrelevant websites selected</td>
<td>0.9</td>
<td>1.9</td>
<td>1.1</td>
<td>1.9</td>
</tr>
<tr>
<td>Directly selecting a relevant website</td>
<td>8 (61.5%)</td>
<td>37 (50.0%)</td>
<td>15 (68.2%)</td>
<td>26 (40.0%)</td>
</tr>
<tr>
<td>Selecting hyperlinks on a website</td>
<td>7 (53.8%)</td>
<td>39 (52.7%)</td>
<td>19 (86.4%)</td>
<td>42 (64.6%)</td>
</tr>
<tr>
<td>Searching within a website</td>
<td>2 (15.4%)</td>
<td>5 (6.8%)</td>
<td>5 (22.7%)</td>
<td>11 (16.9%)</td>
</tr>
<tr>
<td>Using a new search query for information found</td>
<td>2 (15.4%)</td>
<td>15 (20.3%)</td>
<td>0 (0%)</td>
<td>5 (7.7%)</td>
</tr>
<tr>
<td>Checking the information on another website</td>
<td>8 (61.5%)</td>
<td>29 (39.2%)</td>
<td>5 (22.7%)</td>
<td>12 (18.5%)</td>
</tr>
</tbody>
</table>

Concerning task 1, the participants from both groups had difficulties with directly formulating a search query emergent from the task. Multiple times, they formulated an appropriate search query later in the process. However, 39% of the participants with correct answers and 51% with incorrect answers did not formulate a search query that combined ‘crowdfunding’ with ‘types’ or a synonym. Remarkably, 70% of the participants with incorrect answers actually looked at a webpage where the answer was visible. This finding shows that participants found it difficult to select information that was appropriate to the task. Furthermore, 62% of the participants with correct answers checked the retrieved information on another website. This evaluation strategy was less common for participants with incorrect answers (39%).

Concerning task 2, the participants with correct answers more often formulated a search query emergent from the task (55% compared to 39%). Of participants with incorrect answers, 28% (compared to 9% of those with correct answers) did not formulate an appropriate search query at all. Furthermore, 46% actually visited a webpage where the answers were visible. The participants who answered this task correctly more frequently selected relevant hyperlinks on a website (86% compared to 65% of participants with incorrect answers). Often, they had to display more information on a website to find the answer. Finally, they more often checked the information on another website (23% compared to 19%), but the percentage was still low.

In task 3, only two participants (6%) with incorrect answers directly used a search query emergent from the task (see Table 2). Additionally, for 67% of the participants, the answer was not visible on the webpages they visited. The average number of relevant websites selected was quite low. Remarkably, in this group, 39% did not even select one relevant website. Furthermore, there was a...
large difference between the groups with respect to the percentage of participants who directly selected a relevant website (82% of those with correct answers compared to 24% of those with incorrect answers). Finally, participants with correct answers more frequently used a new search query for the answer found (15% compared to 6%) and checked the information on another website (22% compared to 0%).

Regarding task 4, the percentage of correct answers was quite high (79%). However, 21% did not find the correct answer. Of the participants with incorrect answers, 94% were not able to formulate an appropriate search query. As a result, the percentage of participants who were able to directly select a relevant website was also quite low (17%). A relatively high percentage in this group (67%) did not select one relevant website. In both groups, checking the information (23% of those with correct answers compared to 6% of those with incorrect answers) and using a new search query (12% compared to 0%) to evaluate the information found were rarely applied.

4.2. Critical-thinking digital skills

Table 3 shows that, on average, the participants spent approximately twelve minutes justifying their points of view with the help of information found on the Internet. A relatively high percentage was able to provide arguments for multiple perspectives: 36% for two perspectives and 44% for all three perspectives (comfort, health, and security). A relatively high percentage (74%) was also able to provide proof or examples for the arguments presented. Moreover, 46% of the participants presented positive and negative arguments for one or multiple perspectives. Furthermore, more than half of the participants (51%) provided new perspectives. With regard to critical assessment, the participants often assessed their arguments (53%) before they formulated a conclusion (64%).

4.3. Creative digital skills

Table 4 shows that, on average, the participants spent approximately nine minutes on the Internet to seek Internet of Things devices and applications. They proposed an average number of 3.7 devices and 4.7 applications to encourage productivity at work. In total, 24% proposed a device that was not mentioned by other participants. Additionally, 45% proposed a device that was mentioned

Table 3
Overview of the critical thinking-related skill indices (N = 87).

<table>
<thead>
<tr>
<th>Skill indices</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average time spent on the task in minutes</td>
<td>11:58</td>
</tr>
<tr>
<td><strong>Argumentation</strong></td>
<td></td>
</tr>
<tr>
<td>Providing no arguments (−/−)</td>
<td>5 (5.7%)</td>
</tr>
<tr>
<td>Providing arguments for one perspective (−)</td>
<td>13 (14.9%)</td>
</tr>
<tr>
<td>Providing arguments for two perspectives (+)</td>
<td>31 (35.6%)</td>
</tr>
<tr>
<td>Providing arguments for three perspectives (+/+</td>
<td>38 (43.7%)</td>
</tr>
<tr>
<td><strong>Proof/examples</strong></td>
<td></td>
</tr>
<tr>
<td>Providing no proof/examples for the arguments (−)</td>
<td>23 (26.4%)</td>
</tr>
<tr>
<td>Providing proof/examples for the arguments (+)</td>
<td>64 (73.6%)</td>
</tr>
<tr>
<td><strong>Perspective-taking</strong></td>
<td></td>
</tr>
<tr>
<td>Not presenting both sides of a perspective (−)</td>
<td>47 (54.0%)</td>
</tr>
<tr>
<td>Presenting both sides of a perspective (+)</td>
<td>40 (46.0%)</td>
</tr>
<tr>
<td><strong>Breadth of understanding</strong></td>
<td></td>
</tr>
<tr>
<td>Providing no new perspective (−)</td>
<td>43 (49.4%)</td>
</tr>
<tr>
<td>Providing a new perspective (+)</td>
<td>44 (50.6%)</td>
</tr>
<tr>
<td><strong>Critical reflection</strong></td>
<td></td>
</tr>
<tr>
<td>Not assessing the arguments (−)</td>
<td>41 (47.1%)</td>
</tr>
<tr>
<td>Assessing the arguments (+)</td>
<td>46 (52.9%)</td>
</tr>
<tr>
<td>Not drawing a conclusion (−)</td>
<td>31 (35.6%)</td>
</tr>
<tr>
<td>Drawing a conclusion (+)</td>
<td>56 (64.4%)</td>
</tr>
</tbody>
</table>

Table 4
Overview of the creativity-related skill indices (N = 87).

<table>
<thead>
<tr>
<th>Skill indices</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average time spent on the task in minutes</td>
<td>9:12</td>
</tr>
<tr>
<td><strong>Fluency</strong></td>
<td></td>
</tr>
<tr>
<td>Average number of devices</td>
<td>3.7</td>
</tr>
<tr>
<td>Average number of applications</td>
<td>4.7</td>
</tr>
<tr>
<td><strong>Originality</strong></td>
<td></td>
</tr>
<tr>
<td>Proposing a device mentioned once</td>
<td>21 (24.1%)</td>
</tr>
<tr>
<td>Proposing a device mentioned three or fewer times</td>
<td>39 (44.8%)</td>
</tr>
<tr>
<td>Proposing an application mentioned once</td>
<td>42 (48.3%)</td>
</tr>
<tr>
<td>Proposing an application mentioned three times or fewer</td>
<td>54 (62.1%)</td>
</tr>
</tbody>
</table>
three or fewer times, which could still be considered quite original. The most frequently mentioned devices were smartwatches, smartphones, and smart lighting. Examples of original devices were apparel, a handheld text scanner, and a virtual reality headset.

The participants had less difficulty inventing unique applications (48%) than inventing unique devices. Additionally, 62% devised an application that was mentioned three or fewer times. The most mentioned applications were focused on regulating temperature, turning on/off lights, and stimulating movement. Original applications varied from those offering compliments and recognizing emotions to those training an employee, recording travel expenses, and digitally transforming drawings.

4.4. Problem-solving digital skills

Table 5 shows that, on average, participants spent approximately nine minutes on the Internet to seek solutions. They found an average of 2.2 solutions, but only half of these solutions were accompanied with an explanation. Again, the participants had difficulties directly formulating a search query derived from the problem situation (39%). Furthermore, one participant could not come up with any solution, 39% proposed one solution, and 60% proposed multiple solutions. The number of explanations provided was rather low relative to the number of solutions proposed. In total, 35% did not provide any explanation, 41% provided one explanation, and 24% provided multiple explanations.

5. Discussion

5.1. Main findings

The contemporary economy requires workers who have the skills to use the digital environment to support information searching, critical thinking, creativity, and problem solving. However, the assessment of these and other skills needed for the 21st century is limited (Voogt & Roblin, 2012). Current assessments often do not successfully measure the actual digital skill levels and call for task-based approaches (Siddiq, Gochyyev, & Wilson, 2017). However, performance tests are scarce, especially related to creativity and critical thinking (Van Laar et al., 2020). This study outlines the development of a performance test pertaining to information processing, critical-thinking, creativity, and problem-solving skills. A refined set of skill indices is proposed to provide an in-depth analysis of the skill levels. The observations below illustrate that it is possible to measure a broader range of digital skills actually performed by professionals working within the creative industries. The test results reflect working professionals’ actual skills and does not rely on their own judgment. The proposed operationalizations can be adapted in future research to fit the sample.

A first observation concerning information digital skills is that participants rarely double-check the information they find online. This finding is in line with the previous research that shows that information seekers frequently do not spend time critically evaluating information they find online (Metzger, 2007). A possible explanation for this finding might be that they use heuristic cues that guide information evaluation while minimizing cognitive effort (Metzger, Flanagin, & Medders, 2010). In general, information seekers must refine search queries quite often to find appropriate information. People often adjust their original search according to what they were able to find (Walraven, Brand-Gruwel, & Boshuizen, 2008). In the present study, even if the correct answer was visible, the participants encountered difficulties with extracting the correct information. They found it difficult to accurately identify and define the information needed.

In relation to critical-thinking digital skills, the results were promising. The participants often provided arguments for multiple perspectives supported with proof or examples. In the critical-thinking task, most participants were able to draw a conclusion but were not able to combine and translate the arguments into support for a final conclusion. It was most challenging for the participants to see and compare both sides of the arguments. To be a proficient critical thinker, it is necessary to have a certain detachment from one’s own beliefs with a willingness to consider alternative viewpoints (Munix, 2012). One could argue that most people have insufficient skills to be actively open to new ideas, to be critical in evaluating these ideas and to modify their thinking in light of
proposes a performance test to measure these skills among workers in the creative industries. The results are an important step work activities. Information, critical thinking, creativity, and problem solving digital skills are important assets. Therefore, this study tensive activities and technological developments. In this sector, knowledge creation and innovation are at the core of professionals’ organizational practices related to new skill-intensive technologies. The creative industries are strongly linked to knowledge-in

daylight to interpreting these findings is remembering that originality is vital for creativity (Runco et al., 2011). Although the participants were able to produce a large number of ideas, the ability to generate both common and original ideas was more difficult. Nevertheless, a relatively large portion of the participants proposed devices and applications that were mentioned by not more than two other participants. Many participants from this group mentioned unique examples.

Finally, concerning problem-solving digital skills, a relatively small percentage of the participants were able to provide more than one solution accompanied by an explanation. This finding is worrisome because problem-solving skills are highly valued in today’s workplace. Work is no longer defined by the possession of a specialty or technical ability, but rather by the task or problem a worker and his or her team is trying to solve (Wagner, 2008). The low levels of problem-solving digital skills may be explained by the relatively high cognitive capacity that is necessary for this skill (Greiff, Kretzschmar, Müller, Spinath, & Martin, 2014). Moreover, as problem-solving digital skills require a high level of information digital skills (Van Laar, Van Deursen, Van Dijk, & De Haan, 2019), another explanation might be that those who have low levels of information digital skills are also unable to use the online environment to come up with solutions.

The findings demonstrate the need to learn more about how the process of skill acquisition occurs within the workplace. Research needs to define and test detailed policy recommendations on how organizations can improve the skill levels of their workers. For example, some researchers favor courses and guided learning for skill development (Mossberger, Tolbert, & Stansbury, 2003), while others propose learning by trial-and-error (Matzat & Sadowski, 2012). As such, it is necessary to obtain contextual information and capture data from professionals working within the creative industries. For example, it could be useful to discuss practical solutions for skill improvements with managers responsible for skill development to be effectively incorporated into organizations. Policy recommendations should be aimed at helping working professionals acquire, maintain, and improve their digital skills.

5.2. Limitations and future research directions

Eighty-seven professionals working within the creative industries participated in the current study. It is not possible to generalize the results. However, the aim was to deepen our understanding of the levels of four 21st-century digital skills. Due to the labor-intensive process, performance tests often involve only a small sample. Future research could look further into how to incorporate performance assessments in tests that also include more constructed response items. Another research direction could be to combine survey questions with more standardized performance-based assignments in one test.

Furthermore, this study is potentially limited by the topics of the assignments. Although we have developed realistic informational tasks, we do not know whether the topics might have, for example, affected the participants’ motivation to complete the assignments. On the other hand, one could also argue that in a test situation, the pressure to succeed might be higher, and participants are therefore more willing to complete an assignment. Remarkably, participants scored relatively low on the first information skills assignment in comparison with the final assignment. Thus, participants might need some time to familiarize themselves with the topic. During the development of the tasks, every effort was made to adhere to the skill indices. However, the results evidently depend on the difficulty of the proposed tasks. In future tests, more tasks should be developed, and other topics might be used to determine whether the same pattern of results occurs.

Scholars are encouraged to identify and incorporate additional skill indices in future tests. For example, creativity is primarily understood as divergent thinking, where one generates many unique ideas. Yet, it also involves convergent thinking, where one combines ideas into the best result (Sousa, Nunes, & Monteiro, 2019). In addition, it is important to note that incorporating multiple digital skills in one test brings another layer of complexity to clearly measure separate skills. A key issue in this respect is that skills overlap in the available operationalizations. Existing scales or tests often measure a combination of skills, such as ‘creative problem solving’ or ‘critical information skills’. Overall, the decision to incorporate skill indices is based on how easily they can be translated to a performance-based task.

A final limitation to address is that digital communication and collaboration skills were not included in our performance test. Although we investigated the possibility to include social skills, they remain difficult to measure by means of a performance test because a form of social interaction is required. Overall, measuring 21st-century digital skills by means of a performance test is a complex task. Although this study builds upon the previously developed survey questions (Van Laar, Van Deursen, Van Dijk, & De Haan, 2018), this does not lead to a simple translation to tasks. As a researcher you have to make a choice in the skill indices that can be incorporated in a task-based approach. For example, the item ‘do you give proof or examples of arguments you give’ can be more easily translated into an assessment criterion than ‘do you communicate via the internet with co-workers from other disciplines’. The assessment of social skills is even more complex and, therefore, future research could look into how to measure such skills by means of a performance test.

6. Conclusion

As a result of the rapid integration of ICTs in the workplace, professionals need to adapt to changing job requirements and organizational practices related to new skill-intensive technologies. The creative industries are strongly linked to knowledge-intensive activities and technological developments. In this sector, knowledge creation and innovation are at the core of professionals’ work activities. Information, critical thinking, creativity, and problem-solving digital skills are important assets. Therefore, this study proposes a performance test to measure these skills among workers in the creative industries. The results are an important step
forward in the exposure of detailed skill indices. Future research is encouraged to build on our test experiences and to validate the observations. Overall, the results suggest the need to monitor and measure the skills that workers should attain. A next step is to elaborate on the ways to equip working professionals with such skills. Future research must take an active role to prioritize and incentivize programs to empower workers to have the skills they need for the current workforce.

Acknowledgments

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Appendix A. Assignments

1. Information digital skills

Assignment 1.1

Imagine you have invented smart toothbrushes that are capable of making a profile of your brushing technique and can share this information with the dentist. However, it is not easy to find financing to produce them. You are now investigating how you can finance your new company by means of “the crowd”. Multiple variants are possible; the basic principle is that many people collectively fund a venture by providing parts of the requested funding. You want to finance your new company by means of a loan from "the crowd".

Start a search query on Google to answer the following question:
Which form of crowdfunding best fits the abovementioned situation best?

Assignment 1.2

There are regulations for crowdfunding platforms when, for example, loans are provided to consumers and/or companies.

Start a new search query on Google to answer the following question:
What specific condition is imposed on crowdfunding platforms when companies can obtain a loan?

Assignment 1.3

Your crowdfunding campaign has received a lot of interest from consumers. A consumer is willing to invest 5.000 Euros in your new company.

Start a new search query on Google to answer the following question:
What tool should crowdfunding platforms use to see if a consumer invests a responsible part of his/her capital?

Assignment 1.4

Imagine that a consumer is willing to invest 10.000 Euros. This particular consumer has a total capital of 75.000 Euros.

Start a new search query on Google to answer the following question:
Is an investment of 10.000 Euros justified? Explain your answer.

2. Problem-solving digital skills

Assignment 2.1

As with any form of investment, crowdfunding can also cause problems. Imagine that you are an investor who has participated in a successful crowdfunding project. Unfortunately, you have been deceived because the crowdfunding platform is not willing to pay anything.

Start a new search query on Google to answer the following question:
What actions could you have taken to prevent the above stated situation?

3. Creative digital skills

Assignment 3.1

Refrigerators, thermostats, TVs, and cars: more and more devices are connected to the Internet. Together, they form the Internet of Things (IoT), a network of devices that share information. One of the most visible forms of the IoT is the advent of wearables such as watches or bracelets that are connected to the Internet. On the next page, you will find an assignment. You have ten minutes to complete this assignment.

Use the Internet to come up with as many original ‘Internet of Things’ applications, within ten minutes, that improve productivity at the workplace. For example, you might think of applications that enable working faster and more efficiently.

Write down 1) the device and 2) the corresponding application. Briefly explain your applications.
4. Critical-thinking digital skills

Assignment 4.1

The prediction is that the IoT will have a huge impact on our daily lives. The IoT is often presented as the trend that will connect each device in one large network and thereby make maximum use of the collected data. On the next page, you will find an assignment.

A utopian view of the IoT is described. The statement is as follows: “The Internet of things makes life easier, healthier, and safer.” To what extent do you agree with the above statement? Justify your point of view with the help of information found on the Internet. You have fifteen minutes for this assignment.

Appendix B. Coding scheme

Information digital skills

Defining the search queries
- Directly using a search query emergent from the task
- Using Booleans to limit search results (e.g., AND, OR, “”) 
- The average number of search words per search query
- The average number of search queries

Selecting a website to seek information
- Using advanced search methods (e.g., date, type)
- Directly selecting a relevant website
- Checking more than the first three search results
- The average number of relevant websites
- The average number of irrelevant websites

Selecting information on websites or in search results
- Selecting hyperlinks on a website
- Searching within a website
- Selecting information appropriate to the task

Evaluating the information found
- Using a new search query for the information found
- Checking the information on another website

Critical-thinking digital skills

Justification
- Providing arguments
- Providing proof/examples
- Presenting both sides of a perspective

Breadth of understanding
- Providing a new perspective

Critical assessment
- Assessing the arguments
- Drawing a conclusion

Creative digital skills

Fluency
- The average number of devices/applications

Originality
- Proposing a device/application that is mentioned once
- Proposing a device/application that is mentioned three or fewer times
Problem-solving digital skills

Identifying the problem

Directly using a search query derived from the problem situation

Providing appropriate solutions

Proposing multiple appropriate solutions to the problem

The average number of solutions

Explaining the solutions

Providing an explanation for the solutions proposed

The average number of explanations

References


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