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Digital Literacy in the Service of Science and Scientific Knowledge

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Abstract: The subject of this paper is the interdependence of communication and digital literacy, as original entities, and especially digital communication and science and scientific knowledge. In the present day, digital literacy is a necessary ability for scientific professionals. The concept of digital literacy is increasingly prevalent in the 21st century. Scientific research requires the capacity to efficiently use digital tools, platforms, and databases as technology continues to improve at an unparalleled rate. The capacity to get and assess data from a variety of online sources is a crucial component of digital literacy for scientific professionals. In order to encourage cooperation and creativity across scientific groups, digital literacy is vital. Moreover, scientific professionals that possess digital literacy are better equipped to disseminate their research findings to a larger audience. The essence is that the higher the level of digital literacy, the easier it is to find suitable and therefore the best forms of communication.

Keywords: *digital literacy, scientific research, digitalization.*

Introduction

The purpose and goal of digital literacy are recognized in every aspect of our lives. Whether one is a student, a scholar, employed, or entering retirement, it is now essential to possess certain technological skills for communication with the external world and for performing administrative, creative, and educational tasks. «Digital» is no longer a separate realm entered occasionally and reserved for specific individuals. It has become fully integrated into the mass population through various means of personal device proliferation, such as smartphones, various digital devices, and tablet computers. News of the unilateral declaration of independence by the British colonies in the New World in 1776 (USA) took a month to reach Europe. The most significant news in the 19th century, the assassination of U.S. President Abraham Lincoln in April 1865, took 12 days to «travel» to Europe. «In November 1963, the U.S. President was assassinated in Dallas, Texas. He died at 1:00 PM. At that moment, 68% of Americans already knew about the news; by 2:00 PM, it was 92%, and by 6:00 PM, 98.8%. Today, thanks to the internet, media, and digital literacy in some ways, news is transmitted in «real-time.»

Paul Gilster (1997) popularized the term «digital literacy» in his book of the same name. It is the capacity to comprehend and use knowledge that is delivered through computers in a variety of formats and from a broad range of sources. Gilster first defined digital literacy as the «ability to understand and use information in multiple formats from a wide range of sources when presented through computers.» This enlarged meaning of «digital literacy» in English. Since reading with meaning and understanding is the foundational act of knowledge, the idea of literacy encompasses more than just learning how to read. Digital literacy extends the boundaries of this concept as it involves the awareness of what is seen on the computer screen using online media. Here, demands are placed that have always been present, though less visible in analog media such as newspapers and TV.Literacy is more than merely learning to read, as reading with comprehension and meaning is the fundamental act of knowledge. The idea of digital literacy

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is expanded upon as it encompasses the understanding of what is viewed on a computer screen when utilizing online media. Demands that have always existed but are less apparent in analog media like TV and newspapers are made here.

Pure diversity means that digital literacy can be considered a «framework for integrating various other literacies and skill sets» without the need for a comprehensive overarching literacy or serving as «one literacy to rule them all» (Martin, 2006; Dašić et al., 2023b). The idea and concept of «digital literacy» must be explained in terms of its relationship to various other «information literacies,» a topic explored in many works (Bawden, 2001; Bawden and Robinson, 2002; Secker, 2007; Venkatesan, 2023). Their notion is that digital literacy not only needs to find its place among information literacy, computer literacy, ICT literacy, e-literacy, network literacy, and media literacy, but it must also be paired with terms that avoid the idea of «literacy,» such as informativeness and fluidity. „It is observed that in some cases, mentioning information or anything similar is avoided, and terms like «basic skills,» «smart internet,» or «smart work» are used instead“ (Robinson et al., 2005).

The digital age has brought about significant disruptive changes in many facets of life, including how people connect to one another and learn. As such, scientists and practitioners need to be able to handle this dynamic change. (Yustika, Iswati, 2020). Competencies in operation, reasoning, teamwork, and awareness are essential for scientific professionals who are digitally literate. Operation skills are the technical know-how needed to operate technology effectively. Scientific personnel need to exhibit thinking abilities, particularly a high degree of analytical thinking, in addition to operating skills. Scientific personnel that possess critical thinking abilities are able to comprehend technology and have a favorable outlook on it. To develop work that benefits both the general public and themselves, they must also exercise creative thought. Furthermore, because digital technology makes it easier for people to collaborate and interact, scientists need to be aware of cooperation and awareness techniques. Since we are now responsible for gathering, sharing, and preserving information resources and for taking advantage of the opportunities that arise from digitising these resources, the position of an information expert has evolved to encompass the development of digital material. One study (Kaeophanuek, et al., 2018) asserts that the development of an information specialist's digital literacy requires the practice of three skills: the creation of new material, the use of digital technologies, and information management. The development of cognitive abilities, which must be included at each stage of the developmental process, is the foundation for the three skills.

Theoretical framework

In the highly technical age we live in today, digital literacy is essential for scientific professionals. It gives students the tools necessary to successfully explain their study findings in addition , giving them the ability to locate and assess trustworthy information. Furthermore, by facilitating smooth communication and utilizing cutting-edge technology, digital literacy promotes cooperation and creativity within scientific communities. In order to be at the forefront of scientific innovation, scientific personnel must constantly develop their digital literacy abilities as technology continues to evolve.

According to one study (Asrizal, et al., 2018), digital literacy must be included in teaching materials in order to enhance school literacy programs. Digital literacy encompasses basic, scientific, economic, technological, visual, informational, and intercultural literacy (Bain, Siddique., 2017; Vuković, et al. 2023). Digital literacy consists of functional, visual, scientific, technological, information cultural, and global literacy (Shafeeq, 2013). Students must employ a range of multimodal interpretation strategies in their digital literacy instruction, including foundational, scientific, technical, visual, gestural, spatial, informational, intercultural, and global awareness skills (Jing, 2016). It is thought that using integrated science resources is crucial to the educational process. Researchers were drawn to create integrated scientific teaching materials with digital literacy because of this.

Science nowadays is being shaped in large part by digital literacy. The scientific environment has changed dramatically as a result of the capacity to acquire and analyze enormous quantities of data, work with academics from around the world, and use sophisticated software and simulations. The Internet and other technologies have significantly changed many domains, including the political, social, cultural, and economic ones, as well as the ensuing behavioral patterns in today's "information and communication society." (Méndez Domínguez, 2020). Technology advancements in information and communication have altered the way literacy is taught. Lack of time, direction, and training has made the quicker shift to

practical usage of digital media difficult. Because it requires new knowledge and abilities to be utilized effectively for the intended purpose and to provide benefits, digital literacy has emerged as a cutting-edge method for gaining access to, obtaining, and managing the information that is all around us (Reddy et al., 2022b). The act of increasing awareness and providing people with specific information and abilities to enable them to grasp ICT is known as "digital literacy".

Because digital literacy's primary goal is to improve everyone's quality of life, regardless of position, gender, ethnicity, religion, or origin, Bawden and Robinson (2002) claim that it is a factor in social inclusion. It suggests that one may perform "the necessary activities to ensure that information and communication technologies are accessible to and used by all individuals and communities, including the most disadvantaged." Digital literacy is essential for adjusting to the quick and constant changes brought about by digitization, and education must alter to accommodate these new technologically enabled learning and teaching contexts (Pérez-Escoda et al., 2019).

Digital literacy is crucial for researchers and scientists in today's world as it enables more efficient searching, analysis, and interpretation of large amounts of data. Additionally, digital literacy allows researchers to utilize advanced tools and technologies, such as data analysis software, simulations, and modeling, enhancing the speed and accuracy of research. The ability to collaborate via digital platforms is also increased, enabling researchers to share information and collaborate with colleagues worldwide. Critical thinking skills regarding digital sources are also becoming essential for the validity and integrity of research. In summary, digital literacy is key to improving efficiency, precision, and global collaboration in contemporary scientific research. Digitalization enhances people's quality of life and education, promotes economic expansion and environmental preservation, and raises a nation's competitiveness (Marti and Puertas, 2023). The need of expediting the digitization of all facets of socio-economic growth has intensified due to the COVID-19 pandemic's expansion (Kolupaieva, Tiesheva, 2023).

Technology has a significant influence on society, thus it is crucial to make sure that it is created, implemented, and utilized in ways that uphold human values and advance societal well-being. Negative effects like digital divides, uneven access to technology, data breaches, job losses, cultural homogeneity, and the deterioration of democratic governance may result from failing to take the social aspect of digital transformation into account. Through tackling the social aspects of digital transformation, society can guarantee that technology is employed to advance human growth and bolster societal advancement. Stated differently, the social sustainability of digital transformation should assess how technology affects society and how society can guarantee that everyone can benefit from technology (Nosratabadi, et al., 2023).

The Interdependence of Digital Literacy and Successful Communication

The more purely social facets of community life, such as interacting with people and relating to them through digital tools inaccessible to those who are not proficient in their use, naturally come to mind when discussing the subject of digital literacy (Vitković, 2023; Campanozzi, et al., 2023). The capacity to locate, assess, use, exchange, and develop ideas responsibly and ethically utilizing Information Communication Technology (ICT) tools and technologies in conjunction with the Internet is essential in this period of exponential technological prominence and acceptance. Digital literacy refers to this new human quality. To survive and prosper in today's digital world, digital literacy is a necessary component of everyone's personal and professional lives. The responsibility for promoting digital literacy globally rests with higher education institutions. The institutions are essential in helping the younger generation become digitally literate so they can successfully contribute to the advancement and development of the person, society, and country (Reddy, et al., 2022)

The concept of «digital literacy» must largely include some understanding of the benefits that «digital» provides. The continuous increase in the use of online media content for gathering information also challenges students and the wider population to nonlinearly organize information and integrate visual media to synthesize information, making this set of skills also referred to as digital literacy. A collection of cognitive thinking techniques employed by users of digital information is referred to as digital literacy. Other terminology, such as information and communication technology (ICT) literacy, computer literacy, internet literacy, 21st-century literacy, and online reading comprehension, are used in literature and practice. While each word has a precise meaning, they are all grouped together theoretically under the

same «umbrella» of new literacies due to shared assumptions.

The conclusion is drawn that the majority of emerging literacies, encompassing digital literacy, are grounded in four principles: first, that these literacies encompass novel skills, strategies, dispositions, and social practices necessitated by new technologies in information and communication (Ilić et. al., 2022); second, that these literacies are indispensable for complete engagement in the global community; third, that these literacies evolve with shifts in defining technologies; and fourth, that they are diverse and demand comprehension of all their facets.

The literature notes that the terminology itself is very confusing, leading to questions about the place of digital literacy in relation to information literacy, computer literacy, ICT, and e-literacy, as well as network and media literacy, and the relationship to concepts such as informativeness and fluidity. There are many approaches trying to dissect these relationships, and the essence is to identify the essence of digital literacy, as well as some forms of this education, and some of the questions that could be raised in this field.

New digital media can no longer be understood as just being about «information» or «technology,» thus it's important to understand «digital literacy» in a way that goes beyond some of the present methodologies used in the field of information technology in education. Our understanding of the connection between literacy and communication is also impacted by this. Although there is consensus on many theoretical issues in the fields of contemporary communication and digital literacy, different perspectives on learning and literacy can be observed, as well as a set of priorities that arise from them.

In one study (Vlajković, 2021), it was published that graduate students were excited about sharing their research with the public, even concerned about the long-term consequences of publishing their work in an online environment. Open and collaborative information networks created by digital conversations provide new participants with much greater visibility than was ever possible in the past. Participants have a larger audience but may also be subject to greater control; much needs to be done and explored before hitting «publish.» Acquiring digital technology skills is fundamental at all educational levels as a means of enhancing students' ability to identify and use relevant modern scientific and technological knowledge for the appropriate discipline (Xiao, 2024).

Today's students communicate in digital language and process information very differently from previous generations. Professors belong to the generation of digital immigrants, while students are digital natives; they simply speak different languages (Rizal, et al., 2019). Today's professors must make an effort to communicate in the language of their students. Everything is essentially a presentation, and besides changes in methodology, instructors need to keep in mind that the brain of today's generation has also changed. Digital natives think differently because they grow up with computers and other digital technologies that practically train them to think multidimensionally, to overlap their thoughts, to perform tasks in parallel rather than sequentially, one by one. If their attention in class drops, it is not because they are uninterested or unfocused, but because the presentation of material in such a way is not acceptable to them (Šmakić, 2012).

The capacity to locate, assess, produce, and share information requiring cognitive abilities via the use of information and communication technologies is known as digital literacy. In order to find and choose pertinent information, assess critically, be creative, work with others, communicate effectively, and still pay attention to aspects of electronic security and the sociocultural context that is expanding in society, one must also possess functional skills in addition to digital literacy. Digital literacy is a life skill that encompasses not only the use of ICT technologies but also social skills, human learning capacities, and attitudes, critical thinking, creativity, and inspiration. Digital literacy encompasses more than just reading proficiency; it also refers to reading comprehension and meaning. The capacity to comprehend, assess, and integrate information in a variety of computer-presented media is also a component of digital literacy. (Akhyar, et al., 2021).

The Impact of Digital Literacy on Science and Scientific Knowledge

Digital literacy, it is widely held, is an essential part of personal competency and improves the «marketability of the national education sector,» highlighting the fact that literacy is a more important skill than ever in today's knowledge-based society (Vučković, 2022; Vuković, et al. 2023). Digital literacy has a particular benefit for each individual as it lays the groundwork for skill development and lifetime learning.

It may raise everyone's standard of living and let them share in the economic prosperity of the country. These strategies, which mostly draw from human capital theories, seek to show that education and literacy investments are more important for sustained economic growth than capital gains over the long run. Thus, each person's wellbeing is taken into account while calculating aggregate welfare (Vuković, et al. 2023).

Digital literacy questions, however, surely have something to do with economic competition, the technocratic apparatus that governs people in the global economy, and the teaching of individual competencies for «networking,» even if they have nothing to do with ICTs, those electronic and invisible binary sequences of ones and zeros, or the previously mentioned promises.

The need for digital education was sparked by the advancement of technology and its application to digitalization. The usage of digital technology is growing at a rapid rate, thus it is important to take into account how people use it, interact with it online, and what skills they have to complete the tasks involved in digitalization. Thus, through creative learning trajectories, educational institutions facilitate the transfer of relevant digital skills to the next generation of workers (Reddy, et al., 2023). It is challenging for educators to keep up with the increasing number of ICT tools that are now accessible and to think about how they might utilize these resources to assist teaching, learning, and research in the most efficient and fruitful way possible. Researchers and practitioners create models of necessary knowledge for teachers and how they use such information to their own learning and teaching situations in order to support educators in developing ICT integration (Redmond, Lock, 2019).

The expansion of scientific knowledge has had the most significant impact on the advancement of human understanding. Science has taught us a great deal about how our bodies function, how celestial bodies operate, and much more. These pieces of information are astounding, especially when compared to our growing understanding of the mundane and routine aspects of life. Many philosophers of the 20th century believed that studying how scientific knowledge increases is a crucial task in epistemological research. Thus, some authors argue that scientific progress «follows the increase in scientific understanding, not the accumulation of knowledge» (Dellsén, 2016).

Today, the world is increasingly acquiring new knowledge through organized research and less through spontaneous and accidental discoveries. In recent years, many aspects of our lives have been drastically changed, or in many cases, completely transformed by digital transformation. This broad concept encompasses the adoption and use of digital technology, such as computers and the internet, for various applications, from communication to research. In one study examining research trends in digital literacy through scientometrics, focusing on journals indexed in WoS, it was concluded that to increase the originality of studies related to digital literacy, researchers and scientists can collaborate with colleagues from different countries and cultures to explore a broader spectrum of digital literacy environments (Hyejin, et al., 2021).

For example, the phenomenon of the mutual interaction of sciences was discussed by Dobrov as «inevitably and necessarily becoming more actively and consciously organized mutual interaction of different sciences» (Dobrov, 1969, 59-68). Leonardo da Vinci had numerous brilliant ideas that could not be realized at that time due to insufficient knowledge of science, collaboration, materials that did not exist at the time, and so on. However, today, thanks to «digital literacy,» scientists worldwide have access to the latest scientific discoveries. Digital literacy is an essential skill for scientific workers in the modern age (Dašić, 2023a). As technology continues to advance at an unprecedented rate, the ability to effectively navigate digital tools, platforms, and databases becomes increasingly important for conducting scientific research. One key aspect of digital literacy for scientific workers is the ability to access and evaluate information from various online sources. With a vast amount of information available on the internet, it is crucial for scientists to be able to distinguish reliable and accurate sources from misinformation or biased articles. Without digital literacy skills, scientific workers may fall victim to false or misleading information, which can significantly impact the validity of their research findings.

Digital literacy has a profound impact on science and research across various disciplines. Digital literacy enables scientists to access a vast amount of information through online databases, journals, and repositories. Digital literacy is crucial for handling large datasets that are common in modern scientific research. Digital tools facilitate collaboration among scientists across the globe. Researchers can collaborate in real-time, share data, and communicate findings using various online platforms, leading to more efficient and diverse research outcomes. Digital literacy allows scientists to use advanced computational tools for simulations and modeling. This is particularly important in fields like physics, chemistry, and biology, where experiments may be expensive, dangerous, or logistically challenging.

Digital literacy is essential for publishing research in online journals and disseminating findings through various digital channels. This accelerates the sharing of knowledge and increases the visibility of scientific work.Digital literacy is critical for scientists to leverage machine learning and artificial intelligence in their research. These technologies can automate data analysis, identify patterns, and make predictions, enhancing the efficiency and accuracy of scientific investigations. In one study (Wang, Si, 2023), articles related to the COVID-19 period were selected from the same dataset, and 3961 papers published between January 1, 2020, and December 31, 2022, were analyzed to explore trends that emerged in digital literacy research during the pandemic. Researchers examined the use of keywords by authors of scientific papers and identified the terms most commonly used. According to their study, two concepts that frequently appeared in digital literacy research during the pandemic were “health literacy” (153) and “Covid-19”.

Digital literacy supports the principles of open science, where research findings, data, and methodologies are openly shared. This fosters transparency, reproducibility, and collaboration in the scientific community. With the increasing reliance on digital platforms, scientists need to be digitally literate in terms of cybersecurity to protect sensitive research data and maintain the integrity of their work. So,Digital literacy is integral to the advancement of science and research by providing scientists with the tools and skills needed to navigate the digital landscape, collaborate effectively, analyze complex data, and communicate their findings to a global audience. Georgina and Hosford (2009) looked at how university staff perceived digital skills in order to investigate literacy skills among teachers. They discovered that the new objective in higher education is to enable a university-wide professoriate to improve both their information literacy and technology literacy skills.

Furthermore, digital literacy empowers scientific workers to effectively communicate their research findings to a wider audience. Gone are the days when scientific research was solely presented in print journals. Nowadays, it is common for researchers to communicate their findings through digital platforms such as online journals, blogs, or social media (Dašić, 2023b). Being digitally literate allows scientists to reach a broader audience and promote their work to the public. Additionally, digital tools and software enable scientists to present their research in interactive and engaging ways, such as through data visualization or multimedia presentations. By acquiring digital literacy skills, scientific workers can enhance the dissemination of their findings, making them more accessible and understandable to diverse audiences.

Lastly, digital literacy plays a crucial role in fostering collaboration and innovation among scientific communities (Dašić, 2023a). Many scientific breakthroughs have been made through collaborative efforts, as researchers from different disciplines come together to tackle complex problems. Digital tools facilitate seamless communication and information sharing, allowing scientists to collaborate across distances and time zones. Furthermore, digital literacy enables scientific workers to leverage emerging technologies and platforms, such as machine learning algorithms or cloud computing, to analyze vast datasets or conduct simulations. By embracing these digital tools, scientists can significantly enhance their research capabilities, accelerate the discovery process, and promote cross-disciplinary collaboration. Overall, digital literacy has brought about a paradigm shift in the field of science. The ability to navigate, utilize, and harness digital tools and technologies is no longer optional but essential for success in the scientific realm. By embracing digital literacy, scientists can effectively tackle complex scientific challenges, collaborate on an unprecedented scale, and contribute to scientific advancements that have the potential to positively impact society as a whole.

Conclusion

Digital literacy is vital for scientific workers in today’s technologically driven era. It not only enables them to access and evaluate reliable information, but also equips them with the skills needed to communicate their research findings effectively. Moreover, digital literacy fosters collaboration and innovation within scientific communities by enabling seamless communication and leveraging emerging technologies. As technology continues to evolve, it is crucial for scientific workers to continually cultivate their digital literacy skills to remain at the forefront of scientific advancement.

Digital literacy plays a crucial role in shaping the field of science today. The ability to access and analyze vast amounts of data, collaborate with researchers from across the globe, and utilize sophisticated

software and simulations has revolutionized the scientific landscape. Digital literacy not only enhances the efficiency and accuracy of scientific experiments, but it also enables scientists to make groundbreaking discoveries that were previously unimaginable.

With the internet, researchers can now access a wealth of scientific literature, research papers, and scholarly articles at the click of a button. This ease of access allows researchers to stay updated with the latest advancements in their field, saving time and effort. Moreover, digital platforms enable scientists to share their own findings instantly, fostering collaboration and knowledge exchange. This interconnectedness has accelerated the pace of scientific discovery and facilitated interdisciplinary research, leading to breakthroughs in various scientific disciplines.

Advanced software and simulations not only facilitate the design and execution of experiments but also enable scientists to model complex phenomena and predict outcomes. For instance, researchers can use computational models to simulate the behavior of molecules to study the properties of materials or simulate the impact of climate change on ecosystems. These digital tools not only reduce the need for costly and time-consuming experiments but also enhance the reproducibility and reliability of scientific findings. Digital literacy empowers scientists to leverage these tools effectively, thereby increasing the rigor and validity of scientific research.

Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization: D.D.; methodology: D.D.; resources: M.V. and M.I.K., supervision: M.P.; writing—original draft preparation: D.D, and M.P.; writing—review and editing: M.I.K and M.V. All authors have read and agreed to the published version of the manuscript.

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