Chapter 11:

Digital Literacy: A Conceptual Review of Concepts, Skills and Models from the Perspective of Digital Transformation and Technology and Innovation Management

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Abstract

As information and communication technologies reshape every field from education to business, digital literacy is increasingly regarded as one of the basic conditions for individuals and organizations to adapt to digital transformation. This book chapter is a conceptual review that examines digital literacy in an integrated way through its definitions, its relationship with education, its developmental levels, its component skills and its theoretical models. The chapter first evaluates the terminological development of the concept since its first use and the research focusing on teachers; it then discusses the three-stage approach consisting of digital competence, digital usage and digital transformation, together with the components of information, media and technology literacy. The common and diverging aspects of different models are compared, and the boundaries with sub-disciplines such as computer, library, internet, information, media, electronic information and digital information literacy are examined. The review shows that definitions have expanded from technical skills toward cognitive and socio-ethical dimensions, while research has largely concentrated on determining levels. It is therefore argued that the highest level of digital literacy, which is linked to creativity and innovation, deserves more attention from a technology and innovation management perspective. The chapter closes with recommendations for practice and future research.

Keywords: digital literacy, digital transformation, digital competence, technology and innovation management, teacher education

1. Introduction

In the twenty-first century, information and communication technologies have permeated every layer of society, and taking part in this digital world requires competencies beyond basic literacy. Conceptualized by Paul Gilster in 1997 (Gilster, 1997, as cited in Belshaw, 2012), digital literacy is not merely the ability to operate technical devices; it is also the competence to evaluate information in digital environments critically, to synthesize it and to reproduce it in line with ethical values. In education in particular, teachers' possession of this competence is a strategic factor in how well new generations adapt to digital transformation. The following sections examine the terminological development of digital literacy and its organic link with education. They then elaborate the theoretical models that address the technical, cognitive and social dimensions of the concept and present the levels, components and sub-disciplines of this complex skill set within a theoretical framework.

Despite its wide use, there is no consensus on a single definition of the concept in the literature. Some authors treat digital literacy as the ability to evaluate information, others as a set of skills that makes it possible to survive in the digital age, and others as the competence to use technology safely and ethically. The proliferation of proposals on levels, skills and models has increased this diversity further and left open the question of which framework researchers should adopt.

The aim of this chapter is to bring these scattered approaches together in a single conceptual framework and to discuss digital literacy by relating it to core concepts of the management information systems field, such as digital transformation and technology and innovation management. The chapter is a conceptual review; it does not collect new data but interprets the existing literature. It can also be read as a complementary review that broadens the theoretical ground for the author's doctoral dissertation (Temel, 2025), and for the joint study derived from it, which is in press (Temel & Gündüzyeli, in press).

The second section presents the definitions and terminological development of the concept, and the third section addresses its

relationship with education. The fourth and fifth sections cover developmental levels and component skills, the sixth section covers theoretical models, and the seventh section covers sub-disciplines. The eighth section discusses the reviewed literature as a whole, the ninth section states the limitations, the tenth section offers recommendations, and the eleventh section concludes the chapter.

2. The Concept and Definition of Digital Literacy

The entry of the concept into academic literature is associated with Paul Gilster's work (Gilster, 1997, as cited in Belshaw, 2012). Gilster regarded digital literacy as the capacity to grasp and evaluate information presented in different formats and to bring that information together, and he grouped the content of the concept under the activities of internet searching, hypertext navigation, knowledge assembly and content evaluation (Bawden, 2008).

The advance of digital technologies is one of the cornerstones of today's societies and of human development throughout history. At the basis of this process lies the concept of "digital," which is defined as the expression of data in numbers in electronic devices.

Martin (2006) defines digital literacy as individuals' ability to recognize, access, use, combine, evaluate, analyze and synthesize digital materials, and to use technological tools to reach new information through these skills.

Later authors have extended this core from different directions. While Hague and Payton (2010) place the focus on the correct and safe use of technology, Eshet-Alkalai (2004) sees the concept as a condition of surviving in the digital age. Ferrari (2012) includes in the definition understanding media, finding and critically evaluating stored information, and interacting through various communication tools. According to Bawden (2008), the concept is the set of skills that enables an individual to complete tasks in the digital environment successfully.

Besides covering the efficient use of mass communication tools, digital literacy can also be described as acquiring the abilities to use technologies safely and in line with moral norms and laws, for individual development, problem solving and benefit in social activities (Özerbaş & Kuralbayeva, 2018).

Digital literacy mediates the appropriate use of information once its source has been reached, and its importance in educational activities continues to grow. The literature shows that many countries, such as England and Scotland, have recognized the need to raise generations with high digital literacy and have added digital literacy topics to their curricula (The Royal Society, 2012).

Steps to spread the concept have also been taken in Türkiye. According to an announcement by the Yükseköğretim Kurulu, training was given to academic staff in some provinces and a Digital Literacy course was added to the curricula of these provinces. A news report on the same project states that more than 30,000 students at eight pilot universities took the digital literacy course (Anadolu Ajansı, 2019).

Kaya-Özgül et al. (2023) found in their study that digital literacy levels were higher among male teachers than female teachers, younger teachers than older teachers, experienced teachers than inexperienced ones, teachers in private schools than those in state schools, teachers with postgraduate education than those with a bachelor's degree, and teachers who own a personal computer or tablet than those who do not.

The same study also compared the digital literacy levels of classroom teachers in state and private schools, and concluded that factors such as the greater technological resources of private schools and their more frequent use might enable teachers in private schools to be more knowledgeable on the subject and to develop themselves. Furthermore, they were found to be open to evaluating technological opportunities and to hold a positive attitude toward the use of technology in education.

The embedding of digitalization in everyday life has made digital literacy an indispensable skill for individuals (Öztürk & Ateş Kaya, 2023). Because digital technologies are so heavily relied on to find and produce information, students' literacy levels need to be raised to prepare them for the future. The concept is therefore not limited to the use of tools; it should also cover accessing reliable information, producing and sharing information, and using technology in learning and teaching processes (Hamutoğlu et al., 2017).

A review of the research on digital literacy shows that most studies aim to determine the digital literacy levels of teachers and teacher candidates working in different fields (Aksoy et al., 2021; Arslan, 2019; Öztürk & Budak, 2019; Üstündağ et al., 2017; Yaman, 2019; Yontar, 2019).

There are also studies that determine and compare the digital literacy levels of pre-service teachers in different countries such as Kazakhstan (Özerbaş & Kuralbayeva, 2018), and of school administrators (Sönmez & Gül, 2014).

According to Çubukçu and Bayzan (2013), digital literacy holds a more important position than literacy acquired through traditional methods. Individuals who lack the ability to use digital technologies are thought to miss out on many of the opportunities that technology offers.

The widespread use of the many digital platforms that support curricula in education, and the wish to use them even more intensively, make it necessary for teachers to gain competence in this area (Aksoy et al., 2021).

According to the emphasis of Gürtekin (2019), digital literacy is more important than traditional literacy because it stresses not only the ability to use technology but also the abilities to access, produce and share accurate information. This reveals the importance of the ability to use technology effectively in learning and teaching processes.

In today's digital world, digital literacy stands out as a right that enables people's cultural and social participation. Developing students' digital literacy provides them with the skills, knowledge and understanding

they need to take on their future social, cultural, economic, civic and intellectual roles fully and effectively (Hague & Payton, 2010).

Digital literacy is not limited to technical skills; it also includes a wide range of cognitive abilities, from internet use to user interfaces and communication (Özoğlu, 2019).

3. Digital Literacy and Education

According to Kara and Atasoy (2019), the greatest effect of technological advances today is felt in the field of education. They note that children meet the digital world, especially the internet, before starting school.

Digital literacy enables young people to benefit from the opportunities technology offers while also encouraging them to be careful about possible risks. As digital technology and media become more central to social life, young people's knowledge, skills and understanding in this area will become more decisive (Hague & Payton, 2010).

As Tulay (2019) states, integrating technology into the educational process makes teachers its main supporters. This approach directs teachers toward a student-centered perspective and helps them encourage transformation in education inside and outside the classroom.

Digital literacy skills contribute to students' critical thinking and increase their integration with technology. They also facilitate access to reliable information, develop effective virtual communication skills and encourage conscious internet use. In addition to enabling the effective use of traditional and social media platforms, they develop the abilities to interpret, analyze and reproduce information. By giving students operational and technical knowledge and skills, they support the educational use of digital media (Taşkıran & Salur, 2021).

Cabı (2016) argues that digital technology affects education and teaching just as it affects every area of life. Karabacak and Sezgin (2019) note that the science of education is undergoing significant changes on the basis of people, knowledge and society. Kuru (2019) agrees with these

views and emphasizes that the twenty-first century is defined as the age of knowledge and technology and that information technologies shape the learning-teaching process.

As Cebeci (2020) states, digital literacy is also seen as a skill that requires the ability to bring different pieces together to create new products from existing information by using digital tools. The growing use of technology and digital tools in educational settings therefore increases the importance and necessity of digital literacy.

Teachers must be able to use information technologies at a level that meets the educational requirements of the twenty-first century. They are also expected to be competent in their own fields of expertise, to use appropriate teaching methods and techniques, and to participate actively. This requires technological and pedagogical competence together with content knowledge (Yükseltürk et al., 2017).

Education should give young people the skills to understand and use the digital world. It is therefore important for twenty-first-century teachers to have digital competencies. Research shows that it is difficult for teachers who lack digital competencies to raise students who have them (Timur et al., 2014).

4. Levels of Digital Literacy

Martin and Grudziecki (2006) described the developmental process of digital literacy in three stages: digital competence, digital usage and digital transformation. Digital competence refers to the basic skills and attitudes needed in daily life; digital usage refers to applying these competencies in a professional or personal context; and digital transformation refers to using them to create new, innovative practices. Martin (2008) later placed this structure within the wider discussion of the "digital society". The levels are examined in detail in Section 6.4.

5. Digital (Information, Media and Technology) Literacy Skills

Digital literacy includes the active use of information and communication technologies by individuals as well as the important contributions these technologies make to people and society. It is the set of skills and competencies that supports production-oriented and socially collaborative work, together with the ability to solve problems that may arise in any area of life with technology in an ethical, safe and lawful way (Özerbaş & Kuralbayeva, 2018).

Çubukçu and Bayzan (2013) define digital literacy skills as the ability to recognize technology, to use useful technologies effectively, to recognize and access accurate information, and to distinguish true from false information by analyzing it.

Digital literacy skills consist of three main components: information literacy, media literacy and technology literacy (Trilling & Fadel, 2009).

5.1. Information Literacy

Kızıl (2007) states that the existence of individuals who can apply information to their lives in every respect led to the emergence of a concept such as information literacy.

The characteristics of individuals who have the information literacy skills described by the Partnership for 21st Century Learning (2019) are as follows:

a) They should access information by using their time and resources efficiently and effectively,

b) They should be able to evaluate information critically,

c) When they face a problem, they should reach accurate information and use it creatively,

d) They should be able to analyze and manage information obtained from different sources.

5.2. Media Literacy

Media literacy refers to an individual's ability to analyze and filter messages consciously. This skill first requires reaching messages and then examining them by analyzing them. It must then include evaluating these messages and conveying them accurately and meaningfully to the intended person (Karakoyun, 2014).

New media uses associated with the internet and technology are part of media literacy, which includes the ability to consciously create one's own media content and convey it to others, together with the innovations emerging in the individual's life.

5.3. Technology Literacy

Being able to use today's technology has given rise to the concept of technology literacy.

According to Bölükbaşı (2012), technology literacy has four basic competencies. These are:

1. Adapting to continuously and rapidly changing technology and managing this change,
2. Producing innovative solutions to technological problems encountered throughout life,
3. Using technological knowledge effectively and putting it into practice,
4. Wisely analyzing and evaluating the individual and social effects of technology.

6. Digital Literacy Models

The literature contains different conceptual models of digital literacy developed in education such as the Krumsvik (2011) model, the Calvani et al. (2008) model, the Hobbs (2010) model, the Martin (2008) model, the Hague and Payton (2010) model and the Ng (2012) model.

6.1. The Rune Johan Krumsvik Model

Krumsvik (2011) argued that digital literacy skills should first be acquired by educators. He emphasized that traditional teaching methods should be abandoned and digital opportunities used fully and suggested that students' interest and achievement would increase in this way.

The model consists of two axes, horizontal and vertical. The horizontal axis contains digital literacy skills, while the vertical axis contains levels of digital literacy awareness.

The sections between the axes of the model also have a four-layered structure. Basic skills are at the center, the second layer contains the effective use of these skills in lessons, and the third layer contains learning strategies and metacognition. The final layer aims to help teachers understand how digital planning is affected by digital reforms and digitalized schools.

6.2. Calvani, Cartelli, Fini and Ranieri Digital Competence Model

This model includes a person's responsibilities toward themselves and others, as well as the skills of flexibly exploring new technological developments, analyzing accurate data, evaluating critically, anticipating and solving possible problems, and using technological tools effectively for teamwork.

Digital competence is examined in three basic dimensions: technological, cognitive and ethical. The technological dimension covers the ability to use new technologies effectively and flexibly. In the cognitive dimension, the ability to access information and evaluate it is important. The ethical dimension refers to the ability to communicate effectively with an ethical understanding while using information technologies (Calvani et al., 2008).

6.3. The Renee Hobbs Media Literacy Model

Hobbs (2010) stated that media literacy lies at the foundation of digital literacy. This emphasizes that, besides using computer software and benefiting from internet tools, the use of social media is also fundamental to digital literacy. The five competencies in Hobbs's framework are access (finding appropriate and relevant information and sharing it through media texts and technological tools), analysis (using critical thinking to examine a message's purpose, target audience, quality and credibility), creation (producing content with creativity and confidence), reflection (examining the effect of media messages and technological tools on thought and behavior in daily life) and action (sharing knowledge and solving problems individually or collaboratively). When these five competencies support one another, individuals can remain active in both receiving and producing information and continue lifelong learning.

6.4. The Allan Martin Digital Literacy Model

Martin (2008), building on Martin and Grudziecki (2006), describes digital literacy as a model consisting of three main components: digital competence, digital usage and digital transformation.

Digital competence represents the first, basic level. In general, these are the basic characteristics that everyone should have in order to ease daily tasks and keep up with the age.

Digital usage is regarded as the second, intermediate level. It generally advances with the development of basic competencies. It is the level required for people to cope with problems in working life, leisure time or other areas of life.

Digital transformation represents the third, upper level. When the usages developed at the second level enable innovation and creativity, they can stimulate significant change in the professional or knowledge domain, at the level of the individual, the group or the organization. However, transformation is not a necessary condition of digital literacy; appropriate

and informed usage at the second level is sufficient to describe a person as digitally literate (Martin & Grudziecki, 2006).

6.5. The Cassie Hague and Sarah Payton Model

Hague and Payton (2010) define digital literacy as the intersection of eight interrelated components. These components are: functional skills, effective communication, ability to find and select information, critical thinking and evaluation, cultural and social understanding, collaboration, creativity and e-safety. Digital literacy lies at the center of these components.

Web 2.0 tools enable users at every level to easily perform activities such as communication, interaction, information sharing, access to information, collaborative content creation, content storage and sharing, evaluation and visualization. These technological tools encourage students to be active participants in learning environments and to contribute to content (Yükseltürk et al., 2017).

6.6. The Wan Ng Model

The digital literacy model developed by Ng (2012) consists of the intersection of three different dimensions: technical, cognitive and social-emotional.

The technical dimension basically refers to having technical and functional skills. In education and daily work, it includes the ability to use even the smallest pieces of equipment, such as headphones, projectors and smart boards, without difficulty and to work with them effectively. It also covers the ability to study manuals for such devices and to solve problems independently using platforms such as YouTube.

The cognitive dimension concerns the cycle of critical thinking, evaluation and creation in the process of accessing information. It also refers to the ability to evaluate and select suitable software programs to complete a task.

The social-emotional dimension refers to acting with respect and tolerance for effective communication, choosing appropriate words to prevent misunderstandings and communicating with others in a courteous manner.

7. Sub-Disciplines of Digital Literacy

With the rapid advance of digital technology, a different digital literacy need has emerged in every area of daily life. Koltay (2011) listed the literacy sub-disciplines related to digital technologies as follows:

Computer literacy,

Library literacy,

Internet literacy,

Information literacy,

Media literacy,

Electronic information literacy,

Digital information literacy,

However, particularly from the perspectives of digital communication, new media studies and educational technology, these concepts are generally examined within the framework of digital literacy. The focal points of these literacy types, each of which is closely related to digital technologies, may differ from one another, but it is hardly possible to draw a clear distinction among them.

8. Discussion

The reviewed literature shows that definitions of digital literacy have expanded markedly over time. In the concept's first use, the emphasis was on understanding and evaluating information presented in a computer environment (Belshaw, 2012). Later definitions foreground elements such as surviving in the digital era (Eshet-Alkalai, 2004), understanding media and searching for and critiquing information (Ferrari, 2012), and using technology safely (Hague & Payton, 2010). This trajectory suggests that

digital literacy has shifted from the use of tools toward a relationship with information, and from there to the individual's position in digital society.

When the models are compared, a similar core structure stands out despite differences in naming: technical and functional skills, cognitive and critical skills, and a social and ethical dimension. The Ng model names this triad explicitly as technical, cognitive and social-emotional dimensions (Ng, 2012), and the model of Calvani and colleagues builds a similar structure from technological, cognitive and ethical dimensions (Calvani et al., 2008). The eight-component structure of Hague and Payton presents the same core with a more detailed list of components (Hague & Payton, 2010). This overlap shows that the models can be read less as alternatives to one another than as depictions of the same phenomenon at different levels of detail.

Martin's three-stage approach differs from the others by treating digital literacy as a developing process rather than a state to be measured (Martin, 2008; Martin & Grudziecki, 2006). From the management information systems perspective, the most striking point is that the highest stage, digital transformation, describes a change in which creativity and innovation are encouraged. In other words, the model carries digital literacy from a user-level competence to a capacity that can be related to organizational innovation and technology management processes. The same model also notes that this stage is not required of every user (Martin & Grudziecki, 2006); organizations therefore need to decide deliberately which level they expect from which employees.

In education, the literature stresses two points. First, digital literacy is said to contribute to students' critical thinking, access to reliable information and conscious use; second, teachers' digital competence is regarded as a precondition for students' development (Timur et al., 2014). Krumsvik's view that skills should first be acquired by educators (Krumsvik, 2011) and the start of training for academic staff in Türkiye (YÖK, 2019) are consistent with this emphasis. Teacher competence can thus be seen as the classroom-level counterpart of digital transformation.

Most research on teachers focuses on determining the level of digital literacy. This orientation has produced a rich descriptive body of knowledge on differences by variables such as gender, age, seniority, school type, educational background and personal device ownership (Kaya-Özgül et al., 2023). By contrast, studies that address the relationship between the level of digital literacy and outcomes such as teachers' innovative behavior, entrepreneurial tendencies or organizational transformation processes remain limited within the reviewed literature. A study conducted by the author with private school teachers and currently in press reports that digital literacy plays an indirect rather than direct role in the relationship between talent management and innovative behavior and individual entrepreneurship capacities (Temel & Gündüzyeli, in press). This suggests that the concept has been examined more as a level to be measured and less as a source of other capacities. Martin's digital transformation stage offers a suitable theoretical basis for filling this gap.

Finally, the discussion of sub-disciplines points to the blurriness of conceptual boundaries. It is noted that it is difficult to draw a clear distinction between computer, library, internet, information, media, electronic information and digital information literacy (Koltay, 2011). This uncertainty brings with it the possibility that, in scale adaptation and development studies (Hamutoğlu et al., 2017; Üstündağ et al., 2017), measurements bearing the same name may cover different content. It is therefore important to state explicitly which definition and model is adopted in comparisons across studies.

9. Limitations

This chapter is not a systematic review; sources were selected around the definition, levels, skills and models of the concept rather than through a particular database search with defined criteria. It therefore cannot be claimed to represent the whole literature, and some relevant studies may have remained outside its scope.

The review is dominated by Turkish-language sources and samples of teachers or pre-service teachers. The generalizations in the chapter thus have limited validity for other occupational groups, institution types and countries. In addition, some of the sources are unpublished postgraduate theses rather than peer-reviewed journal articles; the findings of these studies have not been through an independent review process.

Finally, it should be borne in mind that, because digital technologies change rapidly, definitions, platforms and skill frameworks may quickly become outdated, and that the chapter contains no empirical test.

10. Recommendations

10.1. Recommendations for Practice

Teacher education and in-service programs should not leave digital literacy at the level of tool use. Martin's three-stage structure (Martin, 2008; Martin & Grudziecki, 2006) can guide program design: basic competence should be ensured first, the use of this competence in real teaching and work situations should then be supported, and creative and innovative practices should be encouraged among suitable individuals and groups.

Schools and other educational institutions should plan their digital transformation strategies together with the development of employees' digital literacy. Using models that address the technical, cognitive and social-emotional dimensions together (Ng, 2012) in needs analysis can reveal the shortcomings of a transformation approach based only on hardware and software investment.

At the policy level, considering that some countries have added digital literacy content to their curricula (The Royal Society, 2012) and that pilot practices were started in Türkiye (YÖK, 2019), it would be useful to establish evaluation mechanisms to monitor the results of these initiatives.

10.2. Recommendations for Research

Future studies are recommended to conduct systematic reviews based on defined criteria and to include literature in other languages.

There is a need for quantitative, qualitative and mixed-method studies that test the relationship of digital literacy with outcomes such as innovative behavior, individual entrepreneurship and participation in organizational digital transformation. In such studies, managers and employees in different sectors should be included in the sample alongside teachers, and state and private institutions should be compared. Longitudinal designs are particularly suitable for monitoring the developmental stages of digital literacy and the outcomes of these stages.

Finally, because of the blurriness of conceptual boundaries, studies are recommended to state clearly which definition and model they rely on, to support scale selection with theoretical justification and to discuss their relationship with sub-disciplines.

11. Conclusion

This chapter has reviewed digital literacy in terms of its definitions, relationship with education, developmental levels, component skills, theoretical models and sub-disciplines. Definitions were found to expand from technical usage skills toward cognitive, ethical and social dimensions, and different models were found to share a similar core structure despite differences in naming. Research on teachers, in turn, relies largely on determining levels.

The highest stage of digital literacy, which is associated with creativity and innovation, stands out as the strongest theoretical bridge linking the concept to the fields of digital transformation and technology and innovation management. Empirically testing this bridge would both close a gap in the literature and help educational institutions and other organizations manage digital transformation with attention to its human dimension.

Declarations

Ethics Committee Approval: This chapter does not fall within the scope of research requiring ethics committee approval, such as studies involving the collection of data from participants through surveys, interviews, focus groups, observations, experiments, or other qualitative and quantitative approaches; the experimental or scientific use of humans or animals (including materials/data); clinical studies conducted on humans; studies conducted on animals; or retrospective studies subject to personal data protection legislation. Therefore, ethics committee approval was not deemed necessary.

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