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# Financial literacy in the digital age—A research agenda

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## Abstract

Digital innovations are transforming financial services and resulting changes in consumer behavior and personal money management. Diffusion of pervasive digital technologies offers individuals quick and easy access to various digital services bringing opportunities and challenges into their personal money management. The study aimed to explore how digitalization affects individuals' financial literacy and financial capability. As a result, we identified three main themes in the intersection of finance and digitalization: Fintech, Financial behavior in digital environments, and Behavioral interventions. We propose directions for measuring digital financial literacy, updates to the financial literacy curriculum, and developments of digital learning tools. Further, we highlight collaboration between the public and private sectors to create a fairer and more inclusive economic landscape. Our study contributes to existing research by proposing a framework for digital financial literacy and financial capability and a research agenda for future studies.

**KEYWORDS**

digital, digital financial services, financial capability, financial literacy, personal money management

## 1 | INTRODUCTION

The pervasiveness of digital technologies in the economy and everyday life is disrupting the financial industry as well as personal money management practices. Digital innovations in the financial sector, commonly labeled as Fintech, are transforming areas such as retail banking, investment, and payment services. Digital technologies have also an enormous potential to play a pivotal role in financial education and improve financial literacy (Davis & Hasler, 2021; Gomber et al., 2017; Gomber et al., 2018). As consumers are surrounded by an ecosystem of digital financial services (DFS), such as digital money and online and mobile financial services, there is a need for effective financial education, financial consumer protection, and financial inclusion policies that adapt rapidly to the changing environment (Davis & Hasler, 2021; OECD, 2017, 2018). While the digitalization of finance benefits society by offering more convenient, swift, and secure transactions, as well as tailored products and services for individuals, DFS also carry new risks and unintended consequences that may cause serious threats to the financial well-being of the individual and of society (OECD, 2017, 2018).

Financial well-being is known to be a key predictor of individual's subjective well-being. Prior research defines financial well-being as a state of being wherein an individual have control over day-to-day finances; have the capacity to absorb financial shock; have ability to meet one's financial goals; and have the financial freedom to make the choices that allow one to enjoy life (Collins & Urban, 2020; Netemeyer et al., 2018). According to Netemeyer et al. (2018), perceived financial well-being has two dimensions: the consumer's assessment of current money management circumstances and the ability to assess future financial security. A key component of financial well-being is financial literacy. Financial knowledge, understanding, basic financial skills, confidence, and motivation set the foundations of financial literacy (Warmath & Zimmerman, 2019). Basic financial knowledge, skills, and understanding are gained at home and through formal education at school (Lusardi, 2015; Lusardi et al., 2010). While effects of financial education interventions decay over time (Fernandes et al., 2014), financial literacy unfolds through experience, life-events, and environmental changes (Leskinen & Raijas, 2006). A significant body of research has demonstrated that more financially literate people have better economic outcomes (Leskinen & Raijas, 2006; Lusardi et al., 2010; Lusardi & Mitchell, 2011, 2014). A solid financial literacy helps people with personal money management, including everyday financial behaviors (i.e., spending and budgeting) as well as long-term financial decisions, such as saving, investing, and borrowing. Additionally, enhanced financial knowledge improves individuals' abilities to detect fraudulent practices and deter fraud (Engels et al., 2020; OECD, 2018).

The bulk of the literature on financial literacy has focused on three key areas: conceptual definitions of financial literacy (Remund, 2010; Santini et al., 2019; Warmath & Zimmerman, 2019), measurement of the elements of financial literacy (Huston, 2010; Lusardi, 2015; Lusardi & Mitchell, 2014), and financial education (Fernandes et al., 2014; Kaiser et al., 2022; Lusardi et al., 2017; Peeters et al., 2018). While much of the prior research on financial literacy and personal money management was developed in a traditional analog world, it may no longer be compatible with the new and more complex financial landscape created by the pervasive diffusion of digital technologies. Ubiquitous devices offer access to variety of online services and digital tools bringing both opportunities and challenges into their personal money management. For example, online shopping and various digital payment methods provide quick and easy shopping experiences but at the same time they tend to increase spending because they lower the barriers to consumption. In addition, the action is less tangible than

using cash and purchases can be easily triggered by algorithms used in persuasive systems (e.g., deals notification, social media advertising) (Carlsson et al., 2017; Huebner et al., 2020). Additionally, maintaining multiple banking relationships and various credit cards may cause challenges for some individuals to have a complete understanding of one's financial overall situation (Huebner et al., 2020). Today, individuals are expected to be active and well-informed in their financial activities and ready to take responsibility for their financial decisions, such as investing in additional education or planning for retirement (Davis & Hasler, 2021; Leskinen & Raijas, 2006; Lusardi, 2015; Lusardi & Mitchell, 2014).

A report of millennial Fintech use points out that 80% of millennial smartphone owners use their device to some degree for transactional financial purposes (e.g., depositing checks, sending or receiving money, making mobile payments, and paying bills) and 90% for informational financial purposes, such as checking credit score, price comparisons, tracking spending, and getting personalized investment advice (Yakoboski et al., 2018). The results show that paying bills is the most common transactional activity and comparing prices is the most common informational activity among millennials with a smartphone. Previous research has shown evidence that financial literacy can mitigate the effect of mobile payment use that result on account overdrafts (Yakoboski et al., 2018). Hence, new type of financial literacy is essential to improve personal financial outcomes in a digital world densely populated by Fintech (OECD, 2017; Yakoboski et al., 2018).

Digital financial literacy is needed for people to be able to not only leverage the benefits of digital financial services but also to recognize the potential risks associated with the diffusion of such innovations. Although digitalization has been involved in almost all everyday practices, very little is known about how digitalization influences individuals' financial behaviors, and hence, financial literacy. As a result, this study applies an integrative review approach (Torraco, 2005) to critically analyze if and to explore how digitalization affects individuals' financial literacy and financial capability. Based on the literature review, we propose a framework of digital financial literacy and financial capability and lay out a research agenda. In order to achieve this goal, we first illustrate the background of the study by discussing the relationship between financial literacy and financial capability as well as the changes in the financial environment caused by digitalization. Then, we shortly explain the research methodology. After that, we review and synthetize the literature focusing on financial literacy in light of digital ecosystems. Finally, we present recommendations for future research to incorporate digitalization into financial literacy and financial capability.

## 2 | FINANCIAL LITERACY AND FINANCIAL CAPABILITY

Financial literacy sets the foundations of individuals' financial behaviors and personal money management. It also plays an important role in financial well-being. Financially literate individuals understand the key financial concepts and have the ability and confidence to manage personal finances and make effective financial decisions (Huston, 2010; Leskinen & Raijas, 2006; Lusardi, 2015; Remund, 2010; Warmath & Zimmerman, 2019). Individuals must demonstrate knowledge and skills to understand financial practices, such as cash-flow management, credit management, saving, loans, and investment, and financial understanding to gather, evaluate, and understand information needed in decisions concerning one's finances (Huston, 2010; Lusardi & Mitchell, 2014). In addition to knowledge and understanding, people also need to have a solid financial self-belief (i.e., financial attitude, perceived behavioral control, and

financial self-efficacy) that describes one's ability to cope with the financial demands on day-to-day life (Serido et al., 2013). Another concept which is important to the development of financial literacy is financial capability (see Figure 1). It is a broader concept than financial literacy, including not only the ability to act, but also the opportunity to act. Financially capable individuals not only develop financial skills and knowledge, but also gain access to financial products and institutions leading to greater participation in financial services market (Scott et al., 2018; Serido et al., 2013; Sherraden, 2013; Sherraden & Grinstein-Weiss, 2015).

While the understanding of the basic concept has been shared relatively widely, there has been more significant discrepancy how to measure financial literacy empirically. An influential approach exemplified by Lusardi and her co-authors (e.g., Lusardi & Mitchell, 2011, 2014) equates financial literacy with financial knowledge. On the other hand, the OECD (Atkinson & Messy, 2011) has taken a different approach by also including behaviors (for instance, comparisons of alternative products) and attitudes (e.g., planning or short-termism). However, most of the academic research treats behavior as an outcome variable that is influenced by financial literacy rather than part of literacy. Similarly, attitudes (e.g., time preferences or cultural issues) are usually regarded as external variables influencing behaviors, rather than as components of literature (e.g., Huston, 2010).

There is still considerable variation how to operationalize financial literacy. A typical approach has been through multiple choice knowledge questions. These can range from as few as three (Lusardi & Mitchell, 2011, 2014) to as many as 50 (Ranyard et al., 2020). In the shortest available list, there are questions representing inflation, interest rates and diversification. In longer scales there are also items representing the understanding of various products, such as bank accounts, payments, mortgages, and investment products. There is a quite significant literature testing the validity of various questions, the coherence of the scales and the feasibility of shortening the scales and retaining the information (e.g., Houts & Knoll, 2020; Ranyard et al., 2020).

The argument for scales consisting of fewer items is not that it would be optimal to use a small number of questions. Rather, it is that often the only feasible option may be to include

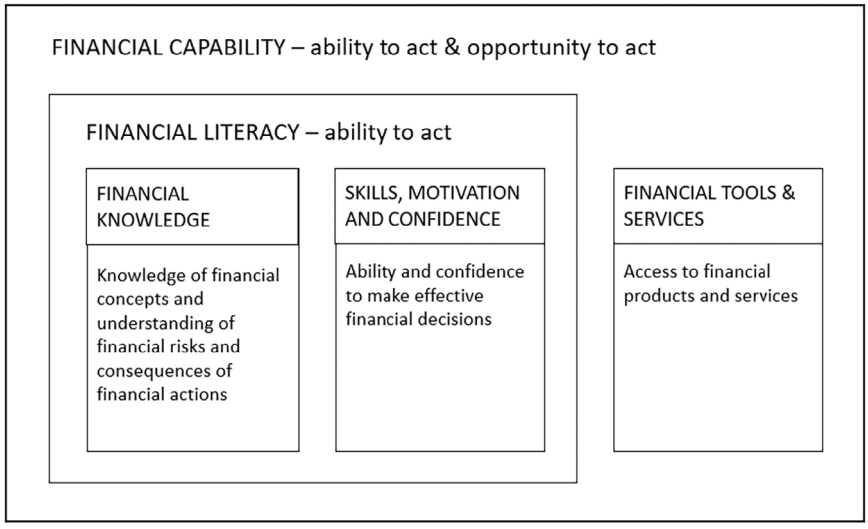


**FIGURE 1** A conceptual description of financial literacy and financial capability.

fewer items on financial literacy to longer questionnaires. Also, Lusardi's team has used larger questionnaires when feasible (e.g., Yakoboski et al., 2018).

There is also literature that broaden the definitions of financial literacy beyond the multiple-choice knowledge questions. Alternative measures to measures include subjective evaluations of financial literacy (e.g., Allgood & Walstad, 2016), subjective assessment of financial skills (e.g., Warmath & Zimmerman, 2019), and self-efficacy measures (Danes & Haberman, 2007; Lown, 2011; Warmath & Zimmerman, 2019).

While existing research on financial literacy and financial capability demonstrates what kinds of skills, knowledge, understanding, and capabilities individuals must have to manage their personal finances efficiently in traditional "analog" world, the body of knowledge focusing on financial literacy and capability in digital environments still is rather limited. Since the financial service landscape is rapidly being transformed by the digital revolution, traditional financial literacy is no longer sufficient to empower individuals to effectively manage their personal finances and to understand a number of emerging issues such as information security, consumer fraud, and the effects of persuasive algorithms in consumption. As a result, to be aligned with the skillset needed to in thrive in a digital world, traditional financial literary needs to be complemented by elements of digital literacy (Elsinger et al., 2018; Engels et al., 2020; OECD, 2021).

## 3 | TOWARDS DIGITAL FINANCIAL LITERACY

The evolution of digital economy has gradually blurred physical, social, and temporal boundaries providing fluid information access and allowing the creation and delivery of digital products and services through a multitude of interconnected channels (Carillo et al., 2017). Consequently, the impact of digital technologies on the economy can be understood as disruption of existing economic processes, systems and sectors, changes in consumer behavior, and reshape of business models and business interactions (Bukht & Heeks, 2018). In digital ecosystems, people are immersed in technology, that is, they do not perceive computing as a separate activity from their everyday activities (Baskerville et al., 2020). For instance, especially during the COVID19 pandemic, it has become increasingly common to purchase groceries from an online store rather than visit a local supermarket, or to pay for purchases using contactless payment instead of cash.

While digital technologies are considered as an effective mean to accomplish goals, most of these systems are not neutral, they often have embedded persuasive algorithms that are capable of influencing people's attitudes and behaviors in one way or another (Oinas-Kukkonen, 2013). For service providers this creates a possibility of persuading and changing users' attitudes and behavior through persuasive technologies that aim at shape, reinforce, or change user attitudes, intentions, or behaviors through software design (Fogg, 2009b, 2009a; Shin & Kim, 2018). Application areas range from persuading users to achieve healthier lifestyle behaviors (e.g., weight loss, physical activity), to adopt greener energy behaviors (Oinas-Kukkonen, 2013) and to purchase additional items (Lembcke et al., 2019; Mirsch et al., 2017). In behavioral economics the concept of nudging refers to external interventions that result changes in human behavior (Thaler & Sunstein, 2008). Consequently, in digital environments people's behavior can be heavily influenced by digital nudging (Weinmann, Schneider and Brocke, 2016; Benartzi, 2017; Mirsch et al., 2017; Cai, 2020; Lembcke et al., 2019). Today, not only large business companies use digital nudging in personalized marketing (Cai, 2020; Mirsch et al., 2017),

but financial service providers have products that affect customer financial behaviors (Dolan et al., 2012). Current literature shows evidence of the paradoxical nature of nudging as the same tools create different kinds of value for customers and for companies. This creates a paradox where digital capabilities that provides benefits for companies may run counter the interest of customers, and vice versa.

As a result, the financial industry is changing rapidly due to the pervasiveness of digitalized environments as fintech companies introduce innovative technologies and new business models to the financial sector (Elsinger et al., 2018). Fintech facilitate access to existing and novel financial products and services and make it possible to tailor products and to lower the costs of services. However, the rise of fintech includes also various risks, such as potential misuse and fraud of digital services, issues of data confidentiality, and digital profiling. In addition to market-driven risks, there are regulation-driven risks and consumer-driven risks. Consumers need the necessary knowledge to understand the quality and the risks of new financial products, additional skills, and competences to understand and use digital services and related IT technology as well as critical evaluation skills (Elsinger et al., 2018). Recent literature emphasizes the need to redefine traditional financial literacy to include digital literacy and show the linkages between financial literacy, digital literacy, and digital financial literacy (Lyons & Kass-Hanna, 2021).

The Digital Literacy Global Framework introduces six core competence areas in digital literacy: information and data literacy, communication and collaboration, digital content creation, safety, problem solving, and career-related competences (Jin et al., 2020; Law et al., 2018). Thus, digital literacy involves the ability to effectively use information and communication technologies (ICT). It encompasses the ability to find information, obtain it and evaluate its relevance in the digital environment, critically analyze the information obtained, and use ICT without risks and dangers (Jin et al., 2020; Rodríguez-De-dios et al., 2016).

In terms of measuring digital literacy, there has been several approaches, as described in Jin et al. (2020). Similar to the approaches measuring financial literacy, also in digital financial literacy self-efficacy questions using a Likert-scale have been used. The literature has also utilized knowledge questions in forms of multiple-choice questions and including simulations within purpose-built digital environments and even fully assessment tasks using real tasks in authentic environments. In this way, the measurement of digital literacy has been heavily geared towards knowledge and applications of the skills in practical problem-solving issues.

Lyons and Kass-Hanna (2021) point out that the assessment of digital financial literacy consists of items such as conducting online shopping, using online and mobile banking, opening a digital financial services menu, initiating, and completing a digital financial services transaction, and correcting errors or canceling transactions. OECD has also included questions related to digital financial literacy in their recent questionnaires, the most recent being released in March 2022. The OECD (2022) includes an even broader range of questions than Lyons and Kass-Hanna (2021), including arranging automatic payments, buying cryptocurrencies, having transactions with stock trading platforms etc. The OECD has also some questions related to becoming victim of frauds, for instance in digital environments.

## 4 | RESEARCH METHODOLOGY

We selected the literature review method because it helps to identify and understand what is currently known and what needs to be known about the topic (Webster & Watson, 2002).

Further, we adopted an integrative literature review approach for this study because it helps us to review, critique, and synthetize the existing research on financial literacy in digitalized world (Torraco, 2005). As an organizational review framework, we adopted the concept-centric approach by Webster and Watson (2002).

As our aim was to explore how digitalization affects individuals' financial literacy and financial capability, we focused on papers that had their core on the intersection of finance and digital technologies. The systematic search was performed during fall 2020 (September – December) in the databases including ProQuest, EBSCO, ACM Digital Library, and Google Scholar. The major terms used to perform the database search, were: "financial literacy", "financial capability", "financial behavior", "personal finance", "money management", "digital finance", "digital financial literacy", "digitalization", "financial technology", "Fintech", and "financial services". Boolean Operation uses of the conjunctions "OR" and "AND" were applied and the main search string used was: ("financial behavior" OR "money management" OR "personal finance") AND (digital OR "digital literacy" OR digitalization) AND "financial literacy". Then, we carefully went through all titles, abstracts, and keywords to check their fit with the goals of this study.

We applied a two-stage approach for selecting the appropriate literature for the study. During the first stage, we excluded papers with a scope not related to our research. The excluded papers focused for example on digitalization in some specific area, such as health services, or digitalization in general. Further, we excluded papers focusing exclusively on financial education. Then, in the second stage, the papers were thoroughly scrutinized to exclude papers that discussed financial literacy but did not have digital services and tools or digitalization playing a role in their research. After careful examination, only 29 peer-reviewed papers were considered relevant to the topic of digital financial literacy and were selected as sample for full reading and detailed analysis. The considerable drop from 603 to 29 papers occurred for several reasons, such as correct use of terminology in a context outside of the topic or the use of terminology focusing solely on traditional financial literacy (i.e., analog world). The selected papers represented four core disciplines: finance (17 papers), economics (6 papers), finance and economics (2 papers), and information systems (4 papers). The classification reflects the primary domain of research and the topic of the study. Seventeen papers were classified in finance considered the topics of Fintech (4), financial behavior (9), and behavioral interventions (4). Six papers included in economics focused on the topics of political economics (2) and consumer economics (3), and Fintech (1). Two papers covered the domains of economics and finance by focusing on the topics of consumer economics and Fintech. Finally, four papers were classified in information systems focusing on the topics of Fintech (1) and behavioral interventions (3).

## 5 | FINANCIAL LITERACY ON THE LIGHT OF THE DIGITAL ECOSYSTEM

The analysis of the selected papers revealed that existing literature in the intersection of finance and digitalization focuses mainly on three themes (1) Fintech, (2) Financial behavior in digital environments, and (3) Behavioral interventions (see Table 1). The first theme includes nine papers and describes the influence of digital technologies in the financial services industry focusing on digitalization, Fintech, digital finance, and digital financial literacy. The second theme consists of 11 papers and incorporates research focusing on consumers' digital financial behaviors. Finally, the third theme includes nine papers and describes research on behavioral interventions focusing on use of nudging and digital nudging in financial market.

**TABLE 1** Research on digital financial literacy

| Category | Focus | Authors |
|---|---|---|
| Fintech | Fintech, financial literacy, and financial stability | Elsinger et al. (2018) |
| | Fintech revolution - Changes and transformation in financial services | Gomber et al. (2018) |
| | Critical view of digital revolution and financial inclusion | Gabor and Brooks (2017) |
| | Digital Finance and Fintech | Milian, Spinola & Carvalho (2019) |
| | Digital Finanace and Fintech | Gomber et al. (2017) |
| | Big Data and algorithmic governance | Cambell-Verduyn, Goguen & Porter (2017) |
| | Financial literacy and Fintech | Panos and Wilson (2020) |
| | Fintech debt ecology and consumer overindebtedness | Burton (2020) |
| | Financial literacy and consumer fraud | Engels et al. (2020) |
| Financial behavior in digital environments | Online banking; consumer financial literacy | Servon and Kaestner (2008) |
| | Digital consumer credit behavior | Carlsson et al. (2017) |
| | Digital portfolio management | Li and Meyer-Cirkel (2021) |
| | Daily financial transactions; Digital payments | Perry & Ferreira (2018) |
| | Use of digital financial management services | Lewis and Perry (2019) |
| | Youth engagement with a mobile banking app | Wijland et al. (2016) |
| | Use of mobile payments | Li et al. (2020) |
| | Use of robo-advisors by individual investors | Fan and Chatterjee (2020) |
| | Research on electronic banking between 1984–2010 | Hoehle, Scomavacca & Huff (2012) |
| | Mobile payment | Dahlberg, Mallat, Ondrus & Zmijewska (2008) |
| | Mobile payment | Dahlberg et al. (2015) |
| Behavioral interventions | Nudging the student loan repayment process | Johnson et al. (2020) |
| | Credit card use; Mobile app intervention | Huebner et al. (2020) |
| | Use of smartphone apps in improving financial capability | French et al. (2020) |
| | Use of nudging in financial market | Cai (2020) |
| | Digital nudging | Weinmann et al. (2016) |
| | The psychological mechanisms underlying digital nudging | Mirsch et al. (2017) |
| | Nudging debt; Critique against behavioral interventions | White (2017) |

TABLE 1 (Continued)

| Category | Focus | Authors |
|---|---|---|
| | Influencing financial behavior | Dolan et al. (2012) |
| | Ethical considerations of digital nudging | Lembcke et al. (2019) |

## 5.1 | Fintech

In the past, the financial industry treated information technology at large as a mere supporting tool. However, in the past couple of decades informational technology in the financial industry has grown into a core aspect of the business, and, in more recently, several start-ups as well as giant IT companies such as Amazon, Google and Apple have entered the financial domain offering innovative products and services (Gomber et al., 2017; Gomber et al., 2018; Milian, Spinola and Carvalho, 2019). Financial technology (Fintech) describes the convergence of modern digital technologies (e.g., cloud computing, mobile internet) with business activities in the financial services industry (e.g., loans, payments, banking operations) (Gomber et al., 2017). The European Banking Authority (EBA) defines Fintech as 'technologically enabled financial innovation that could result in new business models, applications, processes, or products with an associated material effect on financial markets and institutions and the provision of financial services' (European Banking Authority, 2017, 6). According to EBA (European Banking Authority, 2017), the business models of Fintech companies are quite varied including innovative technologies to the financial sector ranging from backend developments to customer services and consulting. Furthermore, technologies promoted by Fintech companies often relate to big data analytics, artificial intelligence, cryptography, and distributed ledger technology (blockchain).

During the past decades, technological development and new business models have provided a basis for innovative financial solutions and continuous evolution in service delivery. The digital revolution is changing the key components of financial services operations and new innovative business models are forcing businesses to become more customer centric (Gomber et al., 2017). From the customer perspective, the digital revolution is enhancing customer experience with new products, services, and functionality, and supplementing it with improvements in existing functionality (Gomber et al., 2017; Gomber et al., 2018; Milian, Spinola and Carvalho, 2019). Fintech companies and other innovative service providers offer customers finance-related software and new forms of customer communication and interaction (Gomber et al., 2017). For example, companies offer consumers easy to use payment methods (such as Apple Pay and Google Wallet) via mobile phones and tablets; crowdfunding platforms allow people to make financial contributions to projects or investing in start-ups; peer-to-peer (P2P) platforms allow money transfer between individuals (e.g., PayPal); and personal finance applications help individuals to manage their accounts and personal credit (Milian, Spinola and Carvalho, 2019). All these innovations influence individuals' financial planning, financial behaviors, and financial well-being. Hence, by building the next generation of financial tools Fintech has potential to enhance financial capability (Panos & Wilson, 2020).

While digitalization of financial sector provides many benefits, it also creates new risks - whether an intended or not. Those risks come in different forms. Some are market or technology driven, some are related to regulation and supervision, and others stem from unprepared consumers (Campbell-Verduyn et al., 2017; Elsinger et al., 2018; European Banking

Authority, 2017; OECD, 2018). Market driven risks involve for example a lack of security, privacy, and rapid access to high-cost/short-term credit, whereas technology driven risks include potential misuse and fraud in digital services, and the ethical issues related to the increased use of persuasive algorithms (Campbell-Verduyn et al., 2017; Elsinger et al., 2018; Engels et al., 2020). Digital environments include many fraudulent activities, such as authorized push payment frauds, contactless card and card skimming frauds, that can continue unhindered for long periods and may remain undiscovered (Engels et al., 2020). Additionally, both market and technology driven risks involve data confidentiality and digital profiling. A digital footprint is a trail of data customers create while using the Internet and digital services. Financial service providers use digital profiling - that is use of digital footprints to form a profile for each individual customer - to offer tailored products to consumers and boost revenues (Gabor & Brooks, 2017). Some recent studies express their concerns about the use of big data and algorithm governance in financial markets (Campbell-Verduyn et al., 2017; Gabor & Brooks, 2017) and use of behavioral economics not only to trace, but also to influence people to make certain decisions (Cai, 2020; Gabor & Brooks, 2017). The digitalization of the economy leads to an ever-growing digital footprint. Not only banks and credit card companies but also other players such as online retailers, social network platforms, fintech companies, crowdfunding and peer-to-peer lending platforms, and governments are increasingly collecting vast amounts of personal data (OECD, 2018).

Regulation and supervision driven risks include information asymmetry, uneven levels of protection within and across countries, consideration of data protection issues, and a lack of coordination among authorities (European Banking Authority, 2017; Elsinger et al., 2018; Milian, Spinola and Carvalho, 2019; Burton, 2020). Consumer driven risks are related to the growing digitalization of daily life and lack of consumer financial literacy and experiences with digital financial products (Elsinger et al., 2018; European Banking Authority, 2017; OECD, 2018). Furthermore, consumers require additional skills and competences to use various digital services as well as knowledge and understanding to critically evaluate new service providers (Elsinger et al., 2018). Fintech may also damage financial well-being by triggering impulsive consumer behavior (Panos & Wilson, 2020) as digital devices provide access to credit and online shopping anytime and anywhere leading to the risk of over-indebtedness (Burton, 2020).

## 5.2 | Financial behavior in digital environments

As digital revolution transforms financial service landscape, individuals must acquire new skills and update their knowledge of financial literacy as well as adjust their financial behaviors according to digital financial products and services in order to be capable on managing successfully their personal finances. Consequently, new innovative products and services, such as new digital payment methods, affect increasingly people's everyday financial behaviors. In addition to novel digital financial services and tools, various information sharing platforms, such as review sites, comparison portals, and discussion communities, have an influence on individuals' purchasing and investment behavior. One of the most recent innovations in the area of financial advice is algorithms (i.e., robot-advisors) that provide investment proposals with no or minimal human intervention (Fan & Chatterjee, 2020). There is evidence that this trend towards hyperautomation and extensive algorithm delegation has even been accelerated during the COVID-19 pandemic due to the strong push for organizations to digitalize processes to support social distancing rules (Fujiki, 2022).

Since the introduction of online banking in early 1990 s, banks have strongly encouraged customers to conduct transactions online (Servon & Kaestner, 2008). Technological improvements and new innovations provide enhanced access to digital banking services and customers have increasingly switched from in-person to computer-mediated transactions. An extensive body of research has been conducted to understand the adoption and use of e-banking channels at the individual level. Researchers have found that perceived usefulness, convenience, and service quality have positive influence on e-banking use, whereas costs and perceived insecurity of e-banking applications may inhibit individuals from using e-banking applications (Hoehle et al., 2012). Due to the rising number of online shops and the wide-spread adoption of smartphones, the demand for digital payments has dramatically increased. Research on digital payments (i.e., mobile payments and e-payments) focuses on three main streams of research: digital payment platforms, user behavior of digital payment systems, and the competition between different digital payment systems (Gomber et al., 2017). In addition to ease of use and trust, the additional factors affecting individuals' intention to use digital payment services are similar to other digital technologies including perceived usefulness, risk, compatibility, relative advantage, image, and network externalities (Dahlberg et al., 2008; Dahlberg et al., 2015). Prior research shows that older, lower income, and disabled consumers are less likely to use mobile payment apps, and therefore may be less likely to gain access to Fintech apps (Li et al., 2020). On the other hand, research on mobile banking usage shows that although young people like to use mobile banking applications because of their temporal and spatial freedom and savings in time and effort, they still need active nudging into making better money decisions (Wijland et al., 2016). Hence, it is important to pay attention to design of mobile banking and other e-payment applications to ensure they do not marginalize segments of the public and serve as an instrument of increasing social inequality (Michael et al., 2020).

In addition to e-banking and mobile payments, a couple of recent articles examine investments in digital environment. Li and Meyer-Cirkel (2021) study the use of a digital financial literacy platform on students' portfolio performances. They discover rapid convergence of individual portfolios to the provided benchmark portfolios and found significant peer influences as students shared portfolio information through class presentations and Facebook postings. Furthermore, a study by Fan and Chatterjee (2020) focuses on investors' decision to use robot-advisor based platforms. Their results indicated that the need to free up time, higher risk tolerance, higher subjective financial knowledge, and higher amounts of investable assets were positively associated with individual investors' adoption of robot-advisors.

While majority of prior studies focuses either on determinants of electronic and mobile banking or the technical aspects of digital tools and services, very little is known about changes in personal financial behavior in relation to development of digital technologies (Carlsson et al., 2017; Gomber et al., 2018). While digitalization of financial services benefits customers in several ways, the fast transformation of financial environment brings challenges as well. Existing research show, for example, that loss of cash payments and pervasive digital financial management services make consumers less aware of their spending (Lewis & Perry, 2019; Yakoboski et al., 2018). This loss of tangibility is aligned with the long-standing literature starting from the 1980 s (Feinberg, 1986) suggesting that people paying with credit cards spend more freely than those using cash (for later evidence, see.g., Prelec & Simester, 2001; Roberts and Jones, 2001).

Another challenge lies on the abundance of data and the emergence of pattern recognition, data mining, machine learning, and other digital-sensing tools used in the financial services landscape (Gomber et al., 2018). Financial service providers can use these tools to combine

various sources of data (e.g., transactional and credit data, mobile phone data, social network data, browser data) for multiple purposes such as creating credit scores for borrowers or building highly targeted recommendations to customers (Campbell-Verduyn et al., 2017; Gabor & Brooks, 2017; Gomber et al., 2018). These issues raise concerns related to information and data security as well as customer privacy and vulnerability.

## 5.3 | Behavioral interventions

Behavioral economics integrates insights from neuroscience, psychology, and sociology into economics to better understand individual behavior and outcomes (Damgaard & Nielsen, 2017; Dolan et al., 2012). It explains why people do not always behave rationally. The financial literacy literature indicates that consumers make suboptimal decisions due to cognitive limitations, deficient knowledge, or psychological biases. Thus, there is a clear connection between concepts of financial literacy and behavioral economics (see e.g., Elliehausen, 2018).

There are two general paradigms for population-wide behavior change (Dolan et al., 2012). First, interventions that aim to change cognitions (e.g., attitudes and beliefs) by means of providing information or changing incentives to bring about behavioral change. We could, for example, provide more financial education at schools. Second, interventions aiming at contextual changes (e.g., environment or situation) to bring about behavioral changes by focusing on the more automatic processes of judgment and influence. Hence, the context approach focuses more on changing behavior without changing minds. We could, for example, provide people automatic saving systems via mobile banking applications (i.e., digital nudging).

The behavioral economics literature suggests that human behavior can be changed effectively by external interventions, or 'nudges', as well as by providing more information and education (Thaler & Sunstein, 2008; Wijland et al., 2016). Nudging refers to action in which we can deliberately design how information and choices are presented to individuals. Richard Thaler and Cass Sunstein (2008) introduced the concept of nudging and defined a nudge as "any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler & Sunstein, 2008, 6). The choice architecture is the context in which people make decisions including, for example, the order in which options are presented, how default options are chosen, and how information is provided (Damgaard & Nielsen, 2017; Münscher et al., 2016). The idea of choice architecture is that small changes in decision environment can influence individual decision-making and behavior while preserving freedom of choice (Benartzi, 2017; Münscher et al., 2016). Nudge-interventions do not limit individuals' autonomy but instead offer guidance and provide an opportunity to improve the ability to make informed decisions in complex social and economic contexts (Lembcke et al., 2019). One example of nudging is to place healthy food options at eye level in the cafeteria, thus making them easier to reach compared to unhealthy options (Thaler & Sunstein, 2008). Research on nudging shows that nudges can be targeted at three not necessarily exclusive goals: selfish goals of the nudger, such as own benefit or profit; pro-social / social goals (e.g., public welfare, gender equality, environmentally friendly behavior); and pro-self / nudge-driven goals, such as increasing physical activity (Lembcke et al., 2019; Mirsch et al., 2017). In practice, nudging is widely used in organizational processes and applications that aim to influence people's decision-making process and associated outcomes.

While there have been considerable successes with the application of nudging, there have also been relevant critiques that stress the limitations of the concept. Nudging does not

necessarily address the underlying causes of societal problems and it usually encompasses a top-down approach that reflects the priorities of technologists and policymakers rather than the citizens. As a result, it can marginalize lay experience and reduce the scope for self-directed behavioral change (e.g., Bhargava & Loewenstein, 2015; Ewert, 2020). Moreover, nudging can be especially problematic if applied by profit-seeking companies (rather than policymakers who focus on broader societal outcomes).

In recent years, the potential of nudging in digital environments has led to the notion of digital nudging. Elements of persuasive systems design such as visually attractive graphical interfaces and a vast amount of information in digital environments divert individuals' attention and can affect decision making (Lembcke et al., 2019). Compared to the analog world and physical world, digital environments offer numerous innovative tools and functions (e.g., filter options, recommender systems, tracking and targeting methods, and feedback tools) that facilitates the diffusion of digital nudging (Lembcke et al., 2019). Hence, in digital nudging, people's choices are influenced through algorithms and user-interface design, and hence, pushed into performing target behaviors (Lembcke et al., 2019; Mirsch et al., 2017).

Digital nudges are increasingly used in business to drive sales. Companies such as Amazon and other big technology companies are incorporating of everyday systems data-driven and personalized nudge marketing (Cai, 2020; Mirsch et al., 2017). For example, on the product pages, Amazon brings out product related items or similar products and draws customer's attention to them. As a result, this may trigger additional purchases that was originally not planned by the customer (Mirsch et al., 2017). Another example of using nudges on hotel booking where statements such as "eight people are looking this room right now" or "Booked 36 times today" are used to trigger the customer to accept the offer and shorten the purchase decision (Mirsch et al., 2017). In addition to using digital nudging for manipulating people's choices in digital environments, digital nudges are increasingly used to influence real-world behavior (Weinmann, Schneider and Brocke, 2016). For example, wearable technologies such as fitness watches, use digital nudges (e.g., giving feedback on activity, remind the user to exercise) to push people into increasing their activity level (Weinmann, Schneider and Brocke, 2016).

The deployment of digital nudging applications can be paradoxical as individuals' goals (and their best interest) may run counter companies' goals, and vice versa. While governments and companies increasingly use digital nudging to influence people's behavior in certain direction, ethical considerations of using nudge-interventions have gained less attention. Existing research raises three important ethical considerations for digital nudging: (1) preserving individuals' freedom of choice, (2) transparent disclosure of nudges, and (3) individual and societal justification of nudging (Lembcke et al., 2019).

Nowadays, many financial behaviors are performed in digital environment in which people's behavior can be influenced through digital nudging (Weinmann, Schneider and Brocke, 2016; Benartzi, 2017; Mirsch et al., 2017; Cai, 2020). Digital nudging could be used to improve financial literacy, to influence financial behavior, and to provide financial advice (e.g., Cai, 2020; French et al., 2020; Huebner et al., 2020; Li & Meyer-Cirkel, 2019). Financial service providers have products that successfully use intervention tools to alter customer behavior and to have an effect on financial capability (Dolan et al., 2012). These products include, for example, tools and services for helping customers to live within their means, keep track of one's finances, and encourage people to plan by saving up for different purposes. Some recent research has highlighted how smartphone apps can be a useful tool for improving financial literacy. French et al. (2020) demonstrated that participants who used the smartphone apps (e.g., a loan interest comparison app, an expenditure comparison app, a cash calendar app, and

a debt management app) were more likely to keep track of their income and expenditure, and thus, were more resilient when faced with a financial shock, than the control group. Another example is the study by Huebner et al. (2020) that shows how smartphone app use increases individuals' salience of credit card transactions and resulted reduced spending. Furthermore, prior research also show that text messages can be used as a nudging intervention in student loan repayment process (Johnson et al., 2020), and that financial literacy and portfolio management process can be promoted through digital platform (Li & Meyer-Cirkel, 2019).

In addition to studies focusing on benefits of financial nudging, some scholars offer a critique against influencing behavioral interventions in the context of financial practices (Gabor & Brooks, 2017; White, 2017). Individuals' personal data is combined to their behavioral data collected through digital profiling and then financial institutions and other service providers use this data for personal targeting, advertising, and (digital) nudging (Campbell-Verduyn et al., 2017). At the same time, not all individuals are aware that companies, governments, and financial institutions use digital profiling and digital nudging to alter customer behavior. White (2017) argues in his study that the use of nudging to help people make better choices in borrowing includes epistemic, ethical, and practical problems because financial service providers cannot know their customers interests.

Other problems related to nudging in financial market include, for instance, the use of complex algorithms (e.g., robot-advisors) as people cannot know how these robots are "trained" using machine learning, or the opportunity to use mass-personalization to nudge large numbers of people simultaneously (Cai, 2020). Additionally, financial institutions and governments collect individuals personal and behavioral data through different means (i.e., digital profiling) and then use the data not only to nudge them towards desired financial behavior but to govern and "'de-risk' individual consumers through constant monitoring" (Gabor & Brooks, 2017, 432). In addition to problematic governance and monitoring issues, this data collection also raises concerns of data security.

In sum, nudging can potentially be quite powerful, but there are certain challenges. These include the problems that influencing consumers is not transparent, nudging may leave little scope for personal development and learning, and it may involve digital profiling or data security issues. These in turn may induce more need for regulation, even though the advocates of nudging claim reduced need for regulation as an advantage of nudging.

## 6 | DISCUSSION AND CONCLUSIONS

Current literature shows that digitalization is affecting financial landscape in several ways. Digital innovations in the financial sector are transforming areas such as retail banking, investment, and payment services. Basic financial literacy gained at home and through formal education at school helps people with personal money management. However, ongoing digital transformation in financial landscape result changes in individuals' financial literacy and financial capability. While digitalization provides new financial services and tools as well as easy access to information and facilitates personal money management, it also creates several new risks that users should be aware of. The aim of the study was to explore how digitalization affects individuals' financial literacy and financial capability. As a result of the literature review, we found that the existing literature in the intersection of finance and digitalization focuses mainly on three themes (1) Fintech, (2) financial behavior in digital environments, and (3) behavioral interventions. Based on the results, we propose a framework that illustrates

digital financial literacy and capabilityby showing how the identified themes affect somewhat all elements (i.e., knowledge, skills, and tools) of traditional financial literacy and financial capability (Figure 2).

The first identified theme is Fintech, which focuses on changes in financial sector caused by digital transformation. New technological innovations continuously shape the financial landscape and result changes not only in the form of services (e.g., digital financial management services, digital money) but also the nature of services (e.g., loss of tangibility, technology pervasiveness). This, in turn, affects consumers' consumption patterns and personal money management. While digitalization offers new opportunities to act, people need additional skills and awareness to gather necessary information and ability to act in complex digital environments. For example, digital skills and awareness help consumers to gain access to financial tools and services and to be aware of various cyber risks as well as digital profiling and algorithm governance. Furthermore, people should understand the contradiction of digital environment, that is, while the use of digital tools is free and easy to use, at the same time the companies will gather users' personal information and use it for digital profiling. We must make sure that the technology cannot use that information against us.

The second theme, Financial behavior in digital environments, illustrates consumers ability to adapt their financial behavior according to innovative digital services and tools as well as novel courses of action in financial services landscape. Digital transformation affects consumers' everyday financial actions as digital money substitutes cash payments and personal services are replaced by online services and chatbots. Financial actions in dynamic digital environment require updated financial literacy and financial capability including understanding of new kind of risks related to compulsive consumer behavior in online contexts, such as loss of tangibility, impulsive shopping, easy access to loans and investments. At large, humans perceive value in algorithm-powered machines due to its performance gains. If the goals, we set for those machines are not clear and do not align to human goals it can lead us to a quite dangerous situation. While a segment of the population need improvement in digital skills, other segments (e.g., digital natives) need guidance into making better money decisions in this pervasive digital ecosystem we live in.

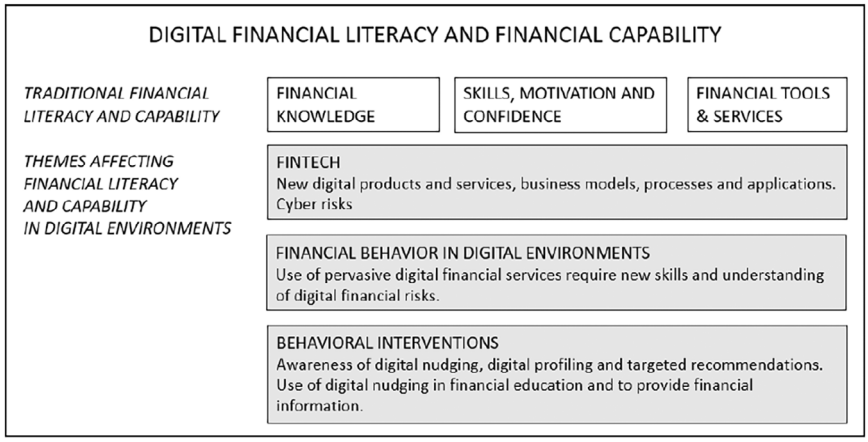


**FIGURE 2** A conceptual description of digital financial literacy and financial capability.

The third theme focuses on behavioral interventions. Digital nudging is increasingly used in business to drive sales, but it also has implications to finance and financial literacy. Digital nudging can be used to improve financial literacy, to influence financial behavior, and to provide financial advice. In that case, tools and services help people for example to keep track on their finances or encourage to saving up for different purposes. The use of digital tools may also lead into more long-lasting behavioral changes. On the other hand, in digital environments, consumers choices can be influenced through algorithms and user-interface design, and hence, pushed into performing desired behaviors. Consumers should be aware of these actions and their possible influence on their financial behaviors.

Based on the results of our study, we present recommendations for future research to incorporate digitalization into financial literacy and financial capability by focusing on four key areas: (1) updating financial literacy curriculum, (2) development of teaching and learning tools, (3) measurement of digital financial literacy and (4) collaboration between the regulators and private sector.

1. Updating financial literacy curriculum: Future studies should focus on what kind of new skills and awareness people need to complement traditional financial literacy as financial services are shifting from semi-digital environment to pure digital. As complexity of financial services environment will increase in the future we need to educate and protect consumers. It is vital to develop some basic understanding of cybersecurity practices and behaviors when accessing financial services and sensitive data. In addition, the constant availability and number of purchasing options may increase impulsive consumer behavior, which in turn can lead to over-indebtedness. Furthermore, there is a risk that a new digital divide may raise between people who understand the effects of pervasive technologies that drive digital nudging and people who are not fully aware of it. Digital finance literacy initiatives should not be limited to technology access and financial skills. It should be focused on understanding and evaluating the outcomes of an always-connected digital life.

There is also the question of when digital financial literacy should be taught. Financial literacy is increasingly taught at younger ages at schools or even preschool. Digital skills are also addressed in the modern school system. As both can be seen as essential "survival" skills in a modern society, there are clear complementarities of teaching them together, perhaps with the help of games or gamified methods. Financial literacy is increasingly seen as a topic that cuts across various school disciplines. The fast-changing digital financial environment also means that the skills need to be constantly updated. Individuals should have enough of a combination of both digital and financial literacy in order to be able to update their skillset as needed. In this context, digital innovations may provide a means to maintain and update financial literacy and capability as they provide just in time financial knowledge necessary for particular situations.

2. The development of teaching and learning digital tools for financial literacy: During the pandemic, more and more financial education materials have become available on the internet. These materials have been produced, at large, by financial institutions, central banks, and other government bodies, as well as non-profit organizations. The positive side of this is that now these materials have become very accessible and scalable to a substantial part of the population in most countries with high digital penetration. The challenge is that the people probably still need a lot of guidance and curation that the material can be best used. There is so much material in the net, that the choice of the material becomes an issue. While the

availability of the material enables self-study, consumers need a lot of autonomy and self-study skills in order to navigate in that abundance of the material. Again, the challenge is how to get people with low digital access and/or skills engaged in this process. The increasingly digital delivery of the teaching material threatens to marginalize some segments of the population.

3. Measurement of digital financial literacy: As noted above, the measurement of digital financial literacy has remained underdeveloped compared to the measurement of financial literacy or digital literacy. Interestingly, the measurement items for digital financial literacy are rather different than the standard financial literacy questions, the latter usually being multiple choice knowledge question. The focus on digital financial literacy in the literature has been very much on behaviors, which may be problematic due to the heterogeneity of consumers. What is an optimal behavior for one consumer may not be for another. Undertaking a certain behavior indicates that a person has the sufficient knowledge and skills to implement such behavior. However, executing a certain behavior also assumes an existing need to execute the behavior as well as the ability to access the necessary resources to accomplish it. For instance, a person would not trade stocks on online platform for a number of reasons. She might not have an interest in owning a stock, or she may perceive that she does not have the financial resources to do so. She might also have a preference towards other investment vehicles than stock. For that reason, not trading stocks on an online platform may not be taken as an indication for not being (digitally) financially illiterate. We suggest that the focus in the measurement of digital financial literacy should be oriented more towards knowledge and problem-solving abilities instead of measured behaviors. This would make the approach more consistent with both the current measurements of financial literacy and digital literacy. This could include multiple choice knowledge questions, or even performing simulated tasks.
4. Collaboration between the regulators and private sector: There is need for more research on how the public and private sector can together work for co-creating a fairer and more inclusive financial landscape. Nudging and financial tools could be used both for alluring consumers to spend more and to make faster decisions with less reflection, but they also could be used to make positive contributions to individual financial well-being. For instance, digital technologies could be used to broaden the range of options, access planning tools to support decision-making and assist with attaining specific financial goals. The regulatory authorities, such as the central banks and the financial supervision authorities, could also take a role in recommending certain types of tools or behavioral interventions – while at the same time being mindful of not promoting specific products, in order to maintain a level playing field for the private sector. At the same time, established financial organizations, especially banks, are concerned about their reputation, and can underline their social responsibility by providing financial literacy tools. In a situation where banks are all the time facing tougher competition from the fintech sector, promoting financial literacy is likely to become more important in signaling their social responsibility.

While this work contributes to research and practice of financial literacy, it also presents some limitations. The current study focused on papers published only in the fields of finance, economics, and information systems. Moreover, to enrich our dataset, it could be interesting to take into consideration selected international conference proceedings. As our analysis is focused on emerging technologies, conference proceedings could be a good source for new technologies that have not been yet addressed in the journal papers. We limited our investigation to papers that had their core on the intersection of finance and digital technologies. It would be

interesting to develop more holistic picture of digital financial literacy and financial capability. Future studies could focus on an analysis of conference proceedings. In addition, there are opportunities to develop further studies focusing in depth in each of the three key themes identified in this research.

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