UNIVERSITY OF GOTHENBURG

DEPARTMENT OF EDUCATION, COMMUNICATION & LEARNING

THE DESIGN OF A MOBILE APP TO PROMOTE YOUNG PEOPLE'S DIGITAL FINANCIAL LITERACY

Author

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Thesis:	30 higher education credits
Program and/or course:	International Master's Programme in IT & Learning
Level:	Second Cycle
Semester/year:	Autumn term 2020
Supervisor:	Thomas Hillman
Examiner:	Mona Lundin
Report no:	HT20-2920-001-PDA699

Abstract

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Purpose: With the popularity of Digital Financial Services (DFS), Digital Financial Literacy learning has been positioned as an essential ingredient for filling in people's knowledge gaps and achieving their lifelong financial well-being. Therefore, this capstone project developed a mobile app to promote people's digital financial literacy. As a pilot study, it specifically focused on content design and delivery design in accordance with the young generation's needs.

Theory: The author formulated a conceptual model of the app on the basis of Activity Theory (Engeström, 1987), which presents a holistic system of mobile learning with a set of elements (i.e. artifacts, subjects, and objectives). Beyond that, the notion of "digital nudges" (Caraban et al., 2019; Weinmann et al., 2016) was adopted in an effort to reduce users' cognitive overload and sustain their engagement throughout the entire learning journey.

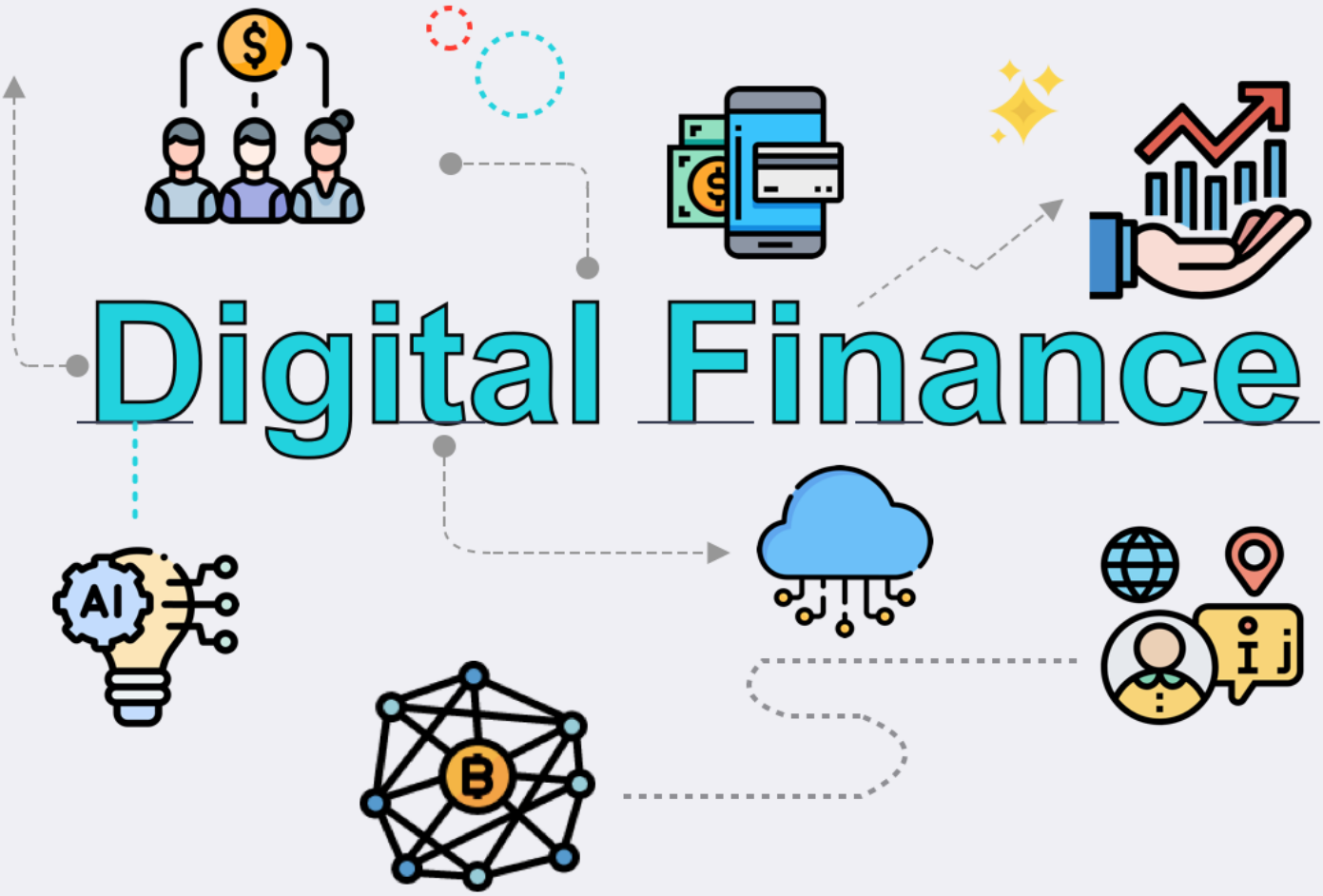
Method: This capstone project applied the methodology of Design Thinking (DT) to design the mobile app. It went through five phases: empathize, define, ideate, prototype and test.

Results: In the content design, this study found that it is necessary to develop tailored content from a demand-side, which involves elaborating on DFS jargon, practical strategies for appropriate DFS use, as well as risks and rewards of DFS. With the provision of these content, young people are more likely to make well-informed decisions, and enhance their overall level of digital financial literacy.

In the delivery design, the study discovered that cognitive overload is a demanding challenge for potential users. Particularly, DFS put an extra layer of complexity to people's cognitive processes. It requires us to think about a set of strategies to nudge users overcoming this challenge: 1) build on a good pedagogy to design the mobile learning for digital financial literacy initiatives; 2) exploit facilitator nudges to keep learning chunks small and easy-to understand; 3) incorporate spark nudges to enhance users' learning motivation; 4) embody signal nudges to navigate the entire learning journey; 5) add inquiry nudges to provide the scaffolding anywhere anytime.

The Design of a Mobile App to Promote Young People's Digital Financial Literacy

YI ZHANG



Foreword

Before embarking on the study at GU, I committed myself to a start-up project, launching an app for online investments. Unfortunately, our team couldn't nail it. Since then, it has always been hovering in my mind that I need to search for the answers to this failure.

I spent these two years refreshing my mind, learning new approaches, and embracing a new mindset. Time flies! It has come to the end of my learning journey at GU. To achieve a momentum that is meaningful to me, I decided to conduct a capstone project to deliver my master thesis. Through the project, I better understand the nature of design practices. "Design should be seen as a conversation with the situation and as experimentation where we as designers have to be good "listeners" and "readers" of the situation" (Löwgren & Stolterman, 2004, p. 23). The ongoing conversations make me revisit the knowledge and skills I have learned in the IT and Learning program. More importantly, it helps me reflect on the failure two years ago, where we focused too much on the competitive products in the marketplace, rather than the people we designed for. We tried to integrate all the features that seem to work. Not surprisingly, our product ended up with a feature-creep combination.

Looking back, I realized that I had been blessed to have so many great people surrounded me and make this project possible. My deepest gratitude goes to my supervisor Thomas Hillman for the time you devoted to supervising my project and providing valuable insights. I got tremendous inspiration from the supervision meetings with you. Thank you for encouraging me to keep going with each milestone of the project. Also, I would like to express my special thanks to the participants involved in the user research and user testing. Your insights shed light on this design project. Beyond that, I would like to thank every instructor I came across at GU. I am grateful for the courses you delivered. You inspire me to speculate the world through an academia lens. Last but not least, I would like to thank my family for supporting me to dedicate to what I am really into.

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Yi Zhang
Gothenburg, August 2020

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Acronym

AI: Artificial intelligence

CBDC: Central Bank Digital Currency

DFS: Digital Finance Services

DT: Design Thinking

G20: Group of Twenty

IFC: International Finance Corporation

IOSCO: International Organization of Securities Commissions

OECD: Organization for Economic Co-operation and Development

UI: User Interface

UN: United Nations

UX: User Experience

Chapter 1 Introduction

1.1 Background and Rationale

Digitalization is the greatest transformational force in this era. As technology innovation progresses, Digital Financial Services (DFS), which incorporates any financial operation using digital technology, has been a global upward trend (G20, 2017; OECD, 2018; WorldBank, 2020). Most recently, DFS have skyrocketed, fueled by a growing appreciation of its value for Financial Inclusion and by the low cost of technology for implementing it. Conventional Financial Institutions and start-ups are increasingly tapping into this innovation landscape. Accordingly, "the financial marketplace is much more complex for the average consumers. Consumers have more opportunities to manage their finances, but increased complexity makes them more vulnerable to financial fraud and more prone to unwise financial decisions" (IOSCO & OECD, 2018, p. 16).

It is the lack of sufficient information and knowledge about DFS that make people exhibit the vulnerability to potential DFS risks (G20, 2017). For this reason, it has become a sense of urgency to initiate programs and initiatives to promote people's digital financial literacy. Digital financial literacy learning has been positioned as an essential ingredient to fill in people's knowledge gaps and prepare for their lifelong financial well-being (G20, 2017; IOSCO & OECD, 2018; OECD, 2018).

Meanwhile, there has been a general consensus on using digital tools to deliver digital financial literacy learning, given that most DFS are delivered through digital means (e.g., mobile phones). That way, people would not only be familiar with the affordances of digital environments, but also get access to the learning in a ubiquitous manner. In particular, mobile phones might be a promising alternative due to its high penetration rate. According to the latest Ericsson Mobility Report (Ericsson, 2020), "the number of smartphone use is forecast to reach 7.5 billion in 2025". The increased access to smartphones would make mobile apps an attractive medium for delivering digital financial literacy learning and facilitate seamless learning support.

Despite the above consensus on delivery channels, there is still very limited practice focusing on the design of digital financial literacy learning. The exploration in this field is still at an early age. Current practices indicate that the vast majority of the available learning materials are developed from a supply-side, rather than a demand-side. Their content appears to be filled with jargon, resulting in people being overwhelmed by the sophisticated DFS concepts and features. The root cause is that they overlook the importance of presenting DFS information in an accessible and salient manner (G20, 2017). Therefore, substantial efforts are required to develop targeted literacy learning solutions catering to DFS consumers' needs. With the provision of DFS concepts and actionable guidance, people would be aware that "along with the new features of DFS market, it may also expose consumers to newer risks and threats, including notably the risk of fraud, misuse of personal financial data, digital profiling, cybercrime, etc.," (OECD, 2017, P.10).

Against this backdrop, this capstone project attempts to design a mobile app to promote users' digital financial literacy. The app serves as an educational tool to equip users with the fundamentals of DFS and actionable guidance about DFS safe use. It is also noted that this project, as a pilot study, considers young people as the intended users. The rationale behind this is that "many fintech companies have targeted younger generations that are used to digital, interactive, customized solutions" (Nicoletti, 2017, p. 20). Yet "young generations are more easily fall prey to personal bias

such as overconfidence in their own digital capabilities to manage DFS risks" (G20, 2017, p. 42). This urges scholars and practitioners to help this target group onboard digital financial literacy initiatives in a timely manner. What's more, with the insights drawn from pilot studies, we would be able to accumulate expertise in scaling up the initiatives for society at large.

1.2 Research Purpose

The overall purpose of this project is to design a mobile app to promote intended users' digital financial literacy. Specifically, it seeks to explore the content and delivery design of the learning, addressing the demand-side challenges. To that end, it employs the Design Thinking (DT) Methodology, which starts with the people designing for and ends with new solutions that are tailor-made to suit their needs (IDEO, 2020). Throughout the entire learning experience, users are expected to improve their awareness and understanding of DFS, increase their abilities to safer DFS use, and ultimately strengthen their trust in DFS. The objective of this study can be broken down into the following sub-goals:

- Target Group: Young People.
- Content: design learning experience with bite-sized content and flexible technologies, enabling users to be familiar with the fundamentals of DFS (i.e. jargon, terms, and principles); the potential benefits and risks of DFS; and the relevant DFS practical strategies.
- Delivery: design effective digital nudges to enhance users' engagement in digital financial literacy mobile learning, so that they could "develop a habit of lifelong learning to improve their digital financial literacy and financial well-being" (OECD, 2016, p. 26).

1.3 Research Questions

Given the objective of this capstone project, the research questions addressed in this thesis are formulated as follows:

- ***RQ1: What knowledge do young people need to promote their digital financial literacy?***
- ***RQ2: What should be considered when designing a mobile app to promote young people's digital financial literacy?***

1.4 Thesis Outline

The thesis is organized as follows: First, the introduction of this capstone project is presented, identifying the background and rationale, research purpose, and research questions. Then it follows a review of previous literature and a description of the methods used in this project. After that, it provides an elaboration on the design procedures this project went through (i.e. five phases of DT: empathize, define, ideate, prototype, and test). Finally, the main findings and reflections are discussed, together with the suggestions for future research based on the limitations of this study.

Chapter 2 Literature Review

2.1 The Rise of Digital Finance Services

2.1.1 The innovations in finance sectors: Digital Finance Services

Today, fast-evolving technologies have transformed the traditional ways of doing things across sectors of society. In the case of the Financial sector, the advent of Artificial Intelligence, Blockchain, Cloud Computing, and Data Analytics has been gearing the entire industry towards digitalization. Digital Financial Services (DFS), which incorporates any financial operation using digital technology, has been a global upward trend (G20, 2017; OECD, 2018; WorldBank, 2020). Policymakers globally thus are keen to explore the landscape of DFS innovations.

As EU (2020, p. 1) defined, "Digital Financial Services include a variety of products, applications, processes and business models that have transformed the traditional way of providing banking and financial services." Such disruptive innovation evolves people's interactions with the financial sector. They expand the delivery of basic financial services to massive people through digital technologies, while lowering costs and entry thresholds to universal access (G20, 2016; OECD, 2018). Beyond that, DFS seek to unleash its potential for diversified alternative finance to meet individuals' financial needs (Nicoletti, 2017; WorldBank, 2020).

Bearing in mind the benefits it enables, DFS has been acknowledged as a promising way to achieve Financial Inclusion. "By increasing access to the innovative, low-cost financial tools and applications, digital financial services open up new opportunities for improving overall levels of financial inclusion" (G20, 2017, p. 8).

2.1.2 The potential risks of Digital Finance Services

Technologies can both aid and impede the overarching goal of financial inclusion. More and more stakeholders in the field stressed that DFS entails associated risks. For instance, G20 (2017, p. 10) emphasized that "along with the new features of the DFS market, it may expose consumers to newer risks and threats, including notably the risk of fraud, misuse of personal financial data, digital profiling, cybercrime, etc." Similarly, OECD (2018) divided DFS risks into three categories based on the underlying causes: market-driven risks, regulation-driven risks, and consumer-driven risks. First, market-driven risks include new types of fraud, mis-selling, and other questionable digital market practices that reinforce behavioral biases, etc.; Second, regulation-driven risks include inadequate disclosure, unfair customer treatment, lack of transparency, etc.; Third, consumer-driven risks refer to increased access and use of DFS coupled with low financial and digital literacy.

Excessive exposure to these potential risks might prevent people from trying even considering the use of DFS. For instance, young people, who are comparatively tech-savvy, still perceive themselves as vulnerable when facing the complexity of DFS. We could imagine if not addressed appropriately, these issues would induce people to lose confidence and trust in the financial system and technological innovation (OECD, 2018; UN, 2019). Ultimately, the potential of DFS as drivers of financial inclusion might be compromised. In this light, policymakers have dedicated to looking into solutions to overcome such a growing challenge. The main focus is a sound consumer protection approach that strive for building trust and confidence in the acquisition and sustainable use of DFS (G20, 2017; OECD, 2018; WorldBank, 2017).

2.2 The Significance of Digital Financial Literacy

2.2.1 Financial literacy to achieve financial inclusion

To achieve Financial Inclusion, we need the presence of both supply-side and demand-side. That means well-functioning financial markets require not only good infrastructure but also informed customers (WorldBank, 2017). With this understanding, spotlights are gradually shifting towards the demand-side role, in parallel with the development of infrastructures. There has been a growing awareness that the degree of financial literacy makes a difference for financial inclusion. Informed customers who possess a high level of financial literacy are more likely to make better financial decisions, thus supporting the development of the financial system (Grohmann et al., 2018). Conversely, consumers with limited financial literacy would feel overwhelmed when dealing with financial services. Even worse, the low financial literacy would make them more vulnerable to frauds and scams, resulting in undermining their trust in the entire financial system.

Hence, policymakers (G20, 2016; OECD, 2018; WorldBank, 2017) advised the economics around the world that financial literacy and awareness is an essential pillar of achieving Financial Inclusion. The key message they are trying to convey is that people must cultivate a critical thinking mindset when dealing with a variety of financial services/products. As the term Critical indicates, "the ability to judge" (Luke, 2012, p. 5) is at the core of this mindset. People need to "be confident to make own assessment of risks without being unduly influenced by marketing or news items" (OECD, 2016, p. 23), as well as "be confident to make a judgement on the level of services and protection provided by a financial service provider" (OECD, 2016, p. 25).

2.2.2 A shift from financial literacy to Digital Financial Literacy

Among the existing literature, there are two schools of thought on how to enhance people's financial literacy. One mainstream considers the acquisition of financial knowledge as an important variable. Scholars in this stream contended that financial literacy is the ability to acquire sufficient information about financial concepts and instruments in order to make informed financial decisions (Asaad, 2015; Lusardi & Mitchell, 2014). Adequately equipped with the necessary knowledge, people would be able to make their own judgements on financial offerings. On the other hand, some scholars emphasized that financial knowledge is not a sufficient condition for ensuring that individuals are able to make rational financial decisions (Drew & Cross, 2013; Estelami, 2009; Guest & Brimble, 2018). For instance, Estelami (2009) asserted that suboptimal patterns of financial decision-making exhibited by people often result from their limitations of cognitive abilities. This finding is supported by numerous behavioral finance studies, which claimed that investors are 'predictably irrational' to make financial decisions due to various kinds of behavioral biases. In a similar vein, Drew and Cross (2013) argued that the effectiveness of financial literacy initiatives may be much more about awareness of fraud tactics than about financial knowledge. It aligned with the statement that "literacy learners should be actors rather than spectators in the world" (Lee, 2020, p. 80). With the awareness of biases and fraud tactics, the underprivileged consumers would ultimately improve their competence to question financial offerings too good to be true, and take actions to change their status quo.

Most recently, the rise of DFS adds another layer of complexity. A variety of financial services are offered through mobile phones or other digital devices. Accordingly, financial literacy is required to explore in a novel context, namely a digital financial environment where rapid innovation in technology is undergoing and where the volume, velocity, and variety of personal data processed increases both consumer access and risks (G20, 2017).

Against this backdrop, the leading authority OECD (2016) expanded the scope of Financial Literacy Framework, incorporating more DFS-related content. They pointed out that informed DFS consumers should: be aware of the cutting-edge products and services in the financial markets, especially those delivered through digital means; be confident to make a sound decision about using a traditional or new type of financial product or service; be able to mitigate the cybersecurity risks when using online platforms for investing (e.g., suspicious URL, platform not regulated, and data security). All these call for an evolving financial literacy, which enable people to make judgements on the state-of-the-art DFS offerings.

2.3 Current Practices in Digital Financial Literacy

2.3.1 The demand-side challenge

Policymakers including WorldBank, OECD, and G20 have stated that financial education is an essential ingredient to promote people's financial literacy. Especially as the technologies continue to evolve, DFS products are becoming increasingly sophisticated and diverse. The overall lack of digital financial literacy would lead to a high degree of information asymmetry between consumers and DFS providers (AFI, 2020; G20, 2017; UN, 2019). This is consistent with the results in the International Survey of Adult Financial Literacy Competencies (OECD/INFE, 2016). As the survey suggested, "inadequate information and insufficient knowledge about DFS is a major source of vulnerability leading to consumer protection risks" (P.38). Yet current practices overlook this demand-side challenge. The vast majority of programs and initiatives are developed from a supply-side (G20, 2016), failing to elaborate on DFS concepts in a simple and straightforword way. Therefore, substantial efforts are required to formulate targeted solutions to nudge consumers into enhancing their digital financial literacy.

In this sense, OECD's definition of financial education provides us some insights. "Financial education is the process by which through information, instruction and/or objective advice, potential and existing investors improve their understanding of investment products, concepts and risks and develop the skills and confidence to become more aware of investment risks and opportunities, to make informed choices, to know where to go to seek advice, and to take other effective actions to improve their long-term financial well-being" (OECD, 2005, p. 4). It hints at a comprehensive and holistic vision to address the demand-side challenge.

2.3.2 A consensus on the delivery of digital financial literacy learning

Despite the limited effectiveness of current practices, more and more policymakers advocated the use of digital tools to deliver digital financial literacy learning. Their reasons for this consensus are as follows: First, digital tools can make people familiar with the affordances of digital environments (G20, 2017; UN, 2019). Gradually, people would feel comfortable when using DFS products. Second, digital tools with interactive features have the potential to provide users with engaging learning experiences (G20, 2017; OECD, 2019). Third, digital tools are capable of facilitating people's learning in a timely manner (IOSCO & OECD, 2018; OECD, 2019). Fourth, digital tools are featured by agile nature, making learning content easier to iterate and adapt to the evolving DFS innovations (OECD, 2019).

2.4 A Promising Alternative: Mobile Learning

2.4.1 Using mobile learning to promote digital financial literacy

Among a variety of digital tools, mobile phone might be a promising alternative to deliver digital financial literacy learning, due to its massive user base. According to the latest Ericsson's Mobility Report (Ericsson, 2020, p. 11), "Smartphone penetration continues to rise. The number of smartphone use is forecast to reach 7.5 billion in 2025". In terms of age distribution, young people account for a large proportion of the entire user base. Taking European Union (EU) as an example, 83 % of young adults in EU use mobile phones on a daily basis, accessing the internet, social media, services, etc., (EU, 2016).

The growing penetration of smartphones has led to the popularity of mobile learning. As noted in the latest statistics, apps for educational purposes experienced an increase in usage of 20%, as well as a net new user growth of 8% (Ericsson, 2020). We have witnessed an increased awareness of mobile learning, which is "driven by personal curiosity, chance encounters and the stimulus of the environment, where mobile devices can provide ready-to-hand access to information and communication, or record learning experiences for future review" (Kukulska-Hulme & Traxler, 2019, p. 190). This fits for the use case scenario of digital financial literacy learning. As most DFS are delivered through mobile technologies (e.g., mobile payment, digital transactions, etc.,), there is a high likelihood that people's curiosity and stimulus might be invoked in mobile settings. If the learning can take place at these ad hoc moments in mobile settings, people would be more inclined to engage in the learning and ultimately enhance their digital financial literacy.

2.4.2 The affordances of mobile learning

A first step in designing mobile learning is to speculate its affordances as a modality in the digital age (Sharples et al., 2005). First of all, mobile learning offers a ubiquitous learning environment, where people exploit mobile technologies to support learning activities anywhere, anytime (Brown & Mbati, 2015; Kukulska-Hulme & Traxler, 2019; Martin & Ertzberger, 2013; Sharples et al., 2005). This is an obvious, yet essential characteristic of mobile learning (Sharples et al., 2005). It facilitates learners with seamless access to learning content (Brown & Mbati, 2015). Accordingly, mobile learning is becoming a HERE and NOW learning, bringing in the relevant information and knowledge to learners' timely request (Martin & Ertzberger, 2013). Aligned with this view, Kukulska-Hulme and Traxler (2019) further posited that mobile learning is characterized by situated and authentic. The learning activities tend to take place in practice-based settings, supporting context-specific and immediate situated learning.

In addition, mobile learning is personalized and informal (Kukulska-Hulme & Traxler, 2019; Martin & Ertzberger, 2013; Sharples et al., 2005; Yau & Joy, 2007). It is personalized in the sense that mobile learning empowers learners to engage in their own learning, from their own settings, and by their own preferences (Kukulska-Hulme & Traxler, 2019; Yau & Joy, 2007). Meanwhile, it is informal in the sense that learners move from topic to topic, devoting time and efforts to small learning chunks, rather than following a defined curriculum (Martin & Ertzberger, 2013).

As Koole and Ally (2006, p. 6) put it, "the major advantages of mobile learning include greater access to appropriate and timely information, reduced cognitive load during learning tasks, and increased interaction with systems and other people". Keeping this in mind, we would be more likely to exploit the affordances of mobile learning to design the fit-for-purpose educational tools in the digital age.

2.4.3 Relevant design approaches for mobile learning

- **Understanding mobile learning: Activity Theory**

When designing mobile learning, it is vital to follow a good pedagogy as an analytic approach (Koole & Ally, 2006). In that spirit, more and more scholars have advocated adopting Activity Theory to explore mobile learning (Jalil et al., 2015; Koole & Ally, 2006; Sharples et al., 2005), which defined learning activities as the central unit of analysis (Engeström, 1987). Specifically, a learning activity entails "a specific interaction of learner(s) with other(s) using specific tools and resources, orientated towards specific outcomes" (Beetham, 2019, p. 34). This theory has profound implications for designing a holistic system of mobile learning, since it identified the key dimensions that we need to look into. That is, the learners' (i.e. subjects) type and need, the affordances of mobile artifacts (i.e. tools), and the outcome we thrive for (i.e. learning objective). Ultimately, the final deliverable would be learning as an engagement with technology, "in which mobile phones function as interactive agents in the process of coming to know, creating a human-technology system to communicate, to mediate agreements between learners and to aid recall and reflection" (Sharples et al., 2005, p. 7).

- **Specific design approach: Micro-learning**

Designers must formulate display strategies that help learners process learning materials in a productive manner. Unlike other settings, mobile learning tends to adopt a micro-learning approach, which divides the materials into small chunks (Elias, 2011; Koole & Ally, 2006). This is due to the following facts: the small screens on mobile phones appear to limit the capacity that can be displayed (Elias, 2011; Koole & Ally, 2006); Learners might feel overwhelmed when the content is delivered in large blocks (IOSCO & OECD, 2018); The participants of mobile learning tend to allocate small amounts of time to learning, and they usually learn on the move (Martin & Ertzberger, 2013; Yau & Joy, 2007).

These insights help us better understand how to design an appropriate mobile learning with micro-content. We need to keep in mind that the design should be featured by "relatively short efforts and low degrees of time consumption, relatively small items or units and rather narrow topics, and relatively episodic knowledge nuggets" (Hug & Friesen, 2009, p. 4).

- **Specific design approach: Digital Nudges**

In a ubiquitous learning environment, people come across a wealth of information, along with distractions and mind wandering. As a result, their ability to process the information might be hindered, increasing stress and anxiety to make sound decisions. As Palalas (2018, p. 19) pointed out, "Cognitive load, which has been identified as a key issue in successful instructional design, is yet another aspect that is impacted by the content, delivery, and setting of mobile learning".

Moreover, the financial marketplace is rather complicated for the average consumer, due to the evolving technology and sophisticated products (G20, 2017; OECD, 2019). This adds an extra layer of complexity for people's working memory capacity, which means people can only "hold in mind, attend, or maintain a small amount of information in a rapidly accessible state at one time" (Cowan, 2016, p. 1). As such, designers need to figure out a set of effective strategies to promote users' learning and engagement in mobile settings.

With this regard, the notion of "digital nudging" (Weinmann et al., 2016, p. 433) shed light on our exploration. It refers to "the use of user-interface design elements to guide people's behavior in digital choice environments" (Weinmann et al., 2016, p. 433). The key message it conveys is that how the

information is presented can exert a subtle influence on the outcomes. Even simple modification would nudge users into behaving in particular ways. Hence, Caraban et al. (2019) summarized 23 mechanisms of digital nudging, and further clustered them into three overall categories: facilitator nudges, spark nudges, and signal nudges. Facilitator nudges apply the rule of thumb to present the information in a simple and straightforward way, so that people can tackle the complexity in an efficient way; Spark nudges are designed to incorporate the motivational elements in the digital environment; Signal nudges aim to provide the ongoing reinforcements for user engagement, such as feedback, just-in-time promotes, etc.

2.4.4 More room for mobile learning design to promote digital financial literacy

After walking through previous literature, it is clear that mobile learning can be a promising alternative for digital financial literacy initiatives. In a mobile setting, learners would be able to benefit from the ubiquitous presence of DFS knowledge and ultimately develop a habit of lifelong learning to achieve financial well-being.

Yet the efforts made in designing such learning are still at an early stage. More studies are needed to formulate the content strategies and delivery strategies to translate DFS knowledge into enhanced digital financial literacy and well-informed financial decisions. Specifically, the relevant mobile learning design approaches haven't been extensively explored in the context of digital financial literacy initiatives. Built on the findings delivered in such studies, we would be able to flesh out a set of applicable plans in an effort to scale up the initiatives for the society at large.

Chapter 3 Methodology

3.1 Research Approach: Design Thinking

This project applied the methodology of Design Thinking (DT) to design a mobile app, which strives for promoting users' digital financial literacy. The rationale is as follows:

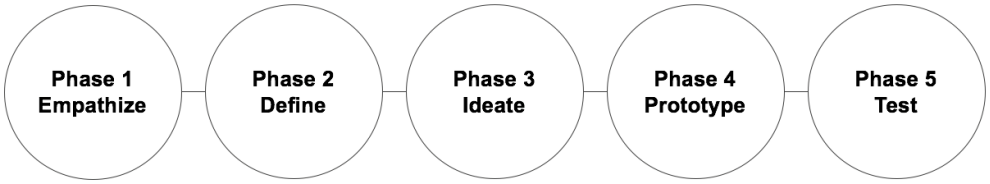
First, DT methodology, at its core, is constructed as a creative problem-solving approach (Luchs et al., 2016). "It draws from the designers' toolkit to integrates the needs of people, the possibilities of technology, and the requirements of success" (IDEO, 2020). This methodology provides us a systematic view to come up with a tailored mobile learning solution to promote young people's digital financial literacy. Within the DT framework, designers could capture users' learning needs, generate a broad set of design ideas, and flesh out ideas through rapid prototyping in order to test users' acceptances.

Second, human-centered design is the hallmark of DT methodology (Norman, 2013). "It ensures that people's needs are met, that the resulting product is understandable and usable, that it accomplishes the desired tasks, and that the experience of use is positive and enjoyable" (Norman, 2013, p. 10). This is in line with the learner-centered instructional design, which articulates that the focal points of learning activities are learners and their performances (Reiser & Dempsey, 2018). They both endeavor to ensure that design solutions fit human desires, needs, and capabilities. As such, we are now seeing a growing trend to employ DT methodology in the practices of instructional design.

3.2 Research Design

This capstone project adopted the five-phases process of DT (Stanford, 2010), which includes empathy (data collection based on user research), defining (data synthesis to frame the problem statements), ideation (generating design ideas), prototyping (developing a tangible solution), and testing (with potential users). Table 1 outlines the overall research design of this capstone project. The total time involved for designing the app was 17 weeks. The detailed time frame is presented in Appendix A.

Table 1 The overall research design



Phases	Empathize	Define	Ideate	Prototype	Test
Description	data collection based on user research	data synthesis to frame the problem statements	suggest ideas for solving the problem	develop tangible and experienceable representations of the ideas	test with the potential users
Methods	Questionnaire	Content analysis	Card sorting	Prototyping	Questionnaire; Think-aloud sessions; Semi-structured interviews
Output	User survey results	Persona; Problem Statements	Conceptual Model	High-fidelity Prototype	User Testing Results
Time Duration	4 weeks	1 week	2 week	5 weeks	5 weeks

- **Phase 1: Empathize.** Empathy plays a critical role in "keeping designers from falling into a common design pitfall-designing for oneself" (Luchs et al., 2016, p. 27). It requires capturing the key attributes of intended users, so that we could identify their needs and unfulfilled requirements. Therefore, this project conducted a user research in the initial empathy phase. The variables relating to digital financial literacy learning were transferred into an online survey. The outcome of this phase was the quantitative data collected in the survey that revealed the potential users' mobile learning requirements for digital financial literacy promotion.

- **Phase 2: Define.** It involved thorough data analysis and synthesis in defining the problem regarding the use of mobile learning to promote users' digital financial literacy. Specifically, the textual material was clustered into two categories relating to the RQs: *content design and delivery design*. The outcomes of this phase were persona and problem statements. Persona "allows designers to maintain focus on the ideal user as they explore and develop solutions" (Luchs et al., 2016, p. 27). Meanwhile, problem statements make the design tasks at hand less ambiguous and drive the design process forward (IDEO, 2020).

- **Phase 3: Ideate.** This phase calls for divergent thinking based on persona and problem statements. A list of "How-might-we…" responses was generated in the light of literature and subject matter experts' suggestions (Instructional design/Finance). After that, a broad set of design ideas were further converged into the most viable option in the form of a conceptual model. It served as a holistic system of mobile learning for digital financial literacy promotion, integrating three main elements (i.e. the affordances of mobile learning, digital financial literacy content object, and the learners' characteristics) into the model.

- **Phase 4: Prototype.** With the conceptual model, this project moved forward to the detailed design phase. A high-fidelity prototype was created to "allow potential users to interact with it and to explore its suitability" (Sharp et al., 2019, p. 394). It functions as a tangible solution, which includes authentic UI design, information architecture and, clickable interactivity. The main idea was to simulate the possible user experience so that users would be able to envision the final product and give meaningful feedback.

- **Phase 5: Test.** The primary task in this phase is to collect user feedback on the developed prototype. To achieve this, I employed a mixed method to run the user testing. Specifically, I conducted a user satisfaction questionnaire, 3 think-aloud sessions, and 3 semi-structured interviews. The metrics for evaluating the content design and delivery design of the app were measured in the testing. The testing results were analyzed and lead to further iterations.

3.3 Research Methods

3.3.1 Data Collection Methods

Throughout the entire DT process, data collection is "a central part of discovering requirements and evaluation" (Sharp et al., 2019, p. 375). Within the empathy phase, data collection is conducted to capture users' needs, motivation for usage, and current challenges, etc. Likewise, in the testing phase, data collection obtains user feedback to measure the usability and acceptability of the developed prototype.

To yield relevant data, I employed convenience sampling and snowball sampling to recruit the participants through my personal network. In total, 38 people responded to the initial user survey and 10 people participated in the follow-up user testing. All of them are young adults between the ages of 20 and 35. The following data collection methods were specifically adopted in order to obtain valuable user insights.

- **Questionnaires**

"The questionnaire is a widely used and useful instrument for collecting survey information, providing structured, often numerical data, being able to be administered without the presence of the researcher, and often being comparatively straightforward to analyze" (Cohen et al., 2007, p. 317). Thus, a standardized questionnaire is an appropriate method to develop a general understanding of the user needs and user feedback. To be specific, this project launched two online surveys. One was a user survey conducted in the empathy phase (see Appendix B). The variables, such as participants' demographic information, current level of digital financial literacy, and digital financial literacy learning requirements, were translated into the questionnaire. The other was a user satisfaction questionnaire in the testing phase (see Appendix C). It was used to measure how the potential users perceive the usefulness/ease of use/ease of learning/satisfaction of the prototype.

- **Think-aloud Technique**

Think-aloud is "a data collection technique for UX evaluation where participants are prompted to verbalize their thoughts and plans as they interact with a design prototype or system" (Hartson & Pyla, 2019, p. 37). In this project, I held three think-aloud sessions via ZOOM, inviting the participants (N=10) to try out the prototype and express their thoughts about their experience.
A series of benchmark tasks were designed to observe how users interact with the prototype. The main idea was to assess users' perceptions of appealing features, UX problems, and unfulfilled requirements, etc.

- **Semi-structured interviews**

Within the evaluation, this project adopted semi-structured interviews to probe the participants' thoughts about the prototype in depth. "Semi-structured interviews combine features of structured and unstructured interviews and use both closed and open questions" (Sharp et al., 2019, p. 254). The interviews are close in the sense that they start with the preplanned questions. Meanwhile, they are open in the sense that the participants are allowed to bring up new ideas relevant to the topics (Hartson & Pyla, 2019; Luchs et al., 2016; Sharp et al., 2019). Its application to this project was to promote the discussion relevant to the users' perception on what they liked and didn't like the prototype.

3.3.2 Data Analysis Methods

- **Content analysis**

After the collection of raw data, content analysis is deployed to "classify the data into themes or categories and then studying the frequency of category occurrences" (Krippendorff, 2013). Specifically, it involves organizing the interview transcripts into categories related to the central research questions (Babbie, 2015; Bowen, 2009). Applied to this project, I clustered the data into two themes: *content design and delivery design*. The qualitative data relating to *content design* were exploited to address the research question "what knowledge do young people need to promote their digital financial literacy". Meanwhile, the information relating to *delivery design* were analyzed to

address the research question “what should be considered when designing a mobile app to promote young people’s digital financial literacy”.

3.3.3 Idea Generation Methods

- **Card sorting Technique**

Within the user survey, there was an open-ended question asking the participants to brainstorm a must-have feature of the app to help them learn the fundamentals of DFS. The responses were summarized on the post-its and further categorized by the card sorting method. According to Hartson and Pyla (2019, p. 155), card sorting is a technique “used to organize sets of data items (e.g., ideas, concepts, features) into a hierarchy of categories, each grouped by a common theme”. Therefore, I clustered the participants’ responses into the relevant category label (i.e. content, delivery), and then made sense of them to generate design ideas. The structured data processed by this method worked as the valuable inputs to drive the ideation phase.

- **Prototyping**

“Prototyping provides a concrete manifestation of an idea, which allows designers to communicate their ideas and users to try them out” (Sharp et al., 2019, p. 394). The goal is to “build to learn” (Kelley et al., 2001), encouraging designers to revisit user needs, test technical feasibility, and discover acceptances of the proposed features. To that end, I created a high-fidelity prototype as a tangible solution to mimic the envisioned uses and generate multiple valuable user feedback. More reflections would be sparked by using this method, and more new ideas would be inspired as well.

3.4 Ethical Considerations

Ethical considerations urge researchers to conduct studies in a responsible manner. A key dimension “concerns questions of how people who participate in research as subjects or informants can be treated” (Vetenskapsrådet, 2017, p. 12). Therefore, this project consistently adhered to the norms of voluntary participation, anonymity and confidentiality to collect the participants’ data. Specifically, voluntary participation ensures that the respondents/interviewees participated in the user survey and user testing voluntarily. Anonymity and confidentiality guarantee that “neither the researchers nor the readers of the findings can identify a given response with a given respondent” (Babbie, 2015, p. 35). The participants’ identities were protected in a respectful and responsible way during the user survey, think-aloud sessions and semi-structure interviews. “No harm to the participants”(Babbie, 2015, p. 30) were treated as a ground rule to implement the research.

Chapter 4 Design Procedures

4.1 Phase 1: Empathize

"Empathy is the centerpiece of a human-centered design process" (Stanford, 2010, p. 1). It is an effort to approach potential users in order to understand their interests, motives, and real needs. Therefore, this project conducted a user survey as a starting point to capture the users' needs, and the challenges in enhancing their digital financial literacy. The questionnaire (see Appendix B) was implemented on the SurveyMonkey platform (www.surveymonkey.com). Convenience sampling and snowball sampling were adopted to distribute the questionnaire through my personal network. Convenience sampling "involves choosing the nearest individuals to serve as respondents" (Cohen et al., 2007, p. 113) while snowball sampling indicates the participants were asked to suggest additional people for taking the survey (Babbie, 2015). After publishing the survey for 2 weeks, I received 38 responses in total. The total time duration of this phase was 4 weeks. The collected data, as the original user insights, would further feed into the following design process.

4.1.1 The description of the participants

- **Demographic information**

Figure 1 reported the demographic profiles of the participants. Most of them are young adults between the ages of 20 and 35, using DFS on a regular basis. Among them, 50% have an IT-related background, which indicated their tendency to accept DFS, even engage in DFS. As Table 2 showed, 47.37% of the participants make the investments through DFS channels on their own. Based on these data, we could acknowledge that this user survey sample reflected the views of young adults who are the main target users of DFS.

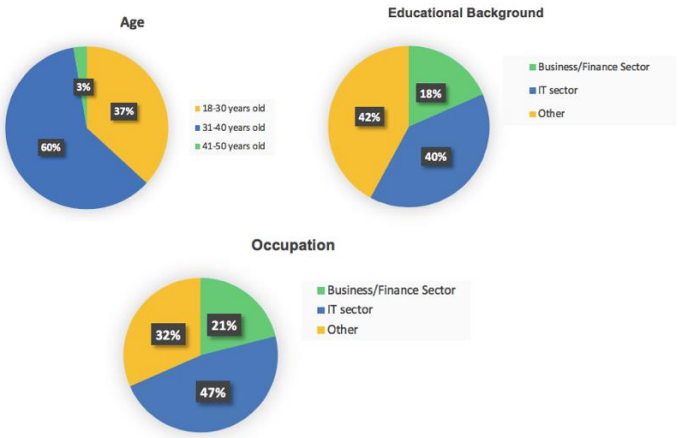


Figure 1 The demographic information of the participants

Table 2 DFS experience of the participants

Variable	Items	Percentage
Digital Finance service Usage	use digital finance services very often	94.74%
	prefer traditional financial services	5.26%
Investing Experience	have no experience in investing	23.68%
	make the investments with the aid of brokers/investment advisors	28.95%
	make the investments on their own	47.37%

- **Financial literacy and risk awareness**

As Figure 2 suggested, the participants have a basic level of financial literacy. A clear majority of respondents realized that the risk-return tradeoff (92%), and the diversification of investments to reduce risk (81%). However, the participants felt confused when handling personal digital keys and information asymmetry. Only 18% were confident about how to protect the personal keys, digital wallets, and other access information relating to DFS against fraud or theft (Figure 3). The situation was even worse when it comes to information asymmetry. Only 5% perceived that they fully understand the prices, or terms and conditions of DFS, before putting them into use. Taken together, we could sense that the participants who are financially literate still felt overwhelmed in the face of DFS risks and information asymmetry.

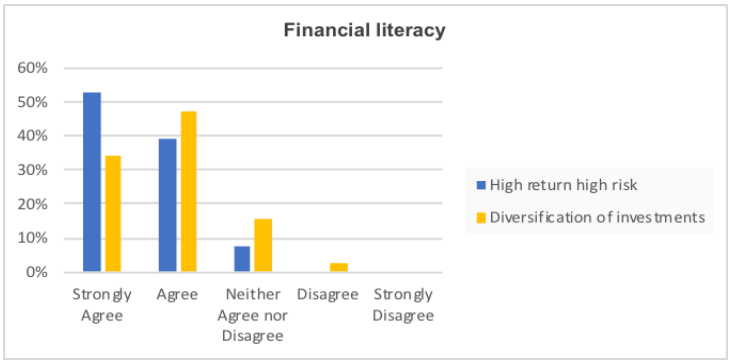


Figure 2 The participants' financial literacy

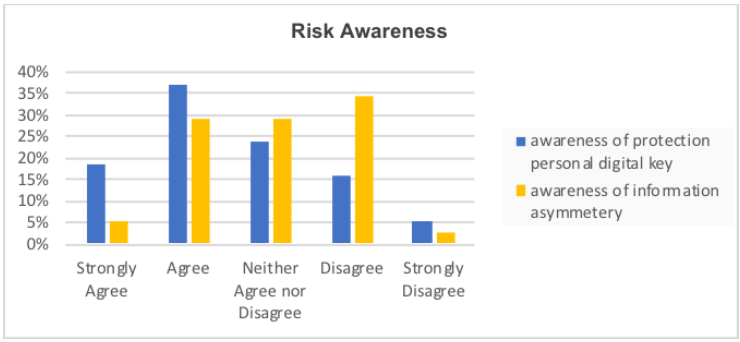


Figure 3 The participants' risk awareness

4.1.2 The participants' digital financial literacy

- **The knowledge of DFS jargon**

In the second section, the survey investigated the variables relating to digital financial literacy. First of all, jargon as the building blocks of digital financial literacy were tested. The participants were asked to rank DFS jargon based on the familiarity with them. As Figure 4 showed, *mobile banking* (100%) ranked first place, followed by *cryptocurrencies* (82%) and *digital wallets* (79%). Consistent with this finding, *mobile banking* and *digital wallet* were perceived as the jargon easy-to-understand, while *blockchain*, *cryptocurrencies*, *crowdfunding*, and *P2P lending* were perceived as the ones difficult-to-understand (see Table 3). This might attribute to the popularity of mobile banking and digital payments. People recently tend to get more opportunities to interact with these DFS, which leads to a good foundation for understanding the relevant concepts and features.

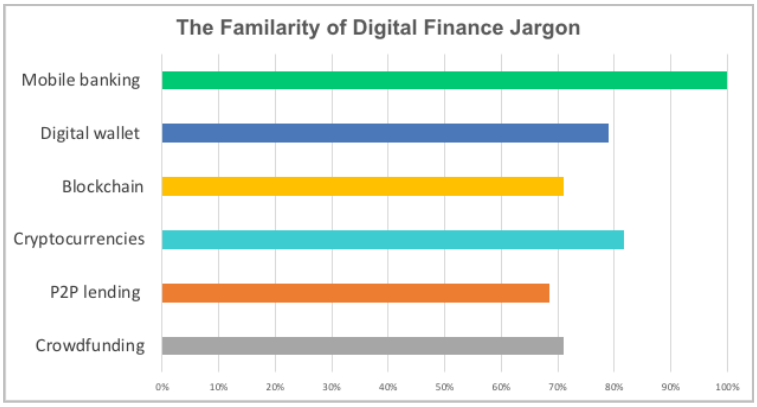


Figure 4 The familiarity of DFS jargon

Table 3 The knowledge gap in DFS jargon

	EASY	EITHER EASY OR DIFFICULT	DIFFICULT	TOTAL
Mobile banking	81.58% 31	15.79% 6	2.63% 1	38
Digital wallet	71.43% 25	20.00% 7	8.57% 3	35
Blockchain	14.71% 5	44.12% 15	41.18% 14	34
Cryptocurrencies	35.29% 12	38.24% 13	26.47% 9	34
P2P lending	50.00% 17	38.24% 13	11.76% 4	34
Crowdfunding	58.82% 20	23.53% 8	17.65% 6	34

- **The current learning resources**

Apart from the jargon, this survey also investigated the channels where the participants get DFS information. It indicated that online information (60%) was a major source, which supported the use of digital tools to deliver digital financial literacy learning (see Figure 5). However, the effectiveness of currently available DFS learning resources was less than satisfactory. As illustrated in Table 4, less than 50% of the respondents perceived the information relating to *blockchain*, *cryptocurrencies*, *P2P lending* and *crowdfunding* were useful. The situation didn't improve when it comes to *mobile banking* (65.79%) and *digital wallet* (54.29%).

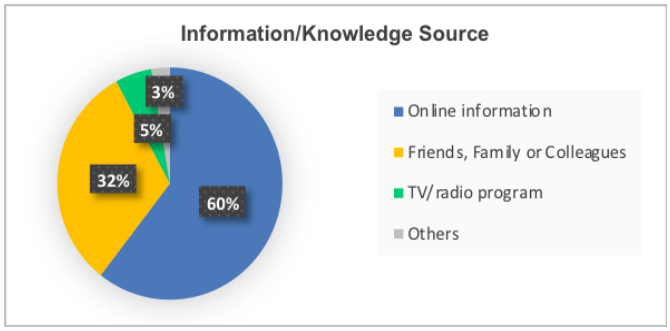


Figure 5 The main sources of DFS information

Table 4 The usefulness of DFS information

	USEFUL	EITHER USEFUL OR NOT USEFUL	NOT USEFUL	TOTAL
Mobile banking	65.79% 25	23.68% 9	10.53% 4	38
Digital wallet	54.29% 19	22.86% 8	22.86% 8	35
Blockchain	29.41% 10	50.00% 17	20.59% 7	34
Cryptocurrencies	35.29% 12	47.06% 16	17.65% 6	34
P2P lending	21.88% 7	43.75% 14	34.38% 11	32
Crowdfunding	44.12% 15	26.47% 9	29.41% 10	34

4.1.3 The learning requirements of the participants

- **Time for digital financial literacy learning**

57% of the participants were willing to devote 15-30 mins/day to digital financial literacy learning (see Figure 6). In other words, people would prefer to cram learning into the interstice of daily lives. This indicated that micro-learning and just-in-time learning might have a greater potential to hit the sweet spot of young people's digital financial literacy learning. What's more, it is also noted that a subset of the participants (31%) was not interested in such learning. Among them, 58.3% make investments on their own. This is consistent with the findings in one mainstream of financial literacy, which asserted that people exhibit the irrational financial decision-making due to behavioral bias (Drew & Cross, 2013; Estelami, 2009; Guest & Brimble, 2018). In particular, seasoned investors are more likely to fall into the trap of overconfidence, which would lead to inaccurate awareness of risks and risky financial behaviors (Drew & Cross, 2013; Shen, 2014).

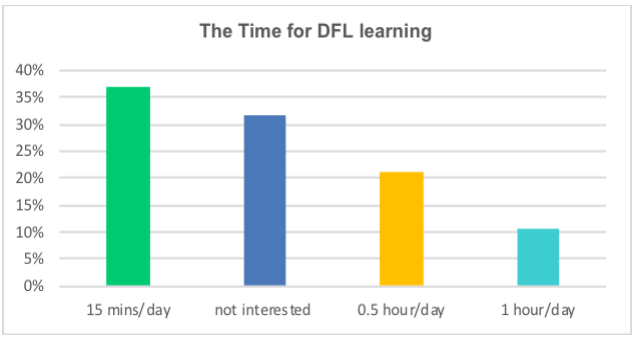


Figure 6 The time for digital financial literacy learning

- **The factors facilitating digital financial literacy learning**

Table 5 presented the perceived factors that could promote young people's digital financial literacy learning. Respondents were asked to rate the factors on a scale of 1-4, where 1 equaled the most important, 4 was the least important. The table was rank ordered by the score of responses for each choice. It revealed that the participants considered *pictures illustrated the definitions, plain and simple language,* and *small chunks of information* as the factors facilitating them to understand DFS concepts better.

Table 5 The factors facilitating digital financial literacy learning

	Most Important	Important	Less Important	Least Important	Total	Score
Pictures illustrated the definitions	51.43% 18	28.57% 10	14.29% 5	5.71% 2	35	3.26
Plain and simple language	26.47% 9	26.47% 9	17.65% 6	29.41% 10	34	2.50
Small chunks of information	15.63% 5	21.88% 7	34.38% 11	28.13% 9	32	2.25
others' experience	10.00% 3	20.00% 6	36.67% 11	33.33% 10	30	2.07

- **The content requirements**

Table 6 revealed the content that young people are willing to learn about DFS. Respondents were asked to rate the factors on a scale of 1-4, where 1 equaled the most important, 4 was the least important. The table was rank ordered by the score of responses for each choice. It suggested that the mechanism and potential risks of DFS were the main aspects that people showed more interest and motivation to learn.

Table 6 The basics of DFS young people are willing to learn

	Most Important	Important	Less Important	Least Important	Total	Score
Mechanism (how it works)	62.86% 22	8.57% 3	8.57% 3	20.00% 7	35	3.14
Potential risks	15.63% 5	46.88% 15	31.25% 10	6.25% 2	32	2.72
Potential benefits	21.88% 7	31.25% 10	28.13% 9	18.75% 6	32	2.56
Consumer protection regulations	8.57% 3	11.43% 4	31.43% 11	48.57% 17	35	1.80

4.1.3 Insights from the participants

At the end of the questionnaire, an open-ended question was presented to ask for the participants' perception of "a must-have feature of a mobile app to promote their digital financial literacy". The textual responses to this question provided some qualitative statements supporting the quantitative evidence. 32 answers were collected and further clustered into the following categories (see Figure 7):

- **Content.** The respondents expected the mobile app as a basic guideline, covering the fundamentals of DFS, potential risks of DFS, and smart tips for safe DFS use.
- **Delivery.** The respondents insisted that a good UX played a significant role in delivering the learning content. Their proposed suggestions can contribute to creating an engaging mobile learning experience for digital financial literacy promotion.
- **Characteristics.** The majority of the respondents emphasized that DFS knowledge should be framed in a simple and straightforward way. They proposed easy-to-understand as the tonality of the app.

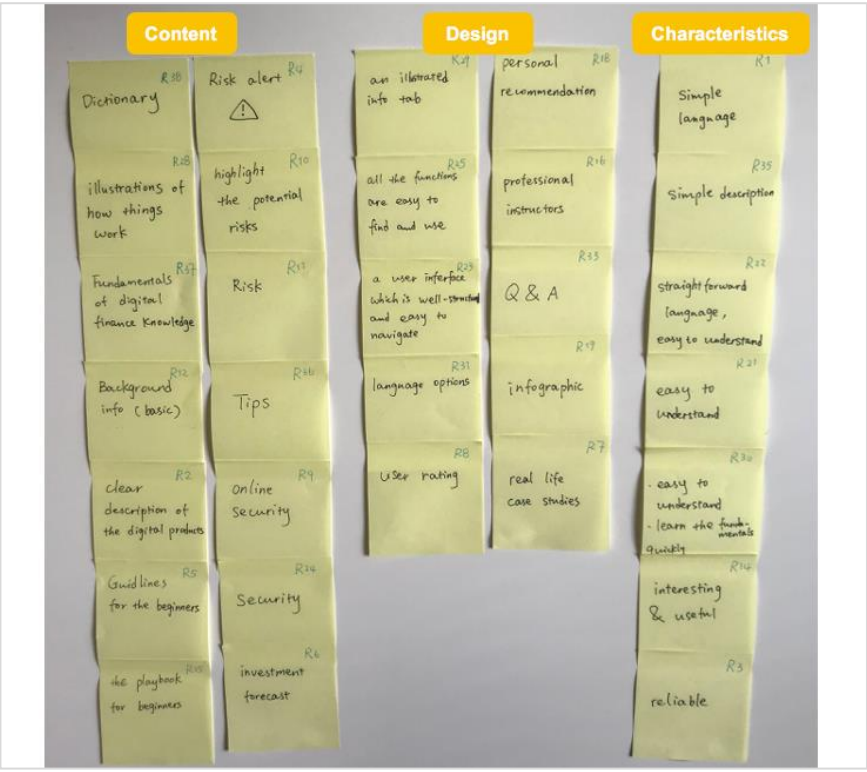


Figure 7 The card-sorting of the responses

4.2 Phase 2: Define

In this phase, it involves synthesizing the scattered data into powerful insights and guiding design efforts forward (Stanford, 2010). Yet “it is all too easy to see only the surface problems and never dig deeper to address the real issues” (Norman, 2013, p. 218). For this reason, I took a step-by-step approach to define the problem statements within a week. First, a persona of intended users was portrayed. After that, the problem statements were framed in order to address the RIGHT challenge.

4.2.1 Target group: young people

As described earlier, the app considers young adults as intended users, given that many DFS target them to offer digital-enabled solutions. However, insufficient DFS knowledge expose young generations to excessive risks, such as online fraud, phishing, social media scams, and personal data insecurity and misuse. The data collected in the user research demonstrated this issue. Therefore, the app is designed to equip young generations with DFS fundamentals so that they can make well-informed DFS decisions and ultimately achieve financial well-being.

4.2.2 Persona

In an effort to describe the users, I created a persona (see Figure 8) which is a commonly used to technique to “achieve a common understanding of a user and the scope of a solution” (Luchs et al., 2016, p. 31). As the empathy work suggested, users expect the app to address the following pain points they are currently struggling with.

- Due to the lack of sufficient knowledge about DFS, they always feel puzzled when dealing with the sophisticated DFS products. They tend to highly doubt their ability to make sound DFS decisions.

- They have limited confidence in safe use of DFS. For instance, they are not well aware of how to protect their personal keys, digital wallets, and other access information relating to DFS against fraud or theft. What they need is an actionable guidance about how to mitigate the potential risks associated with DFS.

- The currently available resources are not helpful to resolve their puzzles about DFS use, since most of them are designed from a supply-side, rather than a demand-side. The materials are filled with jargon, resulting in making people cognitive overload to comprehend DFS concepts. Alternatively, they desire a simple and straightforward playbook to provide them with practical strategies for DFS use.

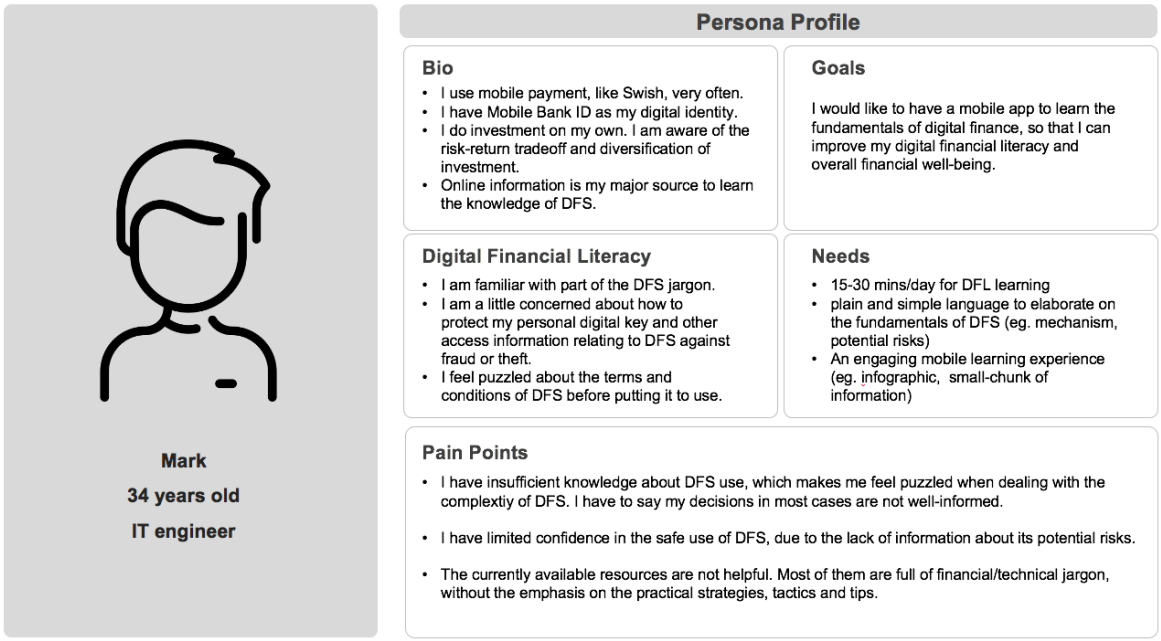


Figure 8 The persona of the app

4.2.3 Problem statements

With the persona, I further framed the problem statements in an attempt to define the RIGHT challenge to address (Stanford, 2010). As scholars and practitioners (Hartson & Pyla, 2019; Luchs et al., 2016; Stanford, 2010) suggested, a common strategy is to translate pain points into a list of "how might we" questions. Therefore, I formulated the problems statements as follows (See Figure 9).

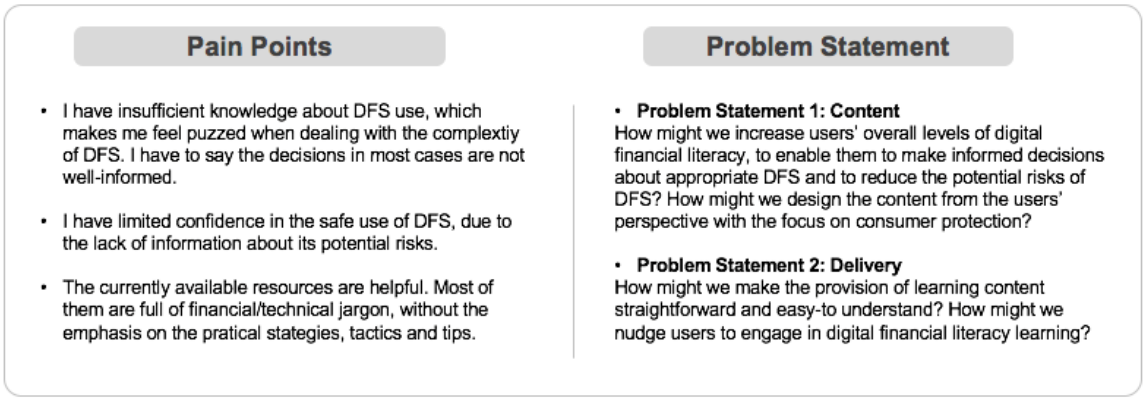


Figure 9 The problem statements

- **Problem statement 1** aimed to address the first two pain points. The problem space focused on the content design of digital financial literacy learning. The content should cater to user needs, helping them undertake research on DFS before committing, question DFS offerings too good to be true, and balance the risks and rewards about a potential DFS investment.

- **Problem statement 2** aimed to address the third pain point. The problem space focused on the delivery design of digital financial literacy learning. By ideation of possible alternatives, an engaging mobile learning experience would be crafted to ultimately increase users' overall level of digital financial literacy.

4.3 Phase 3: Ideate

Ideation calls for divergent thinking. It represents a process of "going wide", thinking through the problem space and user needs with imagination to generate a broad set of design ideas (Stanford, 2010). In that spirit, I exploited the insights from users, literature, and subject matter experts to ideate the solutions to content design and delivery design of the app. After that, I further converged the wide ideas into a conceptual model on the basis of Activity Theory (Engeström, 1987). This phase lasted for 2 weeks.

4.3.1 Divergent thinking

A common strategy to initiate ideation is to make a list of "How-might-we..." responses to different aspects of the problem statements (Hartson & Pyla, 2019; Luchs et al., 2016; Stanford, 2010). In this case, that is to generate ideas in terms of the content design and delivery design of the app. Figure 10 presented an idea board of collective insights, including the data in user research, the suggestions from subject matter experts, and the design ideas of the author. Each color of the post-it notes represented one source of inputs and were clustered into three categories: *content*, *delivery*, *and characteristics*.

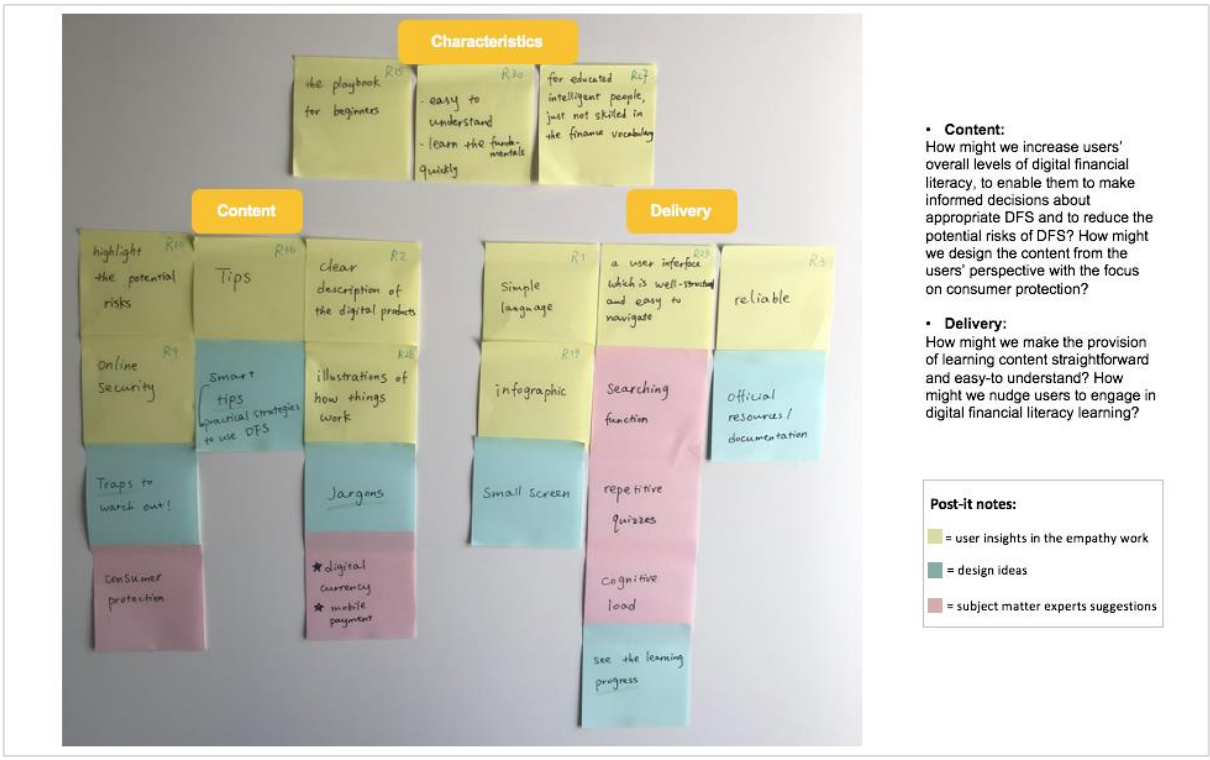


Figure 10 The idea board of the project

- **Responses to Problem Statement 1: Content**

Users: To specify content requirements, the qualitative data collected in the user survey were further synthesized. Three main themes emerged: a clear description of DFS concepts, potential risks of DFS, and practical strategies for safe DFS use.

Subject matter experts: I seek suggestions from two financial professionals about the content design of the app. They agreed that it was necessary to increase young people's awareness of DFS potential riks. In particular, young people get used to learning information through social media, which would make them more vulnerable to social engineering scams, account hacking attacks, and data theft.

Beyond that, they suggested that the app could elaborate on the concepts of mobile payments and digital currency with special attention. The rationale was as follows: young people get used to using mobile payments for online purchases. Yet they might not be aware of the importance of authentication to protect their personal digital keys. Similarly, multiple countries (e.g., Sweden, China, UK) have been developing Central Bank Digital Currency (CBDC) to promote their national digital currency. Yet the myths of bitcoin might make investors reluctant to give CBDC a try.

Designer: As the co-designer of the app, I proposed three content components: *jargon, tips,* and *traps*. First, *jargon* is the building blocks of digital financial literacy. With a good command of DFS jargon, people would better understand the terms and conditions before committing to a particular DFS. Second, *tips* would be collected to inform users of the appropriate use of DFS. Third, *traps* would be designed to remind users of the potential risks associated with DFS. If consumers realize the potential risks of DFS in advance, they would be more likely to mitigate such risks and ultimately make sound decisions.

- **Responses to Problem Statement 2: Delivery**

Users: In the user survey, there emerged 11 functionality requests (see Figure 7). Each request was weighed with respect to the others based on its relevance to digital financial literacy learning and technical feasibility. I chose to prioritize the following requests at the early stage of development: well-structured, easy-to-navigate, simple language, and infographic to illustrate DFS concepts.

Instructional Design Expert: I asked my supervisor specialized in instructional design for advice about how to create an engaging mobile learning experience. My best takeaways were the following: First, the delivery of content should not impose additional cognitive load on learners. The information processed needs to cater to users' working memory capacity. In other words, how to present DFS knowledge in a user-friendly way would be meaningful yet challenging. Second, the reusability of mobile learning enables people to gain immediate and ongoing access to learning materials. It might be beneficial to contain such features as searching and repetitive quizzes to unleash this potential. By doing so, users would be able to look into DFS knowledge in a timely manner and assess their learning outcomes on a regular basis.

Designer: While keeping an open mind on the problem space, designers should never forget the design context (Stanford, 2010). In this case, that is the context of mobile learning. Therefore, I read through the literature studying mobile learning to get some inspiration. As scholars and practitioners claimed, a practical strategy is to deploy a micro-learning approach, considering that small screens limit the amount of information that can be displayed.

- **Responses to usability goals: Characteristics**

Apart from the responses relating to the content and delivery design, there were several ideas presenting the usability goals of the app, such as easy-to-understand, quick-to-learn, and reliable.

4.3.2 Convergent thinking: a conceptual model

After the divergent thinking, I converged the above ideas into a conceptual model. It is "a description of the proposed system in terms of a set of integrated ideas and concepts about what it should do, behave, and look like, that will be understandable by the users in the manner intended" (Sharp et al., 2019, p. 400). In general, there are two main categories of conceptual models: those based on objects and those based on activities (Sharp et al., 2019). Given the design context of this project, I chose to articulate the conceptual model based on the activity category.

Moreover, previous literature suggested that Activity Theory (Engeström, 1987) provides a good pedagogical foundation for mobile learning design. It defines learning activity as "a specific interaction of learner(s) with other(s) using specific tools and resources, orientated towards specific outcomes" (Beetham, 2019, p. 34). Therefore, I formulated the conceptual model (see Figure 11) on the basis of Activity Theory (Engeström, 1987), specifically focusing on three key elements (i.e. artifact, subject, and objectives). The main idea was to envision the design of the app, identifying the dimensions that needed to consider when creating an engaging mobile learning experience.

- **Artifact**

The app is viewed as the artifact for mediating learners' interactions with DFS learning content. This suggests that we need to take into account the affordances of mobile learning when designing the app. To be specific, it includes ubiquitous access to learning resources, limited display capacity, and reusability of resources. Accordingly, the practical design strategies would be 1) to divide the content into small meaningful chucks in order to facilitate people's micro-learning; 2) to provide search function so that people could get access to the relevant DFS knowledge in a just-in-time manner; 3) to make repetitive quizzes available to users so that people could assess their learning on a regular basis.

- **Subject**

Subject refers to the target users of the app, namely young adults. This suggests that the characteristics of young adults as learners need to be considered carefully. Generally, young generations not only crave for speed and process information quickly, but also prefer pictures and immediate feedback (Thompson, 2013). Therefore, it calls for a set of design strategies to cater to these characteristics of learners. The potential design solutions should focus on 1) how to reduce the additional cognitive load imposed on users; 2) how to use infographics to illustrate DFS concepts; 3) how to provide ongoing feedback to keep users engaged in the learning activities in the app.

- **Objectives**

Objectives refer to the content that enables target users to achieve their learning outcomes. In this project, it involved the provision of DFS learning content to nudge young adults to understand the fundamentals of DFS, identify the potential DFS risks, and get to know the handy strategies for safe DFS use. Therefore, the content of the app is made up of three subsections, including *jargon, tips and traps,* and *quizzes*. 1) In the *jargon* part, I sorted jargon based on their underlying connections, rather than in alphabetical order; 2) In the *tips and traps* part, multiple straightforward advice would be offered built on the information synthesized from relevant investor associations and financial institutions, etc. Additionally, I underlined the keywords, allowing users to concentrate on the most critical checkpoints in order to make wise financial decisions; 3) In the *quizzes* part, learners could assess their learning outcomes at the end of each learning chunk.

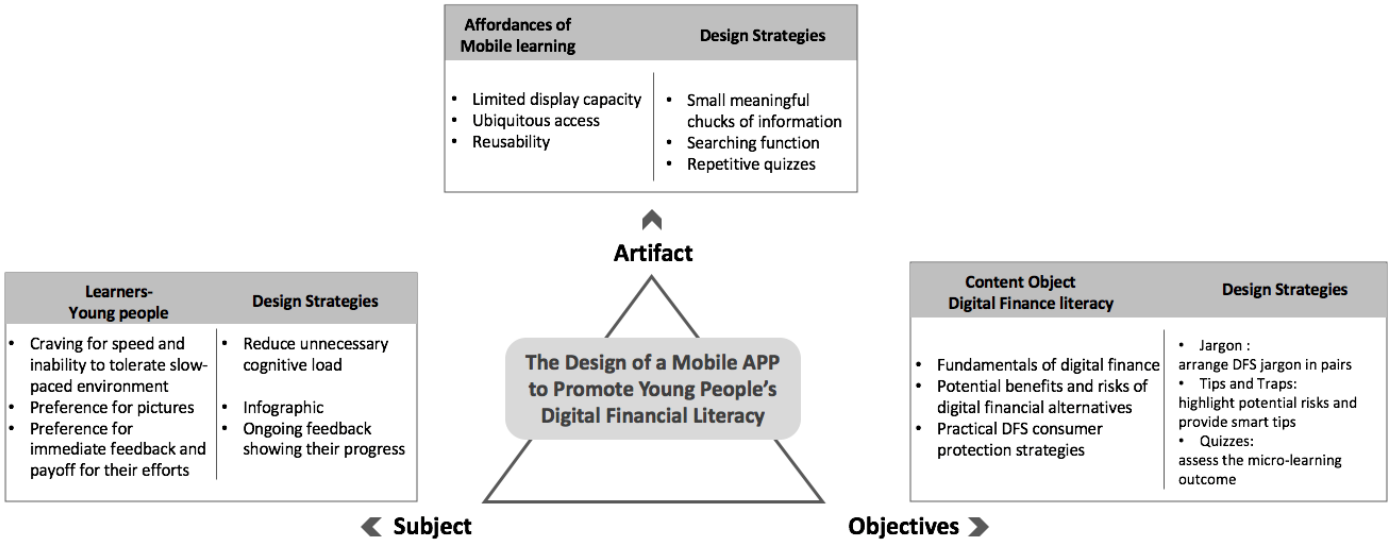


Figure 11 The conceptual model of the app

4.4 Phase 4: Prototype

With the conceptual model, the project moved forward to the detailed design phase. A high-fidelity prototype was created as a tangible solution "to allow potential users to interact with, to gain some experience of using it in a realistic setting, and to explore imagined uses" (Sharp et al., 2019, p. 394). The total time involved for prototyping was 5 weeks. The following section presented the prototype in more detail.

4.4.1 Content: the information architecture of the app

The app strives to enable users to make the most of DFS while keeping them in 'safe' use. Therefore, the scope of its content covers the fundamentals of DFS, awareness of potential DFS risks, and practical strategies for making informed DFS decisions. These content components work together to promote people's digital financial literacy. It appears to be a meaningful yet challenging task, since currently available DFS information remains scattered and fragmented. This calls for a systematic view to structure the intended content coverage.

- **The content framework of the app**

To achieve this, I applied the Digital Finance Cube (Gomber et al., 2017) to develop the app content. It provides me a solid framework to design the content, navigating through the DFS field by three key dimensions, namely *Digital Finance Business Functions, Digital Finance Technologies*, and *Digital Finance Institutions*. Inspired by this model, I linked to the portmanteau of FINTECH to organize the content in the following three dimensions (see Figure 12): Fin-part (DFS dimension), Tech-part (Technology dimension) and Subsections.

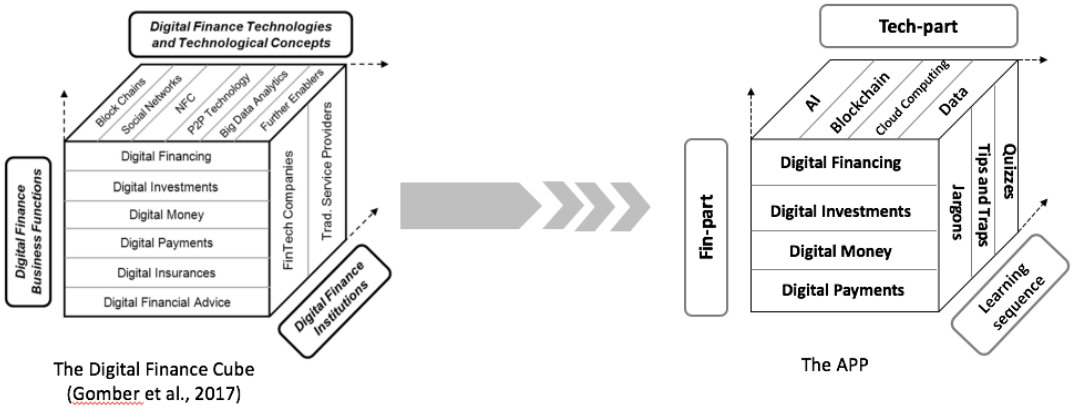


Figure 12 The content framework of the app

(1) **Fin-part (DFS dimension)** includes the concepts of digital financing, digital investments, digital money, and digital payment. Compared to the Digital Finance Cube (Gomber et al., 2017), there were some adjustments in this dimension. I excluded digital insurances, and merged digital financial advice to digital investments, based on the subject matter expert's suggestions. The primary intention was to ensure the right amount of content, incorporating what is necessary.

(2) **Tech-part (Technology dimension)** includes the concepts of AI, Blockchain, Cloud Computing, and Data. Inspired by HKU (2020)'s theory, I used the acronym ABCD to rearrange the technological concepts. As they put forward, the driving forces that have allowed DFS to flourish can be known as

ABCD technologies, namely AI, Blockchain, Cloud computing, and Data. The acronym ABCD gives learners a hint to understand and memorize the sophisticated technology terms.

(3) **Subsections** outline the learning sequences in the app. Specifically, the learning journey starts with the *jargon* section, which serves as the building blocks of digital financial literacy learning. After that, learners would level up to the *Tips and Traps* section. With a better understanding of the DFS tactics, people would be able to undertake their own research on a specific DFS before committing to it, as well as to question offerings too good to be true. Finally, the *quiz* section quickly checks learners' learning outcomes.

- **The information architecture of the app**

Figure 13 illustrated the information architecture of the app, which was designed based on the above content framework. It not only presents an overall structure of the app, but also navigates a potential user experience. As can be seen, the learning content is made up of 8 learning units, including 4 units of DFS financial concepts (i.e. Fin-part) and 4 units of DFS technology concepts (i.e. Tech-part). Each unit serves as a micro-learning chunk, explicitly explaining *jargon, tips and traps*, and finally ending up with *quizzes*.

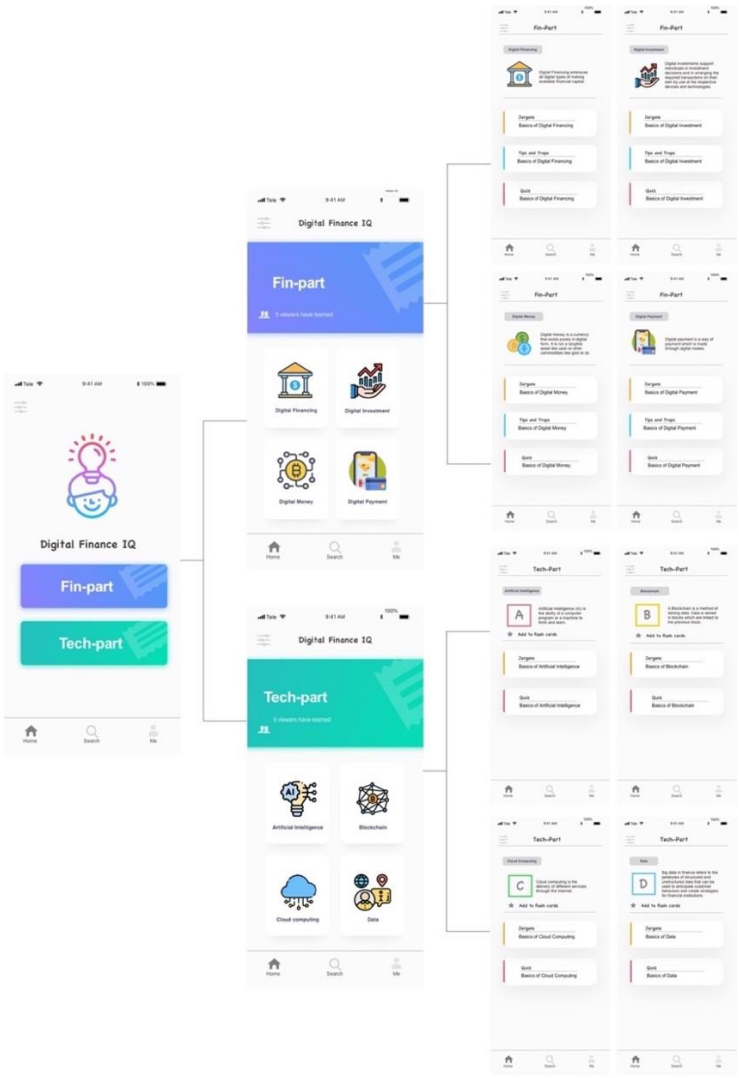


Figure 13 The information architecture of the app

4.4.2 Fin-part Design Examples

- **Design Example 1: Digital Money**

Digital Money unit is composed of 6 relevant jargon, 3 smart tips for digital currencies use, and 2 traps need to watch out (see Figure 14). Throughout the learning, users would gradually form an appropriate attitude towards digital money. On the one hand, they would reinforce their readiness to embrace the advent of national digital currencies (i.e. Central Bank Digital Currency). On the other hand, they would be alert to the potential risks associated with Bitcoin scams, as well as be cautious about the digital currencies boasted through social media. The rationale behind this is that young people, who perceive digital money as a fast track to wealth, tend to expose themselves at the heart of cryptocurrency fever (Clatworthy, 2018). As a result, they inevitably fall prey to cryptocurrency scams. Given that, I synthesized the information in a simple and straightforward manner so that people would be attentive to the most critical decision elements, such as checkpoints of cryptocurrency investing, the common scams of Bitcoin, the benefits of CBDC, and the potential risks of Libra (a digital currency proposed by Facebook).

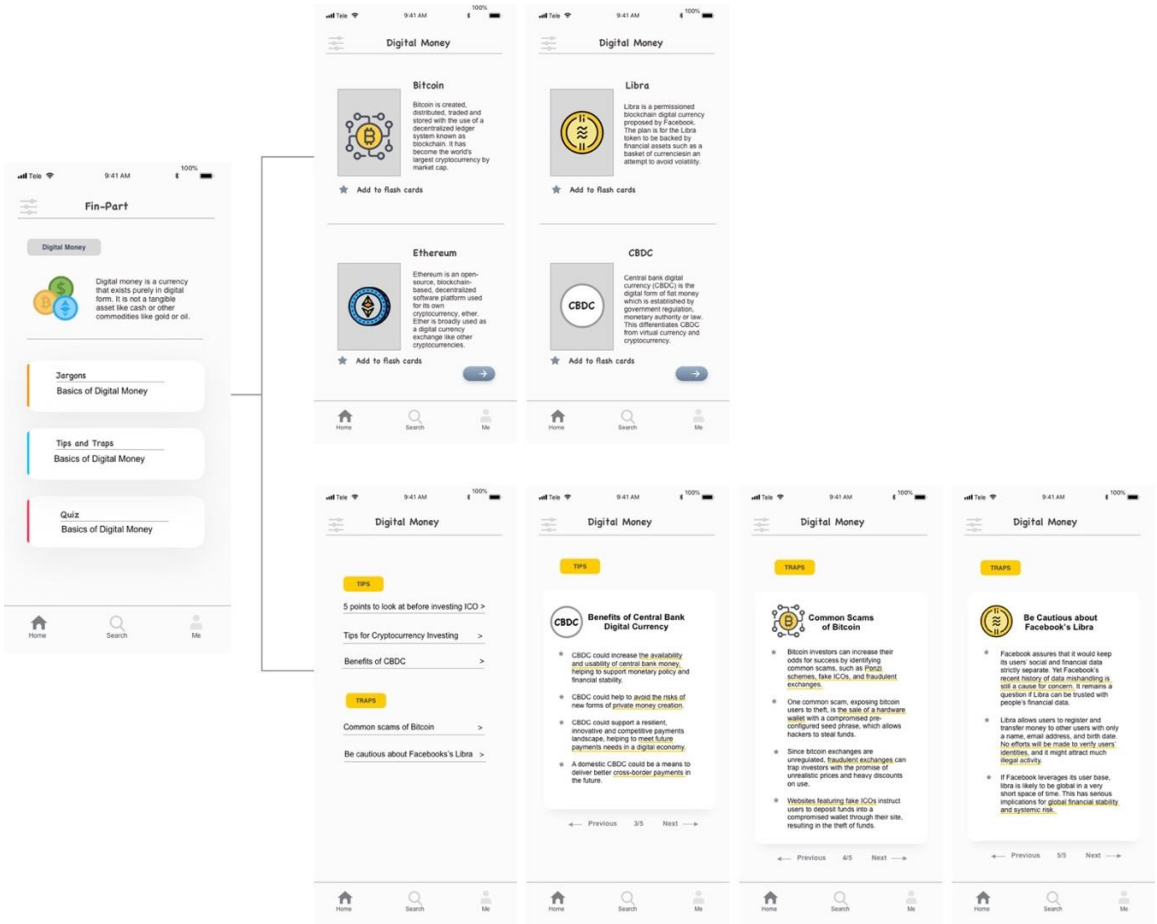


Figure 14 Screenshot of the learning unit Digital Money

- **Design Example 2: Digital Payments**

Digital payments are popular with young generations, due to its convenience and flexibility (Koenig-Lewis et al., 2015). However, when it comes to the relevant cybersecurity issues, young consumers exhibit substantial vulnerability. The user survey showed that the participants have limited confidence in terms of how to protect their digital keys, digital wallet, etc. Therefore, *Digital payments* unit is designed to improve users' competence in this regard. As Figure 15 presented, jargon that users must know about digital payments was listed, including *mobile payment, digital wallet, authentication and NFC*. It is noted that users might be less familiar with the latter two jargon (i.e. *authentication, and NFC*), yet they are commonly used in the terms and conditions of a variety of digital payment services. The jargon listed here aims to fill in this knowledge gap. Similarly, I summarized the corresponding tactics in a simple and salient manner for learners to 1) identify the cyber security risks when making digital payments; 2) keep personal financial information, password and pin numbers secure; 3) spot signs of phishing attacks.

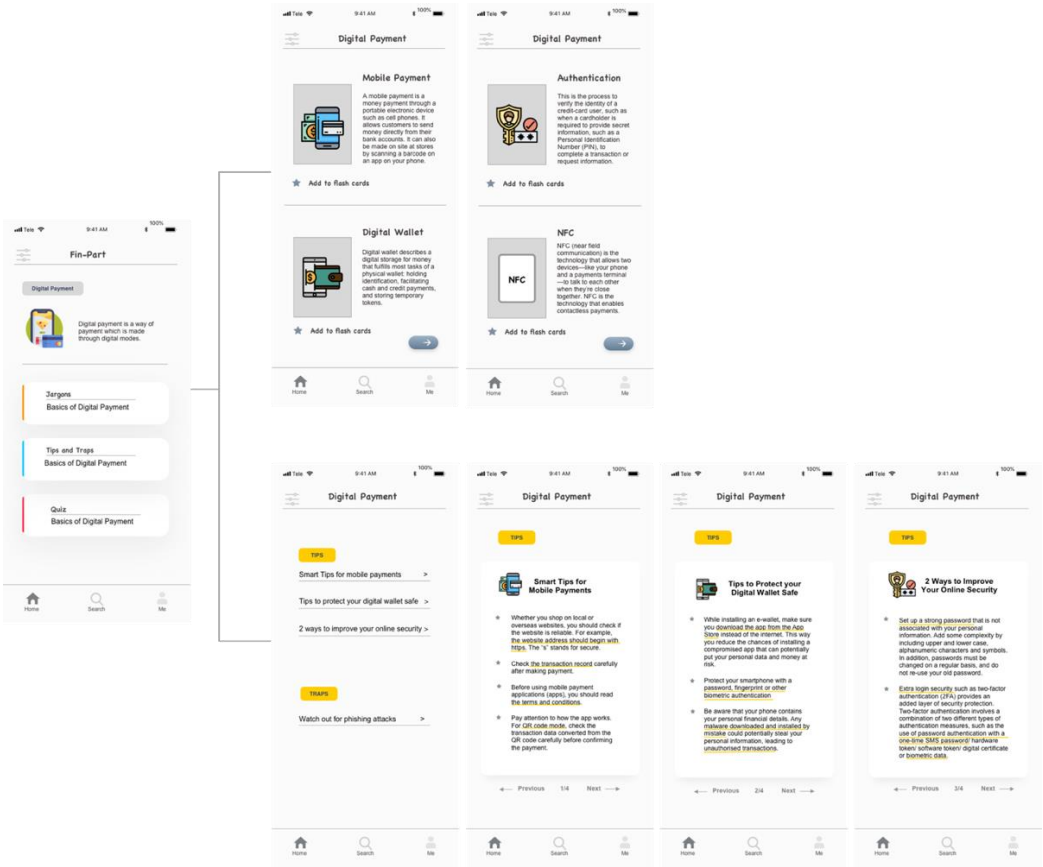


Figure 15 Screenshot of the learning unit Digital Payment

4.4.3 Tech-part Design Examples

- **Design Example 1: Blockchain**

As the user survey revealed, young people still feel overwhelmed when learning about innovative DFS technologies. Blockchain, for instance, is such a challenging concept. Most available information appears to be technical specifications, which might not be suitable for digital financial literacy learning. For this reason, I adopted easy-to-remember rules, using simple language and illustrated infographic to explain how blockchain works (see Figure 16). The main purpose was to reduce users' cognitive overload, reducing the time and effort they need to process the sophisticated technology terms.

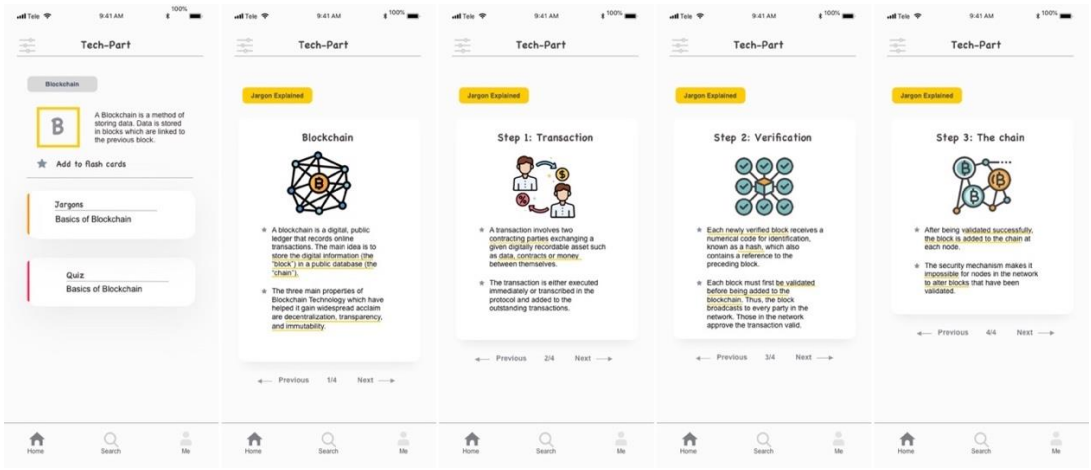


Figure 16 Screenshot of the learning unit Blockchain

- **Design Example 2: Data**

Data is the new oil. Financial sector has benefited greatly from the rise of big data. In particular, many DFS providers target young persons as their intended users. They have relied on and generated a tremendous amount of data, including information from and about customers, their identity, their transactions, and their net worth, etc. Yet limited attention has been paid to the protection of personal data. Young consumers even haven't realized that they are the owner of their person data and digital footprint. For this reason, GDPR as a relevant regulation was introduced, aiming to give learners a sense of how to protect their personal data (see Figure 17).

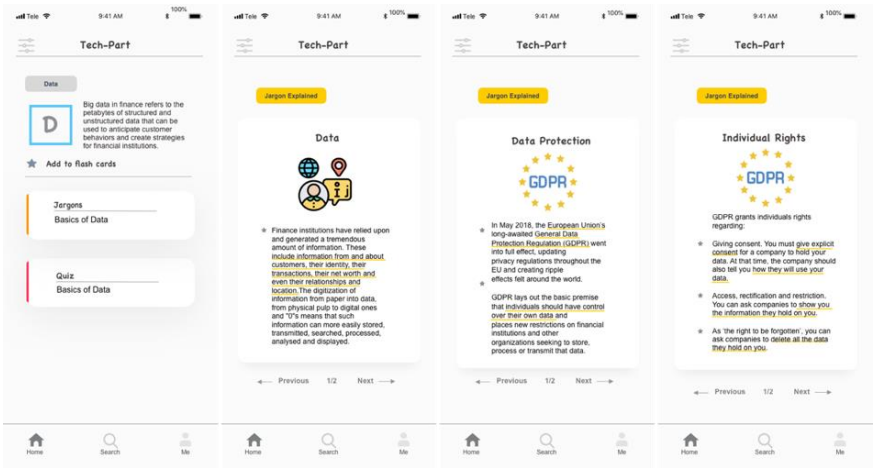


Figure 17 Screenshot of the learning unit Data

4.4.4 Delivery: The digital nudges of the app

To design an engaging mobile learning experience, the app employed the notion of *Digital Nudging* (Weinmann et al., 2016). It is eagerly adopted in UX design, which suggested that subtle changes in digital choice architecture can "alter people's behaviors in predictable ways" (Thaler & Sunstein, 2009). Its application to this project involved design effective strategies that sustain user engagement in the entire mobile learning experience. Inspired by Caraban et al. (2019)'s idea, I selected the following nudges and implemented them through the User Interface (UI) of the app.

- **Facilitator Nudges**

"The complexity of financial services may enable providers to introduce additional information to the consumers' decision environment, some of which may be non-diagnostic and thereby exhaust consumers' short-term memory capacity" (Estelami, 2009, p. 279). Consequently, people appear to think that DFS are complicated concepts that require more time and effort to digest. Especially young generations crave for being fast learners (Thompson, 2013), resulting in low tolerance to redundant information and complicated explanation. To pinpoint this pain point, I incorporated facilitator nudges in the overall content delivery design, aiming to reduce users' cognitive load in their digital financial literacy learning. As Figure 18 showed, the design efforts involved keeping information short and small-chunked, sorting jargon by their relevance, using infographics, and underlining keywords. By doing so, learners would anchor to the essential attributes and ultimately arrive at optimal learning outcomes.

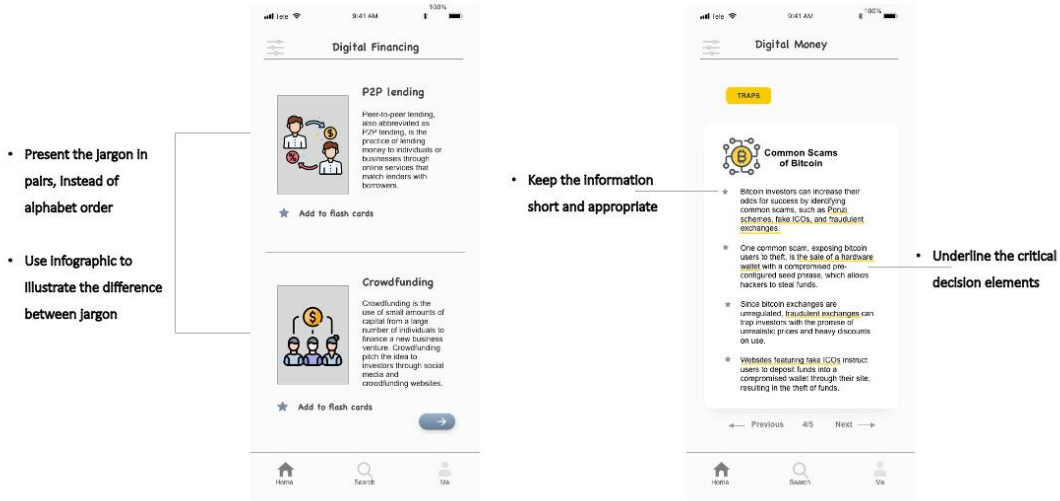


Figure 18 Design examples of facilitator nudges

- **Spark Nudges**

The user survey suggested that a subset of the respondents was not interested in digital financial literacy learning. Among them, 58.3% are experienced investors who make investments on their own. This might attribute to their overconfidence, which would further lead to a status-quo bias making them reluctant to change (Caraban et al., 2019). Therefore, it is necessary to employ a spark nudge to increase users' motivation before they embark on the learning journey. An onboarding survey *Knowing yourself Better* might be a good fit, nudging users into assessing their risk tolerance level and digital financial literacy status (see Figure 19). Users, thereby, could acknowledge why they need to learn DFS fundamentals and commit to the follow-up learning activities. The onboarding survey, working as a spark nudge, would promote clarity, motivation, and more purposeful engagement.

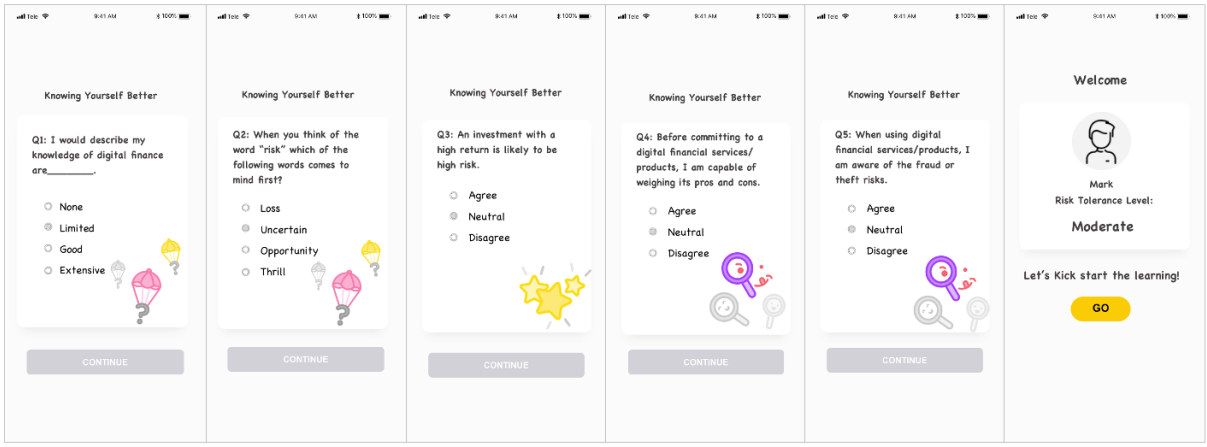


Figure 19 Screenshot of the onboarding survey

- **Signal Nudges**

"Mobile learners have to be able to self-regulate their ubiquitous learning habits, and pay attention to learning tasks consistently and mindfully" (Palalas, 2018, p. 172). As such, I designed a set of signal nudges to constitute a key thread of tasks alongside the learning journey (see Figure 20). The main idea was to promote higher levels of user engagement in the app and increase their attention during a variety of learning activities. The learning journey starts with an onboarding test to assess their DFS risk perceptions and then goes through knowledge sections (i.e. *jargon*, *tips and traps*) and quiz section. The signal nudges as self-regulation learning reminders, keeping users informed of their learning progress.

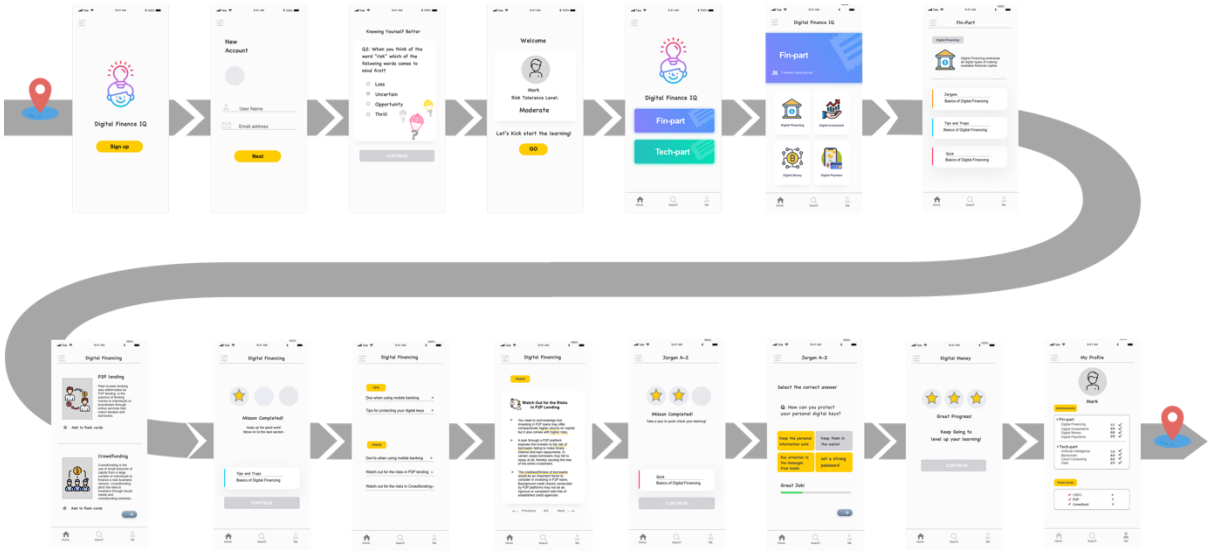


Figure 20 The signal nudges in the app

4.5 Phase 5: Test

To collect users' feedback about the prototype, I performed a series of user testing activities within 3 weeks, including a user satisfaction questionnaire, 3 think-aloud sessions and 3 debriefing interviews. The main idea was to invite potential users to assess the usability and learning experience of the prototype. To evaluate the usability, I conducted a user satisfaction questionnaire to measure the key metrics of usability (i.e. usefulness, ease of using, ease of learning, and satisfaction). To evaluate the learning experience, I held the think-aloud sessions to learn how users actually feel about when interacting with the prototype. Their comments, as the qualitative data, were collected and analyzed. Taken together, these informative test results would help me refine the prototype, carry out the follow-up iteration, as well as revisit the user empathy and problem space (Stanford, 2010).

4.5.1 User Satisfaction Questionnaire

First of all, I conducted a user satisfaction questionnaire to gather the data about how the participants assessed the prototype in general. The measurement was driven by questions about how they perceived the usefulness/ease of use/ease of learning/satisfaction of the app (see Appendix C). Ten young adults were recruited through convenience sampling to respond to the questionnaire. They answered the questions by selecting a rating from a 1-5 scale, with 1 being the lowest rating and 5 being the highest.

Table 6 The results of the user satisfaction questionnaire

Categories	Metrics	Items on questionnaire	Average score (Mean)
Content	Usefulness	This app helps me learn the fundamentals of digital finance.	4.1
		This app makes it easier for me to understand the digital finance jargon.	4.2
		This app makes it easier for me to balance the risk and reward of digital finance services/products.	3.5
		This app makes it easier for me to mitigate the risks associated with digital finance services/products.	4.0
Delivery	Ease of use	This app is easy to use.	4.5
		The app text is easily readable.	4.4
		The app has an effective layout, organization, and grouping.	4.1
	Ease of learning	This app explains the digital finance concepts and features in a simple and easy-to-understand way.	4.3
		This app helps me understand how different digital finance concepts relate to each other.	4.2
Overall	Satisfaction	This app is visually pleasing.	4.3
		I would download the app to learn the digital finance foundations.	3.9

Table 6 revealed that the participants were satisfied with the usability of the app in general. 60% of them would download the app to learn DFS fundamentals. In particular, the delivery of content (i.e. ease of use, and ease of learning) was viewed as the most favored aspect of the app. The mean rating on a 1-5 scale for the metrics *ease of use* was 4.3, followed by the mean for *ease of learning* (4.25). These data reflected the effectiveness of digital nudges incorporated in the app. With the facilitator nudges, the participants perceived that the app elaborated on the DFS knowledge in an easy-to-understand way; the text was easily readable; the app presented the relevance of different DFS concepts in a systematic way. Similarly, the participants assessed that the user flow was easy to follow and offered clear navigation through a set of signal nudges.

Yet there was still some room for improvements regarding the content design of the app. As Table 6 showed, the overall mean for the metrics *usefulness* was 3.95. Particularly, they perceived that the app failed to help them balance the risks and rewards of DFS to some degree. This indicated that more efforts are needed to increase the breadth and depth of content, especially the emphasis on both the pros and cons of DFS. With knowing both sides very well, users would be able to make their critical judgments on DFS offerings. I came to realize that the benefits of DFS seemed to be a missing part of the prototype. The provision of all-around DFS information would be essential for the app to enhance users' digital financial literacy.

At the end of the questionnaire, two open-ended questions were asked to collect suggestions for improvements. In total, eight people responded to these questions. Half of them suggested that the app needs to improve the search function, considering that "people tend to use the search tab/search bar as a shortcut to access the information they need in the app". In addition, the participants recommended that the future version could incorporate more user interactions, for instance, "users can ask or add comments when they have problems in understanding the specific concepts", "the app could encourage user-generated content, allowing users to share their own experience briefly".

4.5.2 Think-aloud Sessions

"Collecting data about users' performances on predefined tasks is a central component of user testing" (Sharp et al., 2019, p. 477). Therefore, I invited three respondents in the user satisfaction survey to participate in the follow-up think-aloud sessions. The sessions were conducted remotely through ZOOM (see Figure 21).

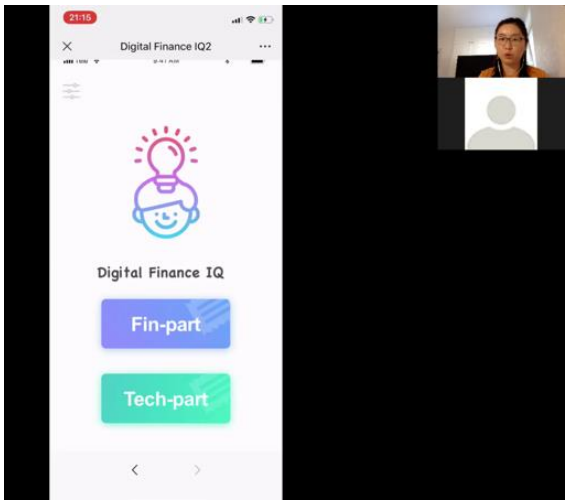


Figure 21 The Think-aloud Sessions through Zoom

For each session, one participant was asked to describe what he/she was thinking and doing out loud (the "think aloud" technique) while interacting with the app. A set of benchmark tasks were designed as vehicles for driving evaluation (Hartson & Pyla, 2019). The predefined tasks followed the learning sequence alongside the user journey, going through the before-during-after phases (see Table 7). During the course of Think-aloud, the participants were encouraged to comment on their learning experience in the app, for example, whether the design was appealing to them, how well it fulfilled their requirements, what feature didn't work, etc.

Table 7 The results of Think-aloud Sessions

	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
	Before	During			After	
	Sign up	Learn the DFS jargon	Learn the Tips & Traps	Take a quiz	Review the user profile	Try out the search function
Task Descirption	The participants were asked to: • sign up a new account • take the onboarding test to assess their risk tolerance	The participants were asked to: • pick a unit of DFS jargon to learn • add the jargon to the flashcards	The participants were asked to: • pick a unit of DFS tips and traps to learn	The participants were asked to: • take a corresponding quiz after learning a specific DFS unit	The participants were asked to: • go into the *Me* subpage and review the design	The participants were asked to: • go into the *Search* subpage and review the design
User Satisfaction	Participant 1: ☺ Participant 2: ☺ Participant 3: ☺	Participant 1: ☺ Participant 2: ☺ Participant 3: ☹	Participant 1: 😐 Participant 2: ☺ Participant 3: ☺	Participant 1: ☺ Participant 2: ☺ Participant 3: ☺	Participant 1: ☹ Participant 2: ☺ Participant 3: ☺	Participant 1: 😐 Participant 2: 😐 Participant 3: ☹
User Comments	**Participant 3**: "The onboarding test is a good idea! It helps me clarify the motivation why I need this APP. And I would suggest that you could personalize the learning content based on each user's risk tolerance level."	**Participant 2**: "I like the way you organize the jargon, like Bitcoin and Ethereum are grouped together. These two are the leading ones in digital currencies." **Participant 3**: "In the digital investment part, the jargon are quite limited. The basic terms of investment, such as equity, yield, and asset, are not included. "	**Participant 1**: "These tips are really helpful! Now I know that I could evalute an ICO project by checking out its whitepaper. Maybe I had a sterotype about digital money before, hahaha." "But I think the part about Facebook Libra might not be a fair point. Even though it was challenged by the U.S. government, we still can see the value in it. It would be better if you mention both pros and cons, and then let the users to make the judgments "	**Participant 1**: Quiz on Digital money Time to complete: 28 sec Accurancy:100% **Participant 2**: Quiz on Digital money Time to complete: 35 sec Accurancy:100% **Participant 3**: Quiz on Digital Investment Time to complete: 15 sec Accurancy:100%	**Participant 1**: "The feature of Flashcard is really thoughtful! It would be easy for me to check in and review the jargon I am not familiar with whenever I feel like to. So, I would suggest having the flashcards in a sperate section. The current version is a little bit crowded. "	**Participant 3**: "The search function could be strengthened in the next version, since I assume this app works as a quick-guide or a cheatsheet of digital finance. Here is a user case. If people have something that they are unfamiliar with, they just need to check in your app and get the answers by using the search function. This would be a quite efficient way to learn. They can learn whatever they need at the moment they need.

As Table 7 revealed, the app's favorable features included: 1) the onboarding test to assess their risk tolerance; 2) the approaches to organizing the content; 3) the quick quizzes after learning; 4) the flashcards for learning DFS jargon. It indicated that the participants had an overall enjoyable learning experience during the entire course (i.e. before, during, and after phases). Yet they perceived that the search function was less satisfactory, since the current version might fail to fulfill their self-scaffolding need. They would suggest that the app could provide a ready-to-hand access to the information they inquire by using the search tab. Additionally, the participants proposed some recommendations to enhance the content, such as supplementing additional investing jargon, summarizing a pros and cons list, etc.

4.5.3 Semi-structured interviews

After that, I conducted the semi-structured debriefing interviews to further probe the participants' perceptions of what they liked and did not like about the prototype. The goal was to promote the discussion relevant to the research questions. To collect the data, the interviews were recorded and transcribed. Content analysis was used to interpret and code textual material. In general, the transcripts were coded into the following two themes: content and delivery.

- **Theme 1: the content aspect**

Overall, the participants considered the app as a useful educational app to promote their digital financial literacy. The content covers the mainstream DFS categories, helping them capture a holistic perspective of DFS knowledge. As a participant commented, "The app is really great! I like the way how it maps out the digital finance concepts. Before trying out this app, I had no idea about what digital finance is as a whole, what it is made up of." Beyond that, the risk-relevant content was viewed as a promising value proposition. "Generally, it is an interesting and informative app. *Tips and Traps* is my favorite part. It gives me heads-ups to avoid the traps when using digital finance services. The financial institutions usually would not put too much effort into stressing the risks. For me, this is really helpful!"

Meanwhile, the participants' responses suggested that it requires ongoing endeavors to build up the learning content. More work needs to be done so that the app can ultimately enable users to balance the risks and rewards of DFS over time. The constructive suggestions they proposed are as follows:

First, the app could personalize the content based on users' risk tolerance. The rationale was that "people have different levels of risk tolerance. For a risk-seeking user, it is really necessary to emphasize the potential risks. Because they normally place great weight on prospects rather than risks. However, for a risk-averse user, more efforts might be put in the rewards part. Otherwise, they would be more reluctant to try out the new stuff in digital finance. It might be a good idea to tailor the content based on the users' onboarding test results."

Second, they suggested embracing an agile approach to build up the content. "The content in the current version is well-structured. But it won't take long for the users to complete the learning. The app has to feed users with a wealth of information sustainably. People would ask for more challenging tasks, after learning the basics." Aligned with this view, another participant proposed that "when explaining the concepts, the relevant YouTube links could be inserted underneath the text as supplementary reading. Also, the app could encourage users to generate content, for instance, sharing their experience. As a designer, you could find some useful insights within the ongoing thread to generate new topics in the app."

- **Theme 2: the delivery aspect**

During the interviews, all of the participants mentioned that they were engaged in the learning the app provides. "The app is thoughtfully designed. There are a bunch of pictures keeping me engaged. Unlike what I received from the financial institutions, filled with texts and hard-to-understand terms. This app is really user-friendly." On the other hand, they suggested that the search function needs further modification. "The search function doesn't work well. Right now, the feature only facilitates me to search for some jargon. As shown here, it is more like a glossary. But in practice, I would like to search for the handy tips by using this search tab." As a participant interpreted, "I would prefer to learn the knowledge when I need it, rather than allocate fixed time every day to learn. This app is like a dictionary. When I get something confused, I just need to type the keywords in the search bar, and then it will help me quickly access to the concepts I am looking into. Timesaving! That might be the scenario when I would like to use this app." These feedbacks made me realize that search function would play a significant role in facilitating users with just-in-time learning support. More importantly, search function might trigger the digital financial literacy learning and enhance users' learning outcomes.

4.6 Iteration

Design Thinking Methodology is an iterative process, rather than a linear one. This suggests that testing is not the final step. As designers, we need to evolve the design ideas based on the inputs from user testing. The ultimate goal is that "with each cycle of the iteration, the ideas become clearer, the specifications better defined, and the prototypes closer approximations to the target, the actual product" (Norman, 2013, p. 228). The following outlines the ideas for iteration.

In content design, the issue concerning the right amount of content was prioritized. As the testing results revealed, the developed prototype lacks 1) the interactive features to pull in user-generated content; 2) the learning content relating to DFS benefits; 3) the personalized content to cater to users' risk perception/digital financial literacy. Therefore, the next iteration would focus on the modifications in such aspects. To increase the breadth and depth of content, I would insert external links (e.g. YouTube links) as supplementary reading for users (See Figure 22). Meanwhile, the interactive feature would be added in the app, allowing users to tag for likes and leave comments on relevant learning content (See Figure 22).

In delivery design, the search function needs further modification. The participants in the testing perceived that they would like to get quick access to the relevant DFS knowledge and handy strategies by using the search tab as a shortcut. Yet the prototype fails to fulfill this need due to the current ambiguous search scope. Building on this feedback, I would redesign the search function, specifying the search scope into *jargon, tips, and traps* (See Figure 23). That way, users would be able to narrow down the search scope and obtain the DFS information they inquire at any given moment.

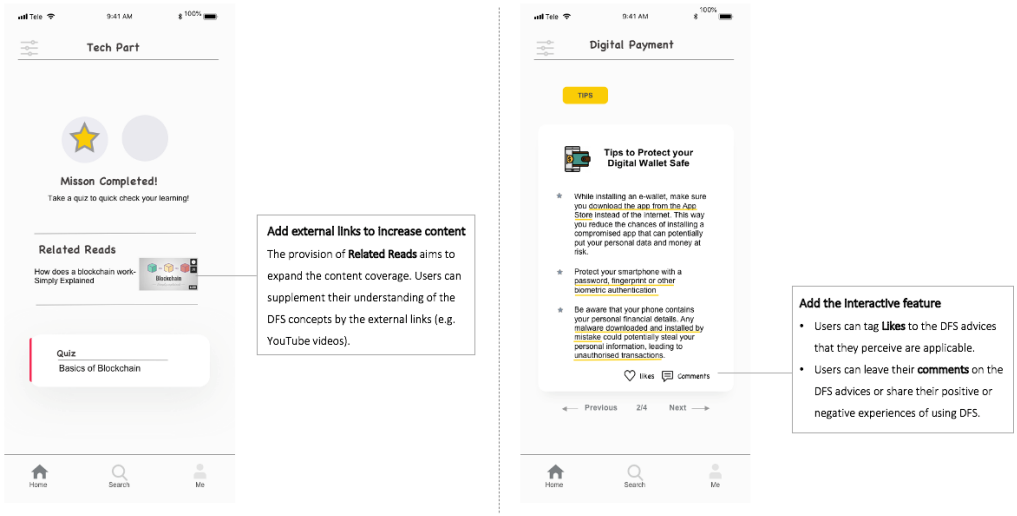


Figure 22 The modifications of content design

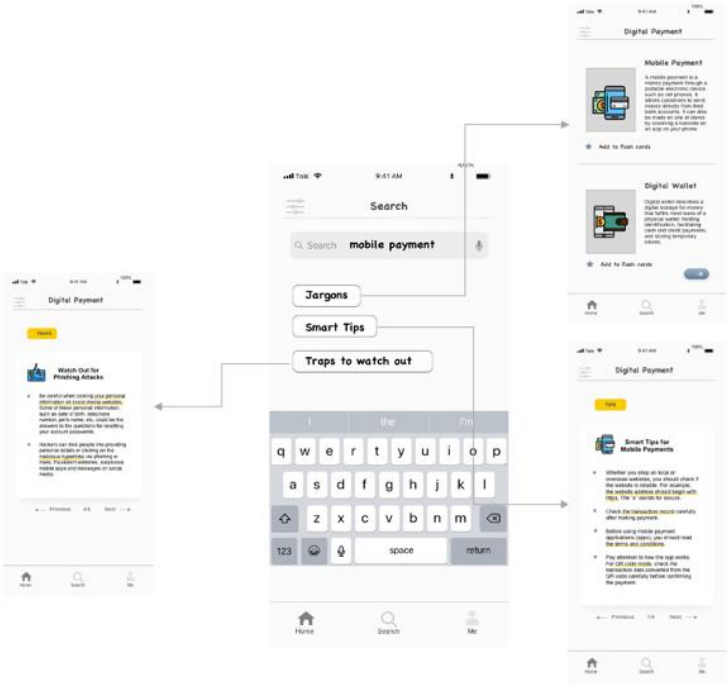


Figure 23 The modifications of search function

Chapter 5 Discussion

5.1 Content Design Strategies

To design the appropriate content for digital financial literacy learning, we need to address the research question ***What knowledge do young people need to promote their digital financial literacy?*** This requires us to summarize and synthesize the findings from an on-going line of inquiry. The efforts involved generating insights from user empathy and revisiting the user content requirements through prototype testing.

5.1.1 The knowledge gaps in digital financial literacy

As the results in the user survey (Section 4.1) showed, the participants have insufficient knowledge about DFS. More precisely, that is the lack of the fundamentals of DFS, such as commonly used jargon and underlying mechanisms. Consequently, consumers are left in a passive position where they have to make decisions without fully understanding the terms and conditions of the DFS they received. This echoed the statements of G20 (2017, p. 33) that "the barriers to accessing and using digital finance effectively can stem from consumers' overall awareness and knowledge about financial concepts and innovation".

Beyond that, "risk is a basic element of decision making in most financial context" (Estelami, 2009, p. 15). DFS is no exception. Key risks may arise in many forms, such as cybercrime, online fraud, phishing scams, digital profiling, and data theft, etc., (G20, 2017; OECD, 2019). Yet young people haven't been equipped with the competences to mitigate such potential risks. As the empathy work in this project showed, the participants lack the knowledge and skills to protect their digital keys, digital wallets, and other access information relating to DFS against fraud or theft. In this regard, IFC (2019) claimed that one factor holding back users is the lack of actionable guidance to help them evaluate the DFS risks. Therefore, beyond the fundamentals of DFS, users also should be well aware of possible DFS risks and a set of practical strategies to prevent themselves from being defrauded.

5.1.2 Content framework to fill in the knowledge gaps

To fill in these knowledge gaps, it is urgent and prudent to develop tailored content for digital financial literacy learning. Yet there seems to be no clear-cut effectiveness in currently available learning resources, due to the fact that most of them are designed from a supply-side, rather than a demand-side. As Dirksen (2016, p. 4) put it best, "information is the equipment the learners need to have in order to perform". Applied to this project, we need to provide the information that users need to make solid decisions about appropriate DFS use and mitigate potential risks.

To that end, this project applied the Digital Finance Cube Framework (Gomber et al., 2017) to build the breadth and depth of intended content coverage (Section 4.4.1). The DFS concepts were categorized into three dimensions, namely *Fin-part (DFS dimension), Tech-part (Technology dimension),* and *learning sequences (i.e. Jargon, Tips and Traps, Quizzes)*. The testing results suggested that the app content fulfilled the potential users' requirements in general. Particularly, the participants were satisfied with the content structure of the app. That demonstrated the effectiveness of applying the Digital Finance Cube as Content Framework, which offered users a systematic view to pursuing DFS knowledge. Moreover, they perceived that the provision of *tips and traps* was a good value proposition, helping them mitigate the risks associated with DFS effectively and efficiently.

5.1.3 Reflections on content design strategies

Meanwhile, the testing results suggested the prototype failed to help the participants balance the risks and rewards of DFS to some degree. This surprise made me reflect on what might cause the unexpected result (Löwgren & Stolterman, 2004). Based on the inputs from users, I realized that the content of DFS benefits was a missing part in the current version. Without knowing both the pros and cons, it is difficult for users to make critical judgments on the products delivered by DFS providers. This is consistent with OECD's statement that the initiatives should strive for "enhancing digital and financial literacy in light of the unique characteristics, advantages, and risks of digital financial services and products" (OECD, 2018, p. 17). In other words, what users need is the all-around knowledge of DFS to promote their digital financial literacy. In doing so, young people would be more likely to make well-informed decisions, and ultimately strengthen their overall trust in the DFS industry.

The above unexpected result also raised the issue about the right amount of content. To tackle it, we need to consider more options to design content coverage in accordance with users' requirements. First of all, designers have to deal with "the apparent contradiction of having to both increase and decrease content" (Garrison, 2017, p. 72). In this case, content could be increased by providing external links that may elaborate on important DFS concepts, or including supplementary material; and decreased by focusing on the essential DFS knowledge and skills. This is an art form where we exploit mobile learning affordances to hit the sweet spot where learners feel comfortable with the amount of content. Another approach is to pull in user-generated content. The focus is to "help learners contribute as well as consume mobile content" (Kukulska-Hulme & Traxler, 2019, p. 193). In addition, personalized content would be an extra option. Designers could provide personally engaging content, considering that users' risk tolerance and digital financial literacy status will differ. For instance, what is necessary for novice learners might be redundant for sophisticated learners (Dirksen, 2016). Content development is not a big-bang effort. Instead, we would be better off taking an incremental approach to building up the breath and width of content coverage. More options and considerations would be tested out by users.

5.2 Delivery Design Strategies

This project strives to design an engaging mobile learning experience to improve young people's digital financial literacy. It applied the DT Methodology to navigate the entire design process. Through these efforts, I learned a lot to answer the research question ***what should be considered when designing a mobile app to promote young people's digital financial literacy?***

5.2.1 A pedagogy for mobile learning design

The previous literature suggested that pedagogical consideration is critical for mobile learning design (Elias, 2011; Garrison, 2017; Kukulska-Hulme & Traxler, 2019). Thus, it is essentially important to consider the appropriate learning theories before proceeding with the design. In this project, I adopted Activity Theory as a conceptual model (Section 4.3.2), which defined learning activities as the central unit of analysis. It presents a holistic system of mobile learning with a set of elements, including subjects (i.e. young people as learners), artifacts (i.e. the mobile app designed in the project), and learning objectives (i.e. digital financial literacy promotion), etc. These elements hint us the dimensions we need to look into when designing mobile learning. Specifically, in the artifact dimension, we need to take into account the mobile learning affordances, such as ubiquitous access, limited display capacity, and reusability; In the subject dimension, the characteristics of young people

as learners need to be considered carefully; In the object dimension, the scope of digital financial literacy learning needs to be identified.
It is also noted that this project embraces an agile mindset to develop the design. Therefore, the prototype presented in this thesis mainly focused on a presentational approach to deliver the digital financial literacy learning. More elements, such as "learning with others" would be incorporated in the future version. As Beetham (2019, p. 142) pointed out, "Engstrom's full activity system allows us to understand the 'other people' involved in learning as part of a deeper and wider social setting". Further suggestions will be discussed in the *Future Research* section (Section 5.3). Yet it is clear that Activity Theory has profound implications for mobile learning design. The job of designers is to bring all the actors and artifacts into closer alignment in mobile settings.

5.2.2 Digital Nudges to reduce cognitive load and promote engagement

Cognitive overload has been claimed as a central issue of mobile learning (Palalas, 2018). DFS puts an extra layer of complexity on people's cognitive processes, given that most DFS are sophisticated and multi-dimensional. People always have confusion about "what they understand to be offered and what is actually being offered by DFS providers" (G20, 2017, p. 38). In the context of digital financial literacy learning, it is particularly true that "cognitive factors may affect the way people receive, understand and use the transmitted knowledge" (OECD, 2019, p. 16). Hence, "the ruthless management of cognitive load" (Dirksen, 2016, p. 167) has become a top priority when delivering the learning content for digital financial literacy promotion.

This is in line with the user insights drawn from this project, which indicated that the participants desire to acquire simple and easy-to-understand learning materials to improve their digital financial literacy. What's more, the time they would like to devote to the learning is approximately 15-30 mins/day. Fulfilling these needs requires thinking about a set of design strategies that can not only reduce users' cognitive load but also sustain their engagement throughout the entire learning journey. Especially for young generations, they crave for being fast learners yet have multiple tasks and distractions compete for their attention. As a pilot study, this project adopted the notion of "digital nudges" (Weinmann et al., 2016, p. 433) in an effort to achieve the desired outcomes. The implemented digital nudges and the corresponding design principles are discussed below.

- **Facilitator nudges: keep learning chunks small and easy-to-understand**

The key actors of digital financial literacy initiatives (G20, 2017; IFC, 2019; OECD, 2018) insisted that the provision of learning content should be simple and easy-to-understand. Many content delivery elements can contribute to achieving this goal. The user feedback presented in this thesis showed that the elements, such as infographic, plain and simple language, and small-chunked information, are favored by the users to facilitate their digital financial literacy learning in the mobile settings. All these can be viewed as facilitator nudges, since they have the benefits of simplifying the tasks and easing the learning-curve (Caraban et al., 2019).

To design effective facilitator nudges, attentions need to be paid in the following two limitations. One is the limitations of short-term memory capacity. As Estelami (2009, p. 275) pointed out, "The number of items that the short-term memory system can hold at any one point of time is approximated to be seven, and the length of time for which the information is available has been determined to be about 10 seconds". To tackle this, the design presented in this project framed the information short and easy-to-understand, so that learners would be able to anchor the most salient aspect of the content and expand their effective working memory capacity (Estelami, 2009; OECD, 2019). The other is the

limitations of display capacity in mobile settings. The small screens of mobile phones make it difficult to show large chunks of information. As such, it is a common approach to deploy micro-learning (Elias, 2011; Hug & Friesen, 2009; Koole & Ally, 2006). The testing results in this project demonstrated that the participants favored this approach to nudging them to dig into DFS knowledge bit by bit.

- **Spark nudges: enhance learning motivation**

Apart from facilitator nudges, spark nudges are also essential elements to consider in terms of the mobile learning design for digital financial literacy promotion. G20 (2017, p. 42) stated that "young generations are more easily fall prey to personal biases such as overconfidence in their own digital capabilities to manage DFS risks". The findings in the empathy phase echoed this point of view. Among the participants, those who make investments on their own showed limited interests in digital financial literacy learning. It was overconfidence that induced people's status-quo bias, making them resist upgrading their DFS knowledge. To address this issue, I launched an onboarding test as spark nudges to increase learners' motivation. More options for spark nudges could be further explored, yet the motivational trait is at the core.

- **Signal nudges: navigate the learning journey**

The results in this project suggested that the participants were willing to allocate relatively limited time and effort to digital financial literacy learning every day. This hints us that signal nudges should be taken into account as well. The main purpose is to promote a higher level of attention and engagement in the mobile learning provided by the app. As Palalas (2018, p. 19) argued, "with mobile learners being able to squeeze in learning in-between other daily activities, they face contesting demands on their attention and their brain". Especially for the young generations, more multi-tasks and distractions in mobile settings compete for their attention at a given moment. This situation calls for signal nudges working as self-regulation reminders, which not only inform them of learning progress, but also provide immediate feedback on the tasks they have completed.

5.2.3 Reflections on delivery design strategies

The testing results presented in this thesis indicated that self-scaffolding was a compelling need of mobile learners, yet the current version of the app didn't fulfill this need. The users positioned search function as a just-in-time learning support to "provide scaffolding WHEN and WHERE learners need it" (Martin & Ertzberger, 2013, p. 78). As the participants mentioned, the information available in the DFS domain is so scattered and fragmented that they have to spend much time searching for the relevant knowledge. Therefore, it would be appealing to them to get ready-to-hand access to certain knowledge when they are struggling with DFS tasks. These are the "teachable moments" proposed by OECD (2019), which means people are provided useful DFS knowledge when it is most needed. At such moments, learners are more likely to interact with learning content in an attentive manner and process information effectively (Palalas, 2018).

More importantly, it helped me better understand how to exploit mobile learning affordances to design digital financial literacy learning. The way young generations receive information and acquire knowledge has been transformed by ubiquitous technologies (Monem, 2015). Learners can decide how, when and where to connect to learning content (Kukulska-Hulme & Traxler, 2019; Martin & Ertzberger, 2013; Palalas, 2018). Accordingly, the actual learning sequences might be different from what we intended in the design process. Digital financial literacy learning would be probably triggered by the authentic tasks in the real-world, or personal curiosity/puzzle. In this sense, a robust

search capability would be an inquiry nudge to scaffold users' learning at any given teachable moment. With the aid of search function, learners can easily connect to the relevant knowledge and information for just-in-time support and future reference. Thus, we would ensure that our design is engaging at delivering content, as well as effective at enhancing user learning.

5.3 Limitations and Future Research

As a pilot study, this project employed convenience sampling and snowball sampling to recruit the participants. For this reason, the user insights generated from the empathy work and user testing might be limited. If more participants had been recruited, the project would have identified more dimensions to integrate into the design of the app.

It is also worth mentioning that this project applied an incremental approach to developing the prototype. It mainly concentrated on three key components (i.e. subjects, artifacts, and objectives) of Activity Theory (Engeström, 1987) to formulate design strategies. More components, such as *learning with others* would be incorporated in the next version of the app. Apart from interactions with digital financial literacy content, interactions between learners would be explored in future study. Accordingly, a community of learners would be created where people could share their authentic DFS experiences and provide peer-to-peer scaffolding. With the involvement of *others*, social interactions between learners would bring different roles and rules into the learning system. For instance, a facilitator role might be set up to promote users' discussion in an open and trusting environment. Especially for the app focusing on financial affairs, it is crucial to ensure that fake news and misleading information must be excluded unconditionally. The boundaries and regulations need to be clarified so that users could "feel sufficiently at ease to engage in meaningful discourse" (Garrison, 2017, p. 38).

As such, "the meaning of activity needs to be understood in relation to a much larger system of collective rules and meaning-making" (Beetham, 2019, p. 35). This suggests that we could expand the conceptual model on the basis of Engstrom's full activity system, which is comprised of six elements (i.e. subjects, artifacts, objectives, others, rules, and division of labor). More dimensions would be explored towards effective mobile learning design for digital financial literacy promotion in the future.

Last but not least, we, as responsible researchers, also need to pay attention to the ethical issues in the course of exploration. In other words, if we capture users' digital footprint as raw data to speculate how such extended elements (e.g. others, division of labor) are played out, ethical aspects should be considered carefully as well.

Chapter 6 Conclusion

This capstone project designed a mobile app to promote young people's digital financial literacy. As a first step towards the learning design, it specifically focused on the content design and delivery design in accordance with the young generation's needs. By the engaging learning experiences, users are expected to improve their understanding of DFS, increase their awareness of safer DFS use, and ultimately strengthen their trust in DFS. To that end, the project employed Design Thinking Methodology to develop the mobile app, starting with user empathy, then working through defining problem space, ideation, prototyping to user testing.

Through these design efforts, the study found that young people have knowledge gaps in DFS fundamentals and risk awareness. To fill in these gaps, it is urgent to make demand-side efforts to develop tailored content, which involves elaboration on DFS jargon, practical strategies for appropriate DFS use, as well as risks and rewards of DFS. With the provision of these content, young people are more likely to make well-informed decisions, and enhance their overall level of digital financial literacy.

At the same time, considerations are needed for delivering the content in a user-friendly fashion. The study discovered that cognitive overload is a demanding challenge for the potential users. In particular, DFS put an extra layer of complexity to users' cognitive processes, which requires us to think about a set of strategies to overcome this challenge.

- Build on a good pedagogy to design mobile learning for digital financial literacy promotion. In this sense, Activity Theory is a good fit as an analytic approach. It identifies the key dimensions (i.e. subjects, objectives, tools, others, rules, and division of labor) we need to look into when designing a holistic system of mobile learning.
- Exploit facilitator nudges to keep learning chunks small and easy-to-understand. The elements, such as infographic, plain and simple language, and small-chunked information, are demonstrated as effective nudges to facilitate users' digital financial literacy learning.
- Incorporate spark nudges to enhance users' learning motivation. Young people tend to have overconfidence in their capabilities to deal with DFS risks, which might make them reluctant to advance their DFS knowledge. As such, it is essential to exploit spark nudges to promote their motivation and clarify learning intentions.
- Embody signal nudges to navigate the learning journey. There is a strong tendency that young people squeeze time for learning in their daily lives. Multiple tasks and distractions compete for their attention. This calls for signal nudges to promote a high level of attention and engagement in mobile learning.
- Add inquiry nudges to provide the scaffolding anywhere anytime. The currently available information on DFS is so scattered and fragmented that people have to spend much time and effort searching for what they need. Therefore, it is appealing to them to get quick access to the relevant knowledge when they are struggling with DFS tasks. Inquiry nudges, such as a robust search function, harness mobile learning's ubiquitous affordances to provide scaffolding at the ad hoc learnable moments.

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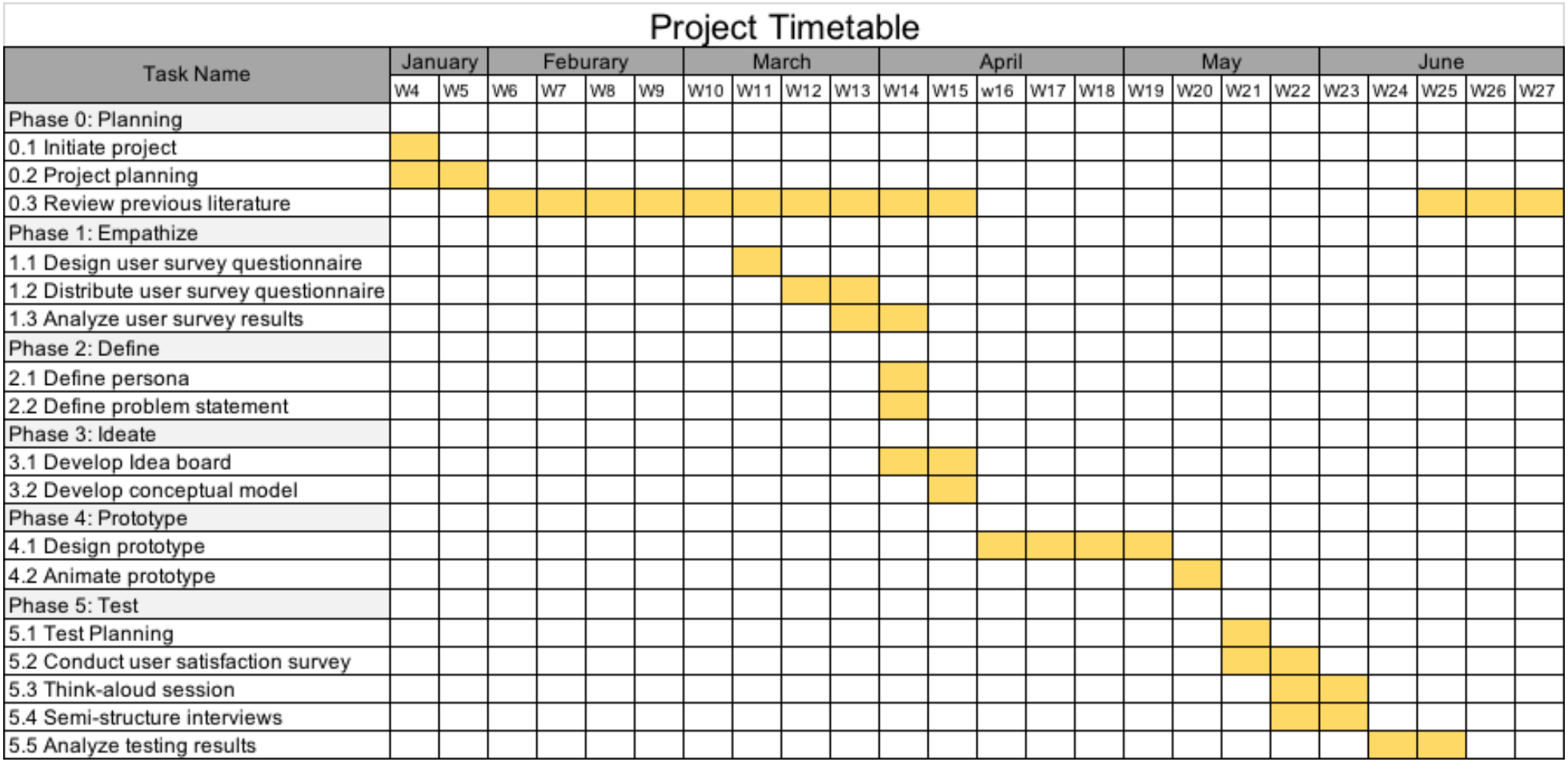
Appendix A

Project Timetable



Appendix B

Digital Financial Literacy Survey

* 1. **Please enter your age:**

- ◯ 18-30 years old
- ◯ 30-50 years old
- ◯ 50+ years old

2. **Which sector are you working in?**

- ◯ Business/Finance Sector
- ◯ IT sector
- ◯ Other (please specify)

3. **What's your educational background?**

- ◯ I studied in business/finance sector.
- ◯ I studied in IT sector.
- ◯ Other (please specify)

4. **Which of the following statements applies to you?**

- ◯ I use digital financial services very often (e.g. mobile bank, Swish, PayPal, Alipay etc.,).
- ◯ I prefer to use traditional financial services.
- ◯ I am not sure at this point.

5. **Which of the following statements applies to you?**

- ◯ I have no experience in investing.
- ◯ I do my investments with the aid of brokers/investment advisors.
- ◯ I do investment on my own.

6. **To what extent do you agree or disagree with the following statements?**
"An investment with a high return is likely to be high risk."

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

7. **To what extent do you agree or disagree with the following statements?**
"It is usually possible to reduce the risk of investing by buying a wide range of financial products."

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

8. **To what extent do you agree or disagree with the following statements?**
"I am fully aware of how to protect my personal key, digital wallet, and other access information relating to my digital financial products/services against fraud or theft."

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

9. **To what extent do you agree or disagree with the following statements?**
"I fully understand the prices, terms, and conditions of the financial services, before putting it into use."

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

10. **Please select the terms you have heard about.**

- ☐ Mobile Banking
- ☐ Digital Wallet
- ☐ Blockchain
- ☐ Cryptocurrencies
- ☐ P2P lending
- ☐ Crowdfunding

11. **Where do you seek digital finance information/knowledge?**
[Please select one answer only]

- ◯ Printed article (e.g. newspaper, magazines, etc.)
- ◯ TV or radio programme
- ◯ General conversations with my friends, family or colleagues
- ◯ Online information
- ◯ Other (please specify)

12. **How useful is the information resource you find to help you understand the following terms?**

	Useful	Either useful or not useful	Not useful
Mobile banking	◯	◯	◯
Digital wallet	◯	◯	◯
Blockchain	◯	◯	◯
Cryptocurrencies	◯	◯	◯
P2P lending	◯	◯	◯
Crowdfunding	◯	◯	◯

13. **How easy are the following terms to understand?**

	Easy	Either easy or difficult	Difficult
Mobile banking	○	○	○
Digital wallet	○	○	○
Blockchain	○	○	○
Cryptocurrencies	○	○	○
P2P lending	○	○	○
Crowdfunding	○	○	○

14. **How much time could you devote to learn the fundamentals of digital finance?**

- ○ 1 hour/day
- ○ 0.5 hour/day
- ○ 15 mins/day
- ○ I'm not interested in this field

15. **What is the most important factor helps you understand the terms in digital finance?**
[Please use the drop-down menu to rank the factors from most to least, most important=1, least important=4]

- Pictures illustrated the definitions
- Plain and simple language
- Small-chunk of information
- Others' experience

16. **Which of the following part of digital finance would you like to know most?**
[Please use the drop-down menu to rank the factors from most to least, most important=1, least important=4]

- Mechanism (how it works)
- Potential benefits
- Potential risks
- Consumer protection regulations

17. **What do you think is a must-have feature of an app to help you learn the fundamentals of Digital Finance/Fintech?**

Appendix C

Usability Testing Questionnaire

Part 1: How do you perceive **the usefulness** of the Mobile APP Digital Finance IQ?

1. This app will help me learn the fundamentals of digital finance.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

2. This app would make it easier for me to understand the digital finance jargons

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

3. This app would make it easier for me to balance the risk and reward of digital finance services/products.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

4. This app would make it easier for me to mitigate the risks associated with digital finance services/products.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

Part 2: How do you perceive **the ease of use** of the Mobile APP Digital Finance IQ?

5. This app is easy to use.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

6. The app text is easily readable.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

7. The app has an effective layout, organization, and grouping.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

Part 3: How do you perceive **the ease of learning** of the Mobile APP Digital Finance IQ?

8. This app explains the digital finance concepts and features in a simple and easy-to-understand way.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

9. I was able to understand how different digital finance concepts relate to each other.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

Part 4: How do you perceive **the satisfaction** of the Mobile APP Digital Finance IQ?

10. This app is visually pleasing.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

11. I would download the app to learn the digital finance foundations.

- ◯ Strongly agree
- ◯ Agree
- ◯ Neither agree nor disagree
- ◯ Disagree
- ◯ Strongly disagree

Part 5: Your feedback is important to us!

12. Does the content cover what you need to promote your digital finance literacy?
What knowledge would you suggest us to incorporate in the next version?

13. Do you engage in the learning the Digital Finance IQ mobile APP provides?
What feature would you suggest us to redesign?
What additional feature would you suggest us to add?