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Designing a Gamified Tool: An ADDIE Approach to Capital Market Flashcard Development

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Abstract: Traditional, lecture-based finance courses frequently overwhelm undergraduate students with dense theoretical content, leading to poor knowledge retention, lower overall engagement, and a heavy reliance on last-minute cramming before major assessments. To address these persistent educational challenges, this study details the design, development, and implementation of a mobile-friendly digital flashcard game specifically tailored for an undergraduate Financial Markets and Institutions (FIN) course using the systematic ADDIE instructional design framework. By integrating active recall strategies, custom visual aids, and an algorithm-driven Spaced Repetition System (SRS), the platform transforms passive studying into a dynamic learning process that prompts students to systematically review challenging concepts based on their individual mastery levels. Subject-matter experts rigorously vetted the curriculum content for accuracy and practical relevance prior to deployment, while formative evaluations directly measured student usability, overall engagement, and conceptual comprehension during active coursework. Formative findings, including high expert ratings for content validity and evidence of adaptive scheduling from system logs, suggest that the tool has strong potential to support active recall. However, its effectiveness in improving long-term knowledge retention and reducing academic anxiety will be examined in a subsequent summative evaluation. Ultimately, by documenting the comprehensive analysis, design, and development phases, this study provides instructional designers and finance educators with a practical, replicable blueprint for implementing gamified, technology-enhanced active learning tools across complex capital markets curricula.

Keywords: *Capital market; flashcard game; ADDIE model; digital learning; spaced repetition system (SRS)*

1. Introduction and Background

Traditional lecture-centered teaching tends to leave learners in a passive state and results in limited knowledge retention (Kooloos et al., 2020). Even though effective for content coverage, these methods may not fully support sustained student engagement or deep cognitive processing (Dzaiy & Abdullah, 2024). Studies of higher education pedagogy have shown that lecture-centered environments limit active participation by positioning students as passive recipients rather than active contributors to their learning (Bhardwaj et al., 2025; Mladenovici et al., 2022). This may contribute to reduced attention span, lower engagement, and difficulties in long-term knowledge retention. A large-scale meta-analysis across STEM disciplines found that traditional lecturing is linked to higher failure rates and poorer exam outcomes compared to active learning methods (Freeman et al., 2014). Although the Freeman study focuses on STEM subjects, its findings are relevant to finance education, which also involves dense, technical material well-suited to active learning approaches. Furthermore, academic boredom is frequently reported among university students, especially in subjects with heavy content and minimal instructional variation or interactivity (Pekrun et al., 2010). Such conditions often undermine motivation, leading students to adopt superficial learning strategies that hinder deep understanding and long-term retention (Hemmings et al., 2019; Sharp et al., 2018).

In response to these challenges, researchers have increasingly advocated for the integration of active learning methods and digital educational innovations within higher education settings. Active learning shifts the focus from passive content consumption to active student participation, resulting in improved engagement, motivation, and learning outcomes (Freeman et al., 2014). Among the various approaches available, gamified

learning has attracted significant scholarly interest due to its potential to transform routine academic tasks into more stimulating learning experiences. Studies have shown that gamification may help alleviate feelings of academic boredom while encouraging greater involvement in coursework (Gyedu et al., 2026; García-López et al., 2023; Ruiz et al., 2024). Furthermore, cognitive learning strategies, particularly spaced repetition and retrieval practice, have consistently demonstrated their value in strengthening long-term memory retention through the systematic reinforcement of previously learned material (Vagha et al., 2025).

Building on recent developments in digital learning, this study developed a customized mobile-compatible flashcard application tailored to the FIN syllabus. The application integrates a Spaced Repetition System (SRS) to support active recall and maintain student engagement throughout the semester. Development was guided by the ADDIE framework (Analysis, Design, Development, Implementation, and Evaluation), which is widely used in instructional design to transform learning objectives into practical educational solutions (Basri et al., 2025). This paper concentrates on the first three phases of the model, namely analysis, design, and development. It explains how capital market topics were organized into a gamified learning structure, evaluated by subject matter experts, and subsequently refined based on preliminary user feedback.

Three key gaps can be identified from the existing literature. First, research on spaced repetition and digital flashcards has largely been conducted in language learning (Yu & Trainin, 2022) and health-related disciplines (Maye et al., 2026, Barrison et al., 2025). Although one study in a finance-related field explored the relationship between the voluntary use of a self-testing application and examination performance (Wuyts et al., 2026), it did not examine how such a tool might be designed and developed to support a specific curriculum. Second, studies of gamified learning in business education tend to emphasize learning outcomes while providing limited detail on the underlying design and development process. As a result, educators may find it difficult to replicate or adapt these interventions in their own teaching contexts. Third, commercially available flashcard decks are generally not tailored to specific course syllabi or the Malaysian higher education environment. Differences in financial instruments, regulatory structures, and market practices mean that materials developed primarily for North American contexts may not fully address local learning needs.

This study contributes to the literature in three ways. First, it provides a transparent description of the process used to convert a content-heavy finance syllabus into retrieval-practice items, thereby supporting replication in comparable disciplines. Second, it reports expert validation at the item level and details the modifications made in response to reviewer feedback, offering greater insight into the development process. Third, it documents both the configuration and observed performance of a spaced repetition scheduling system within a finance education setting, a dimension that has rarely been examined in prior research.

2. Literature Review

Retention Challenges in Finance Education

Undergraduate finance curricula demand that students engage with a complex network of technical concepts, regulatory frameworks, and macroeconomic instruments. In introductory courses, learners must distinguish closely related ideas such as primary and secondary markets while simultaneously building foundational knowledge. From a cognitive perspective, this rapid introduction of highly interrelated concepts places a substantial burden on working memory, which has a strictly limited capacity (Sweller, 1988). When instructional materials are dense and presented without sufficient scaffolding or active reinforcement, this limited capacity is easily overwhelmed, preventing effective transfer of knowledge into long-term memory (Hawthorne et al., 2019; Sweller, 2010). Concepts in business and economics cannot be learned in isolation; instead, high element interactivity means that learners must process multiple interacting elements concurrently, increasing cognitive load exponentially and necessitating deliberate practice for schema construction.

Traditional study strategies frequently used by undergraduates, such as passive highlighting and repeated reading, offer limited benefits for long-term retention. While these techniques may create a sense of familiarity, they do not strengthen memory retrieval or promote deep conceptual integration. Consequently, students often face difficulties recalling key concepts during assessments or applying their knowledge within complex problem-solving contexts. A comprehensive review by Dunlosky et al. (2013) classified these popular strategies as "low utility," noting they do not reliably enhance exam performance or knowledge transfer.

Such passive strategies contribute to what cognitive psychologists term the illusion of competence, where repeated exposure leads students to confuse familiarity with true understanding (Roediger & Karpicke, 2006b; Hazlett et al., 2025). Recognition during study does not guarantee successful recall or application of knowledge in high-stakes situations.

In contrast, decades of cognitive science research demonstrate that actively retrieving information significantly strengthens memory traces beyond what passive restudying achieves. Roediger and Karpicke (2006a) showed that while restudying may support short-term cramming, active retrieval practice yields substantial gains in long-term retention and higher-order learning. When students engage in effortful practice, such as short-answer self-testing, they reinforce connections between concepts and build robust mental schemas (Greving & Richter, 2022; Kooloos et al., 2020). This process moves learning beyond superficial recognition, laying the cognitive foundation necessary for tackling complex financial problems.

Spaced Repetition and Active Recall

Given the limitations of standard passive study habits, cognitive psychology research highlights retrieval-based strategies, specifically spaced repetition and active recall, as effective methods to improve long-term retention. Spaced repetition operates by progressively widening the intervals between review sessions, forcing students to recall an idea when it begins to fade from memory. This timed reinforcement helps strengthen memory over time and increases study efficiency. For instance, landmark research by Roediger and Karpicke (2006) reveals that students who took repeated practice tests retained significantly more information one week later compared to those who merely reread the same material, despite the re-readers initially feeling more confident.

Digital flashcards provide an ideal tool to blend these active recall mechanics with performance-based scheduling algorithms. Across broader educational contexts, digital flashcards and audio-visual inputs have been highly effective in helping English as a Foreign Language (EFL) students master complex vocabulary (Yowaboot & Sukying, 2022; Peters, 2019; Peters & Webb, 2018). Extensive literature demonstrates that intentional vocabulary learning, which relies on focused repetition and retention, noticeably lifts students' baseline knowledge (Hirschel & Fritz, 2013; Honarzad & Soyoof, 2023). Historically, structural study aids like word lists, flashcards, and vocabulary notebooks have served as foundational tools to aid purposeful, structured vocabulary development (Elgort & Nation, 2010).

When these structural mechanics are translated into digital finance and accounting education, the pedagogical benefits hold equally true. Unlike static paper flashcards, modern Spaced Repetition Systems (SRS) dynamically tune the review cadence of individual items based on real-time learner performance. Cards that students find difficult reappear more frequently, while well-mastered content is reviewed less often. In finance-specific settings, undergraduates who voluntarily used a gamified self-testing app earned significantly higher final exam scores than non-users. Crucially, the intensity and accuracy of their active practice, not simply access to the app, predicted these gains (Wuyts et al., 2026). Pulling information from memory without assistive cues reinforces memory pathways far more effectively than passive observation. Together, active recall and algorithmically spaced reviews form a durable engine for long-term learning (Vagha et al., 2025)

However, the benefits of these cognitive strategies are not entirely unconditional. When study material is exceptionally long or conceptually complex, the advantage of active retrieval over restudying can diminish, especially for students already experiencing high cognitive load (Redifer et al., 2026). This underscores the importance of designing learning tools that break down content into manageable units, preventing overload and maximizing the efficacy of retrieval-based practice.

Empirical studies highlight the effectiveness of retrieval strategies, particularly spaced repetition complemented by active recall, as powerful means to enhance retention (Roediger & Karpicke, 2006). By introducing intervals that prompt review just before forgetting, spaced repetition maximizes both efficiency and retention. Digital flashcards serve as a practical application of these strategies, promoting active engagement and adaptability in the learning process. Studies indicate that students utilizing gamified self-testing applications perform significantly better academically than their peers who do not engage with these tools (Wuyts et al., 2026).

ADDIE and ARCS: Structure and Motivation in Instructional Design

While effective cognitive strategies are essential, the design of a learning tool is equally critical to its success. The ADDIE model, comprising Analysis, Design, Development, Implementation, and Evaluation, offers a systematic, phased framework that guides the development of educational interventions. This approach ensures alignment between learner needs, course objectives, and evaluation criteria throughout the development process (Basri et al., 2025).

Motivation complements instructional design as a vital element for student engagement. Keller's ARCS model identifies four essential factors influencing learners' motivation: Attention (capturing interest through novelty or compelling questions), Relevance (linking content to learners' goals and experiences), Confidence (building belief in success), and Satisfaction (reinforcing effort through visible progress and rewards) (Keller, 1987, 2010). Digital learning tools can naturally incorporate these factors via features such as interactivity, immediate feedback, and personalized pacing. For instance, gamified flashcards can effectively capture attention, adaptive content enhances relevance, prompt feedback builds confidence, and progress tracking fosters satisfaction.

Supporting this, meta-analytic evidence in higher education reveals that gamified learning formats generally enhance motivation and engagement more consistently than non-gamified methods. Crucially, the impact is strongest when gamification elements are thoughtfully integrated into, rather than merely added onto, instructional goals (Gyedu et al., 2026).

By combining the structured rigor of the ADDIE model with the motivational focus of ARCS, designers can create comprehensive learning tools that not only deliver content effectively but also encourage consistent student use and engagement.

3. Research Methodology

Research Design

This study employs Design and Development Research (DDR), which focuses on the systematic creation, refinement, and examination of instructional products and processes, as well as the factors that support their effective replication in other educational settings (Richey & Klein, 2014). The ADDIE framework was used to guide the development process. Although the study encompasses all five ADDIE phases, particular emphasis is placed on the Analysis, Design, and Development stages, as these phases generated the primary evidence reported in this paper. Implementation is discussed mainly in terms of the deployment environment, while Evaluation is limited to formative validation conducted before full implementation. An assessment of learning outcomes through summative evaluation falls beyond the scope of the present study and is addressed in a separate investigation.

Table 1: Schematic layout of the ADDIE instructional lifecycle applied in this study

The ADDIE Cyclical Flowchart		
1	Analysis	Identification of curriculum challenges and learning bottlenecks within the FIN course.
2	Design	Categorizing five macro financial market sub-decks.
3	Development	Creating active recall cards & setting SRS parameters.
4	Implementation	Classroom integration & student mobile application usage.
5	Evaluation	Expert content validation and system-log verification of scheduler behaviour.

Following the issues identified during the analysis phase, a digital flashcard application was developed to encourage active learning and continuous review of course content. Rather than relying solely on traditional lecture-based instruction, the tool employs a Spaced Repetition System (SRS) to support retrieval practice and reinforce knowledge retention over time. Table 2 compares the conventional instructional approach used in the FIN course with the features incorporated into the developed flashcard application across four key learning dimensions.

Table 2: Comparison of the traditional FIN approach and the developed SRS flashcard tool.

Dimension	Traditional FIN Approach	Developed SRS Flashcard Tool	Supporting Theory
Learning engagement	Passive listening to lectures and static slides	Active retrieval through a question-and-answer interface	Retrieval Practice Theory (Roediger & Karpicke, 2006)
Study scheduling	Massed cramming before exams	Spaced repetition with SM-2 algorithm adjusts intervals.	Forgetting-curve model (Ebbinghaus, 1885/1913)
Multimedia use	Text-heavy definitions	Text integrated with charts, graphs, and diagrams.	Dual-coding theory (Paivio, 1986)
Feedback	Delayed, exam-based feedback	Immediate formative feedback during learning activities.	Formative assessment framework: Formative Assessment Theory (Black & Wiliam, 1998)

Note: Learning engagement was informed by Retrieval Practice Theory (Roediger & Karpicke, 2006), study scheduling by Ebbinghaus's Forgetting Curve (Ebbinghaus, 1885/1913), multimedia use by Dual Coding Theory (Paivio, 1986), and feedback design by Formative Assessment Theory (Black & Wiliam, 1998).

To evaluate the initial deployment of the application, a formative mixed-method assessment was undertaken. The evaluation drew on two complementary sources of evidence. The first consisted of system-generated logs that captured student usage patterns and monitored the operation of the spaced repetition algorithm. The second source comprised preliminary user feedback that provided insights into students' perceptions of engagement, usability, and overall learning experience.

Research Context and Participants

The study was carried out in the undergraduate Financial Market and Institutions (FIN) course offered by the Faculty of Business and Management at a Malaysian public university. As a core subject for finance majors, the course covers topics including financial systems, capital market operations, regulatory institutions such as Bank Negara Malaysia, and a range of financial instruments.

Three groups of participants were involved in different phases of the study. For the needs analysis, 64 students who had completed the course in the previous semester, together with two instructors who had taught the course for at least two semesters, were purposively selected. Their input helped identify areas of difficulty and common misconceptions among students.

Formative findings, including high expert ratings for content validity and evidence of adaptive scheduling from system logs, suggest that the tool has strong potential to support active recall. However, its effectiveness in improving long-term knowledge retention and reducing academic anxiety will be examined in a subsequent summative evaluation.

During the implementation phase, 95 undergraduate finance students enrolled in two parallel seminar groups participated in the study setting. Purposive sampling was adopted, with the sampling frame consisting of all students registered in these groups. Eligibility was limited to students who were currently enrolled in the course and had access to a compatible mobile device or laptop. Students who chose not to provide consent for log-data collection were excluded from the dataset but continued to have unrestricted access to the application. Of the 95 enrolled students, 90 consented to the collection of usage data, representing a participation rate of 94.7%.

ADDIE Framework Application

Analysis Phase

The analysis phase examined learning challenges encountered by students in the FIN course. Information gathered through discussions with students and instructors, together with a review of course materials, revealed several recurring issues. Students frequently experienced difficulty recalling technical terminology, distinguishing between closely related financial concepts, and maintaining engagement during lecture-centred sessions. Study practices were also largely passive, with many students relying on rereading notes rather than actively testing their understanding.

These observations suggested a need for a learning tool that would promote active recall, encourage regular review, and provide opportunities for independent learning outside scheduled class hours. In response, a digital flashcard application incorporating a Spaced Repetition System (SRS) was proposed to support continuous reinforcement of key concepts.

Design Phase

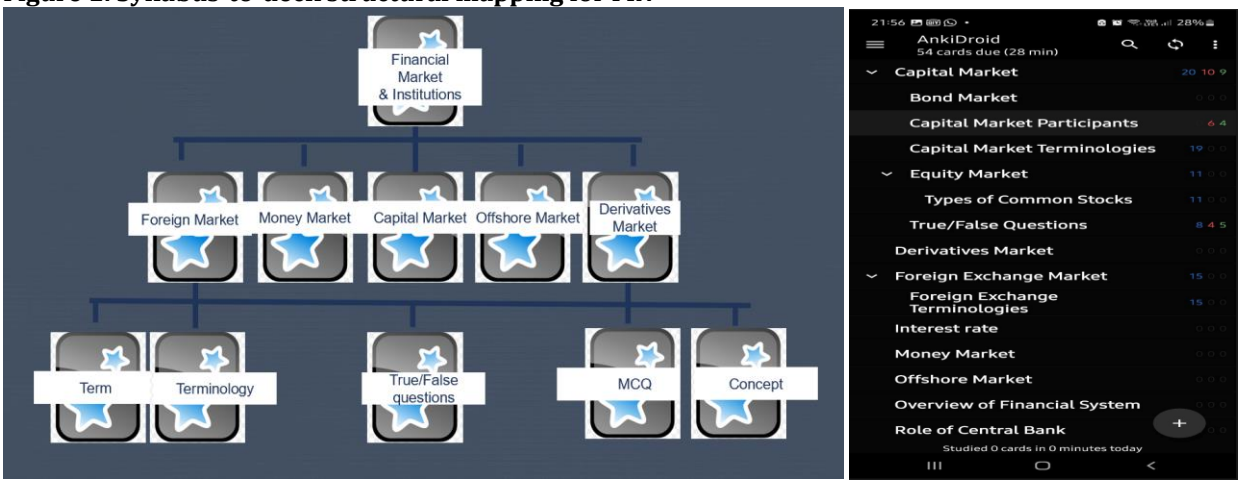
The design phase focused on defining the pedagogical structure and functional features of the flashcard application. The design was informed by established principles of retrieval practice and spaced learning, while learner engagement was guided by Keller's ARCS motivational model.

Several key design decisions were made. Flashcards were organized according to major course topics, including capital market instruments, trading mechanisms, and regulatory institutions. Each card adopted a question-and-answer format to encourage active retrieval rather than passive review. To support long-term retention, an SRS mechanism was integrated to adjust review intervals according to individual learner performance. Gamified features, including progress tracking and immediate feedback, were also incorporated to encourage continued participation.

The ARCS model informed the motivational aspects of the application design. Attention was supported through short and interactive learning activities, while relevance was enhanced by aligning content with course assessments and practical financial market scenarios. Confidence was fostered through graduated levels of difficulty and ongoing performance feedback. Satisfaction was reinforced through visual indicators of progress and achievement.

To facilitate systematic content organisation, the FIN syllabus was divided into five topic-based learning decks: Money Markets, Foreign Exchange Markets, Equity Markets, Bond Markets, and Derivatives. The resulting structure is presented in Figure 1. For the initial implementation phase, the application was introduced to 95 undergraduate finance students enrolled in two parallel seminar groups. Participants were selected through purposive sampling, as all students were registered in the course where the intervention was implemented.

Figure 1: Syllabus-to-deck structural mapping for FIN



Development Phase

The flashcard application was developed using the open-source Anki platform, chosen for its ability to operate across multiple devices and operating systems, including Windows, iOS, and Android (AnkiDroid). Question-bank content was derived directly from the FIN syllabus and organized into interactive flashcard decks. Three card formats were used: definition-based cards to strengthen knowledge of key terminology, multiple-choice items to assess conceptual understanding, and true/false questions aimed at addressing common misconceptions. For example, several cards were designed to reinforce the distinction between bondholders as creditors and shareholders as equity owners.

Card reviews were managed through a four-level response system that allowed learners to indicate the difficulty of each item. Selecting Again returned the card for review within a few minutes, while Hard scheduled an earlier repeat review than usual. Cards marked Good were presented again after a longer interval, whereas Easy extended the review period further. Scheduling was controlled by a modified SM-2 algorithm configured with a starting ease factor of 250%, an interval modifier of 100%, and a maximum review interval of 30 days. These settings were intended to ensure that previously learned material remained in circulation throughout the semester while preventing excessively frequent repetition.

Figure 2: Screenshot of Anki using web and Apps

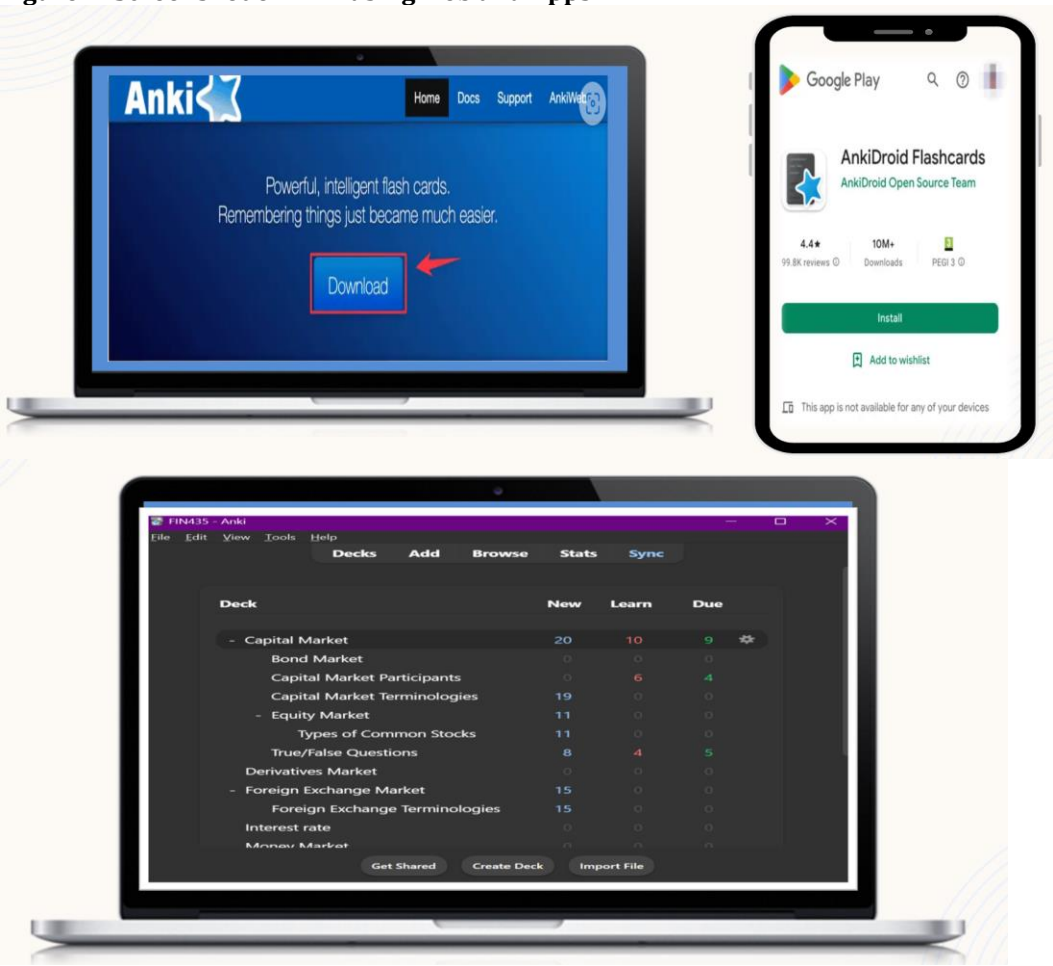


Figure 3: Screenshot of contents

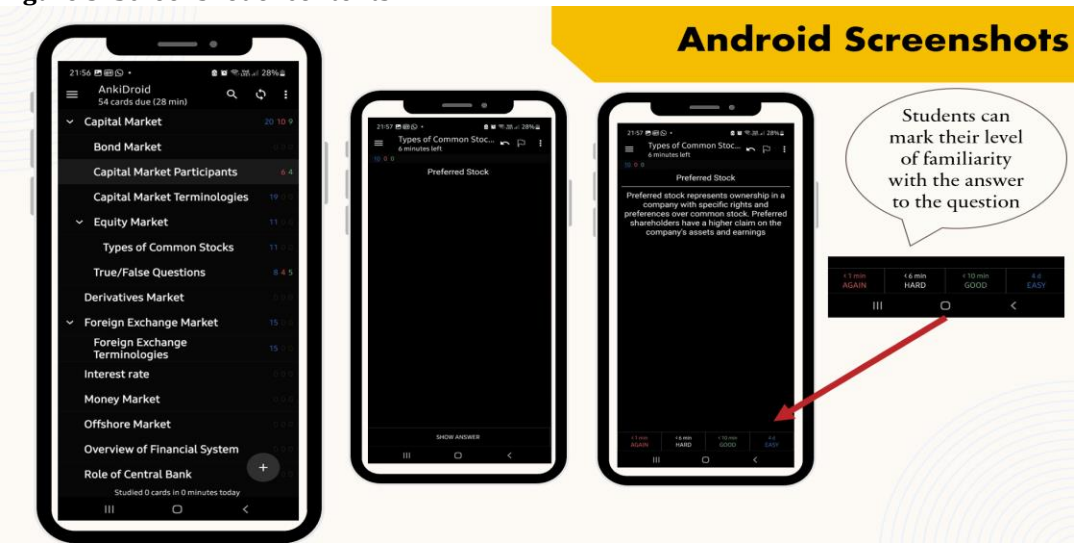


Figure 4: Flashcard front-and-back interface with SRS response buttons.



Implementation Phase

The application was incorporated directly into classroom teaching rather than being assigned solely as an independent learning activity. Upon completion of each topic, the instructor shared the relevant flashcard deck with students for immediate use. Students then participated in short retrieval-practice sessions during class, enabling instructors to monitor understanding, identify misconceptions, and provide clarification where necessary before introducing subsequent topics.

Evaluation Phase

As the primary focus of this study was the development of the application, the evaluation phase concentrated on formative validation to determine whether the content and system functions were suitable for wider use. Two forms of evaluation were undertaken. First, a panel of experienced finance academics reviewed the flashcards for consistency with the course syllabus and relevant regulatory requirements. Second, alpha testing was conducted on both Android and iOS devices to assess key system functions, including scheduling performance, card synchronization, and multiple-choice functionality.

The expert review panel consisted of three senior finance academics, each with more than ten years of teaching experience. The flashcards were evaluated using a four-point Likert scale covering relevance, accuracy, and clarity. Analysis of the ratings produced a Content Validity Index (CVI) of 0.92, exceeding the commonly accepted benchmark of 0.80. This result indicates a high level of agreement among the experts regarding the suitability of the flashcard content for the core learning outcomes of the FIN course.

4. Results

System Architecture and Final Instructional Artifact

The primary outcome of this design and development study is a functional, multi-platform digital flashcard tool explicitly aligned with the FIN syllabus. Built upon the Anki engine, the master deck is structured to progress logically from broad capital market categories to detailed concept-level cards. In total, the deck comprises 95 flashcards, distributed across five core capital market modules as summarized in Table 3.

Table 3: Structure and card distribution of the FIN master deck.

Target Sub-Deck Domain	Card Count (n)	Primary Pedagogical Focus
Money Market Terminologies	15	Intermediation processes and BNM macro-liquidity instruments
Bond Market Mechanics	20	Debt pricing, yield-to-maturity, and common structural misconceptions
Equity Market Operations	19	Common stock rights, equity issuance rules, and trading mechanics
Derivatives Market Dynamics	13	Hedging strategies, forward contracts, options terminology
Foreign Exchange Infrastructure	28	Exchange rate quotation, currency pairs, and regulatory compliance

Each flashcard follows a front-and-back format tailored to address specific learning objectives. True/false prompts are strategically used to correct common misconceptions; for example, clarifying that bondholders possess a credit claim rather than an equity stake in the issuing company. Multiple-choice questions extend beyond mere recall by challenging students to analyze and compute real-world financial scenarios rather than simply recognizing definitions.

Expert Validation and Formative Refinement

Prior to classroom deployment, the flashcard content and visual components underwent rigorous expert validation. Three subject-matter experts evaluated the materials using a standardized 4-point Likert scale questionnaire assessing relevance, structural accuracy, and conceptual clarity. The overall Content Validity Index (CVI) was 0.92, substantially exceeding the conventional academic threshold of 0.80, indicating strong alignment with the core FIN syllabus. Table 4 provides a detailed breakdown of validation scores by dimension.

Table 4: Expert validation scores by dimension.

Expert Validation Dimension	Evaluative Focus	Score
Curricular Relevance	Alignment with FIN course learning outcomes	0.96
Structural Accuracy	Precision of terminology, formulas, and regulatory data	0.91
Conceptual Clarity	Readability of front-and-back layout and explanations	0.89

Although the quantitative scores were high, qualitative feedback from the expert panel led to meaningful improvements. Reviewers noted that several money-market cards contained excessive text, potentially

increasing cognitive load. These cards were subsequently divided into smaller, more manageable units and supplemented with visual aids such as comparative equity charts leveraging dual-coding theory to support learning. Additionally, experts recommended that complex financial calculations include detailed, step-by-step solutions on the reverse side of each card, transforming them into self-contained diagnostic exercises rather than simple answer keys.

System Log Metrics and Algorithmic Functionality

Following the expert-driven content revisions, backend system logs were analyzed to verify that the Spaced Repetition System (SRS) scheduler operated as designed. The average card ease factor remained stable at approximately 250%, indicating that the flashcards were calibrated to an appropriate and balanced level of difficulty, avoiding extremes of being too easy or overly challenging.

The spacing of review intervals aligned with expectations: mastered terms gradually extended their review intervals toward the 30-day maximum, while cards identified as difficult were promptly re-queued within minutes. This behavior demonstrates that the scheduler effectively allocated study time, prioritizing material where students showed weaker recall and minimizing redundant reviews of already mastered content.

Overall, these log data patterns confirm that the tool functioned as intended, serving as a personalized review system that dynamically adapts to each student's recall performance, rather than enforcing a uniform study schedule for all learners.

Discussion

The design, development, and expert validation of the FIN flashcard tool demonstrate that employing a structured instructional framework like ADDIE can effectively transform dense, theory-heavy financial course material into a practical, student-centered learning resource. The high Content Validity Index (CVI) of 0.92 underscores that a deliberate, systematic design process rather than an ad hoc selection of content produces a tool closely aligned with formal course requirements. This finding reinforces prior research highlighting ADDIE's value in maintaining instructional accuracy when converting complex, information-rich subjects into digital learning environments (Basri et al., 2025).

The integration of a structured deck layout with diverse visual formats corroborates recent findings in gamified higher education design, which consistently show that combining game-like structural elements with visual, student-focused materials promotes active recall and mitigates the academic boredom prevalent in content-heavy courses (Gyedu et al., 2026). Notably, this effect is not limited to general educational contexts: in a directly comparable financial discipline, students who voluntarily engaged with a gamified self-testing app outperformed non-users on final exams, with gains tracking closely to the intensity and accuracy of their practice rather than mere tool access (Wuyts et al., 2026). This pattern emphasizes that the anticipated benefits of the FIN flashcard tool depend largely on consistent student engagement rather than novelty alone.

Supporting this, backend system logs provide technical evidence that automated SRS scheduling effectively addresses a major limitation of traditional study habits, which often rely on passive review and lack mechanisms to support durable retention. This aligns with foundational cognitive research demonstrating that repeated retrieval practice significantly enhances long-term recall compared to repeated rereading, even though rereading might feel subjectively more productive during study sessions (Roediger & Karpicke, 2006). Similar spaced repetition interventions in other rigorous technical subjects report comparable improvements, with learners using spaced review outperforming peers who exclusively engaged in massed, pre-exam cramming (Vagha et al., 2025). Collectively, these findings indicate that targeted, algorithm-driven review sharpens learner focus and reduces the cognitive overload that typically leads to disengagement.

At the same time, the effectiveness of retrieval-based strategies is not universal. Research on cognitively demanding material demonstrates that the benefits of testing over restudying can diminish or vanish when content is too dense to be cleanly segmented into manageable learning units (Redifer et al., 2026). This observation resonates with the expert panel feedback discussed in Section 4.2, where money-market cards identified as overly dense were subdivided into smaller, more digestible units, a revision that parallels recommendations from cognitive load theory literature.

Overall, this study confirms that the FIN flashcard tool is a structurally sound and content-valid instructional artifact. Its design decisions are well-grounded in established theories of retrieval practice, cognitive load management, and gamified motivation. These findings naturally lead to the next research phase, which will empirically investigate the tool's impact on student exam performance and motivation during a full-semester, live classroom implementation.

5. Conclusion, Limitations and Future Directions

Conclusion

This study has documented the systematic design, development, and expert validation of a mobile-compatible digital flashcard tool tailored for the FIN course, using the ADDIE instructional design model. It illustrates an effective approach to translating dense, theory-intensive capital market content into an interactive, student-centered learning resource built on the open-source Anki platform. The primary contribution lies in offering a replicable process that integrates financial pedagogy with cognitive science principles, specifically organizing course material into targeted sub-decks augmented by an automated Spaced Repetition System (SRS). With a Content Validity Index (CVI) of 0.92 and stable backend system metrics, this tool demonstrates both conceptual soundness and technical reliability adequate to support active retrieval practice in a challenging academic context.

Limitations

Several limitations should be acknowledged. First, the flashcard set is specifically scoped to introductory-to-intermediate FIN content and would require substantial adaptation to support more advanced or quantitatively intensive corporate finance courses. Second, the tool's effectiveness depends on learners having personal access to compatible mobile devices or laptops, making its utility contingent on hardware availability and basic digital literacy. Third, as a design-and-development study, this research focuses on expert content validation and technical functionality testing but does not yet provide empirical evidence on impacts to exam performance or long-term retention across an entire semester.

Future Directions and Recommendations

Future research will involve a comprehensive empirical evaluation employing pre-test and post-test assessments to measure learning gains, alongside application of Keller's ARCS model to evaluate motivational changes during semester-long classroom use. Practically, subsequent versions could transition away from dependence on the Anki engine by developing a dedicated standalone native application. Finally, the ADDIE-guided design framework proven effective here could be expanded to other content-dense business subjects such as taxation, corporate governance, or auditing to establish an integrated, active-learning toolkit applicable across the broader curriculum.

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