



Inclusive Financial Literacy for Deaf People: Accessibility Analysis of Game-Based Financial Education Media

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Abstract

Background: Limited access to visually accessible financial education remains a barrier for deaf people in understanding financial information and making responsible economic decisions.

Objective: This study aims to analyze the accessibility of a game-based financial education medium for deaf people by examining user needs, the translation of financial content into visual and interactive elements, and user experience toward the developed prototype.

Methods: This study employed a descriptive-evaluative mixed methods design using a design thinking approach comprising empathize, define, ideate, prototype, and testing stages. Data were collected through observation, interviews, user discussions, prototype testing, user experience evaluation, and a financial literacy questionnaire involving 30 deaf participants in Bali. Accessibility was positioned as the primary design principle by integrating visual communication needs into the development of the game-based financial education media.

Results: The findings indicate that deaf users require financial education media with simple language, clear visuals, intuitive navigation, contextual examples, sign language videos, and direct feedback. The Cash Hero prototype showed improvement across all UEQ dimensions, with final scores ranging from 0.658 for efficiency to 1.725 for perspicuity. The average financial literacy index was 72.0%, with 60.0% of respondents categorized as having moderate financial literacy. These findings indicate that game-based learning can translate abstract financial concepts into more concrete, contextual, and interactive learning experiences.

Conclusion: This study concludes that game-based financial education designed through design thinking can serve as an accessible learning medium for deaf people. Future research should develop the prototype into a functional mobile application.

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INTRODUCTION

Financial literacy plays an important role in shaping an individual's ability to understand, analyze, and make rational and responsible financial decisions. In everyday life, financial literacy relates to the ability to manage income and expenses, distinguish between needs and wants, understand loan risks, plan savings, and use financial services appropriately. Adequate financial literacy not only supports individual financial independence but also contributes to national economic stability and growth (Fazil et al., 2024). From a behavioral accounting perspective, this ability reflects how individuals process, understand, and use financial information as a basis for producing rational and responsible economic decisions.

However, increased access to financial services has not always been accompanied by adequate levels of financial understanding. The 2024 National Survey of Financial Literacy and Inclusion conducted by the Financial Services Authority (OJK) shows that the financial inclusion rate in Indonesia reached 75.02%, while the financial literacy rate stood at 65.43% (Keuangan, 2024). This gap indicates that while some members of society have access to financial products and services, they do not fully possess sufficient knowledge and skills to use them effectively, critically, and responsibly.

The issue of financial literacy becomes more complex for persons with disabilities due to barriers in accessing information, limited appropriate educational media, and suboptimal inclusive communication approaches. One group facing these challenges is deaf individuals, who in communication and learning processes rely more heavily on visual information, simple text, sign language, icons, illustrations, and interactive media. In this study, the term "deaf individuals" is used to emphasize accessibility needs and users' visual communication characteristics in accessing financial education.

Data from Indonesia's Central Statistics Agency (BPS) for 2020 show that approximately 2.87% of Indonesia's total population, equivalent to 7.8 million people, were identified as having hearing difficulties in various categories (Dya & Oktora, 2023; Statistik, 2020). However, specific data on the financial literacy levels of the deaf community in Indonesia remain very limited. In 2021, a national study on disability profiles in Indonesia revealed that persons with hearing impairment are among the groups with the lowest access to financial services and financial education programs, partly due to the absence of sign-language-based and visually accessible financial learning materials (Hidayatullah & Syafrial, 2026; Indonesia, 2021). This data underscores the urgency of developing targeted financial education media that responds to the specific communication and accessibility needs of the deaf population.

Deaf individuals face particular barriers in accessing financial education because most learning materials are still delivered through verbal explanations, lengthy text, or media that are not fully accommodating to visual communication needs. This condition makes financial information not always easy to understand, especially when the material relates to abstract concepts such as risk, loans, interest, investment, insurance, and financial planning. Several studies have also shown that deaf individuals still face limited access to sign language-based financial education and learning resources that suit their needs (Engel et al., 2023; Thohari & Rizky, 2021). Furthermore, survey data from the Yayasan Menembus Batas shows that 55.3% of respondents with disabilities had never heard of or studied financial literacy in depth (Al Ansori, 2024). This limited access to financial literacy has the potential to increase vulnerability in personal financial management, consumption decision-making, credit use, and long-term financial planning (Alabshar et al., 2024).

A preliminary study through initial observation at the Bali Deaf Community also showed that community members still experience difficulties in accessing financial information because available educational media tends to be dominated by lengthy text and verbal explanations. Such media is considered less engaging and less suited to the visual communication characteristics of deaf individuals. As a result, basic concepts such as saving, borrowing, managing expenses, understanding risk, and financial planning are not fully understood optimally. These initial findings indicate that the issue of financial literacy for deaf individuals is not only about the availability of materials but also about how financial information is designed, visualized, and delivered accessibly. From a behavioral accounting perspective, the ability to understand basic financial concepts is not only about mastering information but also about individuals' cognitive

processes in interpreting financial information, assessing consequences of choices, and making daily economic decisions.

Therefore, financial education media for deaf individuals needs to be designed not merely as a tool for conveying information but as a visual-interactive learning space that allows users to understand financial concepts through experience, simulation, choice, and direct feedback. Abstract financial concepts need to be translated into more concrete, contextual, and accessible forms. In this context, game-based learning emerges as a relevant alternative because it can combine visual elements, interactivity, challenges, narrative, and simple simulation in the learning process. Educational games have the potential to help users understand the consequences of financial decisions through more engaging learning experiences that align with visual communication characteristics.

A number of studies have shown that gamification and game-based learning can support user engagement, learning participation, and conceptual understanding through interactive experiences (Adeniyi & Kuku, 2020; Akanni, 2026; Patrício et al., 2021; Sun et al., 2023). However, most existing studies focus on general learning effectiveness without sufficiently addressing accessibility for users with specific communication needs, particularly deaf individuals who rely heavily on visual modalities. For example, Adeniyi and Kuku (2020) demonstrated the positive effects of gamification on mathematics achievement among hearing-impaired learners (Akanni, 2026), but did not address financial literacy content or the design principles required for accessible financial education media. Similarly, Cannistrà et al. (2024) and Estima and Peguinho (2024) examined game-based learning among general populations in multi-country settings, leaving the intersection of game-based learning, inclusive financial education, and disability-specific design relatively unexplored. Financial literacy research has also predominantly focused on the general public, students, university students, and business groups, with limited attention to the visual communication needs of deaf individuals. Furthermore, studies integrating inclusive financial education, game-based media, and user-centered design remain limited, particularly in the context of deaf individuals in Indonesia. This gap indicates the need for a design approach that positions accessibility as a primary principle in developing game-based financial education media for deaf users.

This study addresses the identified gap by applying a design thinking approach to the design and evaluation of game-based financial education media for deaf individuals. Design thinking was selected because it places users' needs, experiences, barriers, and characteristics at the center of the design process. In this study, user requirements encompass the needs of deaf individuals to access, understand, and interpret financial information that is often technical, abstract, and presented in formats that are not sufficiently visually accessible. Through the stages of empathize, define, ideate, prototype, and testing, the approach supports the development of educational media that is not only engaging but also aligned with users' visual communication needs, comprehension levels, and learning experiences. Thus, design thinking serves not only as a product development method but also as an approach for integrating accessibility principles into the design of financial literacy media.

Based on this rationale, this study aims to analyze the accessibility of game-based financial education media for deaf individuals using a design thinking approach. The study focuses on identifying users' accessibility needs in understanding basic financial concepts, translating financial content into visual and interactive elements within the game, and evaluating user experience in terms of accessibility, content comprehensibility, and suitability to the visual communication characteristics of deaf individuals.

The novelty of this study lies in positioning accessibility, specifically tailored to the visual communication characteristics of deaf individuals, as the primary design principle in game-based financial education media rather than merely using games as a vehicle for general content delivery. Unlike previous studies that examined game-based learning among general populations (Cannistrà et al., 2024; Estima & Peguinho, 2024) or addressed hearing-impaired learners in non-financial contexts (Adeniyi & Kuku, 2020; Akanni, 2026), this study integrates design thinking, visual accessibility principles, and financial literacy content specifically for deaf individuals in Indonesia. This approach also extends previous applications of design thinking in education (Gunawan et al., 2023; Yulius et al., 2023) by placing disability-specific

communication needs at the center of the design process.

Theoretically, this study contributes to the development of inclusive financial literacy from a behavioral accounting perspective by highlighting the role of information presentation in financial information processing among individuals with different communication characteristics. Practically, the findings provide input for educational media developers, disability communities, educators, and financial institutions in designing financial education media that are more visual, interactive, and accessible. Accordingly, this study positions accessibility not merely as a supporting feature of game-based learning but as a fundamental principle in the development of inclusive financial education media.

Behavioral Accounting Theory

Accounting is not only viewed as a system for recording and reporting financial information but also as a field concerned with human behavior in understanding, interpreting, and using financial information. Behavioral accounting theory examines how individuals interact with financial information, emphasizing psychological, emotional, and cognitive factors that influence their decision-making processes ([Hellmann, 2016](#); [Shank, 2026](#)). Financial information does not always lead to appropriate decisions because each individual has different cognitive abilities, experiences, perceptions, and limitations in processing such information. Therefore, the quality of financial information is determined not only by its completeness and accuracy but also by the extent to which the information can be understood by users.

In the context of financial literacy, behavioral accounting theory is relevant for explaining how individuals receive and interpret financial information before making economic decisions. Financial concepts such as saving, managing expenses, understanding debt, interest, risk, and investment are often abstract and require a complex understanding process. If financial information is presented with complex language, unclear symbols, or media that do not match user characteristics, that information has the potential not to be optimally understood ([Morris et al., 2022](#)). Thus, the form of information presentation becomes an important part of the process of building financial understanding and behavior.

For deaf individuals, barriers to financial literacy are not only related to knowledge levels but also to access to educational media capable of conveying financial information visually and comprehensibly. From a behavioral accounting perspective, these barriers can be understood as issues in the judgment and decision-making process, how individuals interpret financial information before making economic decisions. Information such as recording income and expenses, budget planning, debt management, and understanding simple cash flow requires presentation that aligns with users' cognitive abilities and communication characteristics. Therefore, media accessibility is important because it affects how financial information is received, processed, and used by deaf individuals.

Inclusive Financial Literacy for Vulnerable Groups

Inclusive financial literacy emphasizes that the ability to manage financial resources is determined not only by the availability of information but also by the extent to which that information can be accessed, understood, and used by groups with diverse communication needs. For vulnerable groups, including deaf individuals, limited access to financial information and services can increase the risk of economic vulnerability, poverty, and financial exclusion ([Alabshar et al., 2024](#); [Engel et al., 2023](#)). Therefore, financial literacy needs to be understood as an accessibility issue, not merely as a matter of individual knowledge levels.

In the context of deaf individuals, barriers to financial literacy often arise because conventional educational materials have not been fully designed according to visual communication characteristics and sign language use. Materials that rely on lengthy text, verbal explanations, or abstract financial terminology can limit user understanding. Khan et al. ([2024](#)) show that financial education gaps still occur because learning materials have not met inclusive communication needs for communities that rely on visual modalities. Thus, inclusive financial literacy demands educational media that is visual, simple, contextual, and easy to navigate so that financial information can be understood more equitably by deaf individuals. Referring to these needs, in this study media accessibility is understood through visual clarity, language

simplicity, navigation ease, relevance of examples, and the media's ability to convey financial concepts without relying on verbal or audio explanations.

Game-Based Learning in Financial Literacy Education

Game-based learning is a learning approach that utilizes games as media to deliver material through interactive experiences, scenarios, challenges, and feedback. This approach is relevant in financial literacy education because financial concepts are often abstract and require more concrete presentation to be easily understood. Through games, users do not passively receive information but are actively involved in decision-making, problem-solving, and reflecting on the consequences of their choices.

In the educational context, game-based learning and gamification have both developed as approaches capable of delivering more engaging and participatory learning processes, although they have different emphases. This study emphasizes game-based learning because the developed media takes the form of an educational game, not merely the addition of game elements to conventional learning. Empirical evidence shows that game-based learning can improve knowledge retention, motivation, and active participation compared to conventional learning methods ([Sun et al., 2023](#)). In the realm of financial education, various studies also show that digital games can support improved financial decision-making and consumer education across diverse community groups ([Cannistrà et al., 2024](#); [Estima & Peguinho, 2024](#)). Putri and Artani (2020) also show that games can help participants understand concepts of cash flow, expenditure, savings, debt, and asset diversification more concretely ([Shabrina & Annas, 2025](#)).

For deaf individuals, game-based learning has particular potential because it can present material through visuals, illustrations, short text, interactive flows, and situational examples close to daily life. The findings of Adeniyi and Kuku (2020) show that gamification has a significant positive effect on mathematics learning achievement among learners with hearing impairments ([Akanni, 2026](#)). This finding indicates that game-based approaches also have potential for use in financial literacy interventions for deaf individuals, especially when media is designed with attention to visual accessibility, language simplicity, and navigation ease.

Design Thinking in Inclusive Educational Innovation Development

Design thinking is a user-centered innovation framework increasingly applied in education and financial technology development. This approach emphasizes the importance of understanding user needs, experiences, and barriers before designing a solution. Through the stages of empathize, define, ideate, prototype, and test, design thinking helps improve the suitability of solutions to actual user needs, so that developed solutions are not only function-oriented but also responsive to user experiences and barriers ([Patrício et al., 2021](#); [Schmidberger & Wippermann, 2024](#)). In the context of financial education, design thinking has been used to develop various learning media and platforms that are more relevant to user needs. Yulius et al. (2023), for example, applied design thinking in developing an investment learning application, while Gunawan et al. (2023) used it in developing a financial reporting platform. Both studies show that design thinking can produce learning tools and technologies that are more accessible, contextual, and aligned with user needs.

In this study, design thinking is used as an approach to develop inclusive game-based financial education media for deaf individuals. User involvement is an important aspect because the communication needs of deaf individuals cannot be assumed solely from the researcher's or developer's perspective. Thus, design thinking serves as an approach to guide the development of game-based financial education media so that it is not only visually appealing but also accessible, easy to use, and appropriate to the learning experiences of deaf individuals.

Based on the above description, this study positions the accessibility of financial education media as the intersection between financial information understanding, inclusive financial literacy needs, and game-based media development. Behavioral Accounting Theory is used to explain that financial information needs to be presented in a form that users can understand before being used in decision-making. Inclusive financial literacy affirms the importance of access to financial information for vulnerable groups, including deaf individuals.

Meanwhile, game-based learning and design thinking are used as approaches to design educational media that is more visual, interactive, contextual, and user-centered. Based on this framework, this study focuses on developing and evaluating the accessibility of game-based financial education media for deaf individuals.

Based on the theoretical framework described above, the conceptual framework of this study integrates Behavioral Accounting Theory, Inclusive Financial Literacy, Game-Based Learning, and Design Thinking as interconnected foundations for designing and evaluating accessible financial education media for deaf individuals. Behavioral Accounting Theory provides the underlying perspective that the way financial information is presented can influence cognitive processing and decision-making. This perspective is complemented by Inclusive Financial Literacy, which emphasizes that financial education should be accessible to individuals with diverse communication needs, including deaf individuals. Game-Based Learning then provides an interactive and experiential approach through simulation, challenges, and contextual learning activities that can facilitate the understanding of financial concepts. Meanwhile, Design Thinking guides the user-centered development process through the stages of empathize, define, ideate, prototype, and testing, ensuring that the characteristics, needs, and experiences of deaf users are incorporated throughout the design process. The integration of these four foundations converges on the central construct of this study, namely the accessibility of game-based financial education media, which is evaluated through media accessibility indicators, user experience dimensions measured using the User Experience Questionnaire (UEQ), and basic financial literacy mapping.

METHOD

This study was a descriptive-evaluative study with a mixed methods approach. The choice of a mixed methods design was justified by the complexity of the research objectives, which required both an in-depth understanding of users' subjective accessibility needs (qualitative) and a systematic measurement of user experience and financial literacy levels (quantitative). As Creswell and Plano Clark (2018) argued, mixed methods research is particularly appropriate when neither qualitative nor quantitative data alone would sufficiently address the research questions and when the integration of both types of data produces a more comprehensive understanding of the phenomenon under study (Taheri & Okumus, 2024). In this study, qualitative data provided the contextual depth necessary to understand the visual communication barriers faced by deaf individuals, while quantitative data offered systematic evidence of prototype quality and user literacy levels. The descriptive approach was used to describe the accessibility needs of deaf individuals in understanding financial information, while the evaluative approach was used to assess the suitability of game-based financial education media based on user experience. This study was not intended to test causal relationships between variables but rather to analyze the accessibility of financial education media designed according to the visual communication characteristics of deaf individuals. The research process was developed using a design thinking approach encompassing the stages of empathize, define, ideate, prototype, and testing.

The accessible population in this study comprised deaf individuals who were members of or connected to deaf communities in Bali. The research sample consisted of 30 respondents from the deaf community in Bali who were selected using purposive sampling. The determination of 30 respondents was grounded in the principle that, for mixed methods studies with a descriptive-evaluative design, a minimum sample of 30 is considered adequate to support meaningful descriptive statistical analysis and to achieve data saturation in qualitative inquiry (Creswell & Clark, 2018; Taheri & Okumus, 2024). Furthermore, for user experience evaluation instruments such as the UEQ, a sample of 20–30 evaluators is generally recommended as sufficient to yield stable and reliable results (Nouriska et al., 2023; Schrepp et al., 2017). The respondent criteria in this study were that participants were deaf individuals, were willing to participate in the trial process of the game-based financial education media, and were willing to complete the provided evaluation instruments. Purposive selection of respondents was conducted because this study required participants who matched the characteristics of the target users, particularly users with visual communication needs in understanding financial

information.

This study used primary data obtained directly from respondents. Data were collected through observation, interviews, user discussions, prototype testing, and questionnaire distribution. Observation and interviews were used to explore the needs, barriers, and preferences of deaf individuals in accessing financial information. User discussions were conducted to obtain input on the flow design, display, and presentation of financial content in the game.

The instruments used in this study included observation guidelines, interview guidelines, a user experience questionnaire, and a financial literacy questionnaire. The user experience questionnaire used the User Experience Questionnaire (UEQ), which measures six aspects: attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty. The UEQ is a well-validated psychometric instrument that has been empirically tested across multiple studies and cultural contexts ([Hendrian et al., 2024](#); [Laugwitz et al., 2008](#); [Schrepp et al., 2017](#)). The UEQ demonstrates high internal consistency, with Cronbach's alpha values exceeding 0.70 for all scales in the original validation study, confirming its reliability as a user experience measurement tool ([Nouriska et al., 2023](#); [Schrepp et al., 2017](#)). In this study, the UEQ was adapted for use with deaf respondents by presenting all items in simplified language and providing sign language assistance during completion to ensure that the instrument items were comprehensible and could be answered accurately. The UEQ consists of 26 items with a 1–7 rating scale. Meanwhile, the financial literacy questionnaire was used to describe respondents' basic understanding of financial knowledge, financial attitudes, and financial behavior. The financial literacy questionnaire consisted of 12 items on a 1–5 Likert scale covering the dimensions of financial knowledge, financial attitudes, and financial behavior. This instrument was used to assess media accessibility, user experience, and respondents' basic understanding of the financial material presented in the game.

The entire data collection process was conducted with attention to research ethics principles. This study received ethical approval from the relevant institutional review authority prior to data collection, ensuring compliance with established standards for research involving human participants. Respondents were given explanations regarding the research purpose, form of involvement, and use of their data before participating. Participation was voluntary, respondent identities were kept confidential, and the communication process during interviews, discussions, and prototype testing was assisted by sign language interpreters to ensure that the meaning of questions and answers could be accurately understood.

The research procedure followed the design thinking stages of empathize, define, ideate, prototype, and testing. The empathize stage was conducted through observation, interviews, and discussions to understand the needs, barriers, and visual communication characteristics of deaf individuals in accessing financial information. The define stage was conducted by formulating the main user problems based on the results of the initial data collection and then compiling them into accessibility needs for financial education media.

The ideate stage was conducted by designing ideas for game-based financial education media, including the game flow, financial content presentation, use of illustrations and icons, simple text, and interactive elements. The prototype stage was conducted by developing the media design into an educational game prototype. Subsequently, the testing stage was conducted by asking respondents to try the prototype and provide assessments of user experience, content comprehensibility, and media suitability to the visual communication needs of deaf individuals. The evaluation results at the testing stage were used as the basis for improving the media design. This testing stage was conducted iteratively so that user input at each stage could be used to improve the media design before subsequent evaluations.

The aspects analyzed in this study included media accessibility, user experience, and basic financial literacy. These three aspects were used to assess the suitability of the game-based financial education media to the visual communication needs of deaf individuals.

Table 1

Operational Definitions of Research Aspects

No	Research Aspect	Operational Definition	Indicators
1.	Financial education media accessibility	The media's ability to present financial information so that it is easily accessible, understood, and used by deaf individuals	Visual clarity, language simplicity, navigation ease, relevance of examples, and suitability with visual communication characteristics
2.	User experience	User assessment after trying the game-based financial education media prototype	Attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty
3.	Basic financial literacy	Respondents' understanding of basic personal financial management concepts	Financial knowledge, financial attitudes, and financial behavior

Qualitative data were analyzed descriptively through data reduction, categorization, and conclusion drawing. Data from observations, interviews, and user discussions were categorized based on accessibility needs, barriers to understanding financial information, and preferences for media presentation. The results of the qualitative analysis were used as the basis for developing user personas, empathy maps, game flow, and prototype improvements. Media accessibility was analyzed by combining qualitative findings from observations, interviews, and user discussions with user experience evaluation results, particularly regarding visual clarity, ease of navigation, content comprehensibility, and media suitability to the visual communication characteristics of deaf individuals.

Quantitative data were analyzed using descriptive statistics. User experience data were analyzed based on the results of the User Experience Questionnaire (UEQ), which covered six aspects: attractiveness, perspicuity, efficiency, dependability, stimulation, and novelty. The UEQ data processing procedure involved the following steps: (1) recoding responses from the original 1–7 scale to a standardized –3 to +3 scale, where –3 represented the most negative assessment and +3 represented the most positive assessment; (2) calculating the mean score for each UEQ dimension based on its corresponding item scores; (3) interpreting dimension scores against the UEQ benchmark standard established by Laugwitz et al. (2008), in which scores below –0.8 were classified as "bad," scores between –0.8 and 0.8 as "neutral," scores above 0.8 as "good," and scores above 1.75 as "excellent"; and (4) comparing scores across three evaluation stages (initial, iteration 1, and iteration 2) to assess the effects of design improvements (Hendrian et al., 2024). The selection of the UEQ as a user experience evaluation instrument was consistent with the study by Paramitha and Estiyanti (2025), who used the UEQ for initial prototype testing. UEQ scores were then converted according to the UEQ processing procedures into a value range of –3 to +3 to interpret user experience tendencies across each aspect.

Financial literacy data were analyzed using mean values and financial literacy indices. The financial literacy index was calculated by comparing the scores obtained by respondents with the maximum possible score and expressing the result as a percentage. The results of this analysis were used as supporting data to describe respondents' basic understanding of financial knowledge, financial attitudes, and financial behavior. Because this study was descriptive-evaluative, data analysis was not directed toward testing causal hypotheses but rather toward evaluating the accessibility and user experience of the game-based financial education media.

RESULTS AND DISCUSSION

Results

Respondent Characteristics

The respondents in this study were 30 deaf individuals who were potential users of the financial education game prototype named Cash Hero. Respondents were selected because they matched the target media development audience user groups requiring visual, interactive, and

accessible financial education media. All respondents tried the Cash Hero prototype before completing the user experience evaluation instrument. The financial literacy questionnaire was used to map respondents' basic understanding of personal financial concepts. Respondent characteristics in this study include age, gender, experience playing digital games, types of games most frequently played, and average gaming time per week. Details of respondent characteristics are presented in Table 2.

Table 2

Research Respondent Characteristics

No	Characteristic	Category	Count	Percentage
1.	Gender	Male	14	46.7%
		Female	16	53.3%
2.	Age	17-20 years	9	30.0%
		21-25 years	14	46.7%
		26-30 years	7	23.3%
3.	Actively plays digital games	Yes	23	76.7%
		No	7	23.3%
4.	Type of games frequently played	Puzzle/casual	9	30.0%
		Simulation/strategy	6	20.0%
		Adventure	5	16.7%
		Educational	3	10.0%
		Not actively playing	7	23.3%
5.	Average gaming time per week	<1 hour/not active	7	23.3%
		1-3 hours	10	33.3%
		>3 hours	13	43.3%

Source: Processed data, 2025

Respondent characteristics show that prototype testing was conducted on user groups that match the research target. Respondents were dominated by early productive age and most had experience playing digital games. This condition is important because users in this group are beginning to face personal financial decision-making needs while being sufficiently familiar with interaction patterns in games. Thus, respondents were considered capable of providing relevant feedback on the accessibility, ease of use, and suitability of Cash Hero as a game-based financial education media for deaf individuals.

User Needs Identification

User needs identification was conducted to understand the barriers deaf individuals face in accessing financial literacy education. The results of observation and interviews show that users' main obstacles are not only limited to low understanding of financial concepts but also to the limited availability of educational media that aligns with their visual communication needs. Available financial education media is still predominantly delivered in lengthy text or verbal explanations, making it less accessible to deaf users. This condition causes financial concepts such as money management, financial institutions, investment, and financial risk not always to be fully understood.

Table 3

User Needs Identification Results

No	Finding Aspect	Identification Result	Implication for Cash Hero Design
1.	Access to financial information	Users experience limitations in obtaining easily understood financial education.	Financial material needs to be presented simply, concisely, and contextually.
2.	Communication barriers	Financial education still largely relies on verbal explanations and has not widely used sign	The game needs to prioritize visual communication, icons, illustrations, and sign

No	Finding Aspect	Identification Result	Implication for Cash Hero Design
3.	Educational media format	language. Available educational media tends to be in the form of lengthy text and is less interactive.	language support. Material needs to be packaged in visual form, simulation, and game challenges.
4.	Understanding financial concepts	Users need assistance in understanding money management, investment, and financial risk concepts.	The game needs to contain financial decision scenarios close to daily life.
5.	Learning experience	Users need learning media that is not burdensome and can increase engagement.	Design needs to be simple, attractive, interactive, and provide direct feedback.

Source: Processed data, 2025

Based on Table 3, users' main needs point toward visual, interactive, and accessible financial education media. This finding shows that delivering financial information to deaf individuals is not sufficient by merely simplifying material but also requires adjusting the presentation method to users' communication characteristics. Therefore, Cash Hero was designed as a game-based educational media that combines visual illustrations, simple game flow, financial decision simulation, and feedback on user choices. This approach is expected to help users understand financial concepts through more concrete and relevant learning experiences closely tied to daily life.

Cash Hero Prototype Development

Based on the user needs identification results, this study produced a financial education game prototype named Cash Hero. This prototype was designed as a simulation-based learning media that places users as players making financial decisions in various everyday life situations. The main concept of the game is to provide learning experiences through reading brief information, choosing financial actions, and observing the impact of decisions taken.

Cash Hero was developed by emphasizing four main principles: information simplicity, visual strength, interactivity, and accessibility. Financial material is not presented in lengthy text but is packaged through sign language videos, illustrations, icons, short educational modules, decision simulations, and direct feedback. Each design element is directed to help users understand the relationship between financial choices and the consequences that arise in the game.

Table 4

Cash Hero Prototype Development Components

No	Design Component	Development Form	Purpose
1.	Player profile	Players choose avatar, financial profile, and lifestyle.	Helps users feel engaged in financial simulation.
2.	Educational modules	Financial material presented in brief infographics and sign language videos.	Simplifies financial concepts to make them more understandable.
3.	Decision simulation	Players face financial choices in each game round.	Trains users to understand consequences of financial decisions.
4.	Financial indicators	Game displays cash flow, savings, investment, protection, and net worth.	Provides visual overview of player's financial condition.
5.	Feedback	Each choice is followed by an explanatory message about the decision's impact.	Reinforces users' understanding of financial concepts.

No	Design Component	Development Form	Purpose
6.	Visual support	Design uses icons, colors, illustrations, and simple displays.	Enhances accessibility and readability for deaf individuals.

Source: Processed data, 2025

The prototype development proceeded through two iterative design improvements based on structured user feedback collected at each evaluation stage. In the initial evaluation, users reported that the game interface was unclear in navigation, financial concepts were presented too abstractly without contextual examples, and the absence of sign language video support significantly reduced comprehensibility. Based on this feedback, Iteration 1 improvements included: restructuring the navigation flow to reduce screen complexity, adding contextual financial scenarios close to users' daily life experiences, and incorporating placeholder sign language video icons. In Iteration 2, further improvements addressed remaining issues identified in Iteration 1: sign language videos were integrated into educational modules, visual icons for each financial indicator (cash flow, savings, investment, protection, net worth) were redesigned for greater clarity, and the feedback messages following each decision were simplified to use shorter sentences and clearer visual cues. These iterative improvements directly resulted in the UEQ score improvements observed across all dimensions from initial evaluation to Iteration 2.

The prototype visualization was then realized in the form of a digital interface displaying several main screens: avatar selection, educational modules, decision simulation, and financial condition summary. The display was designed so that users could understand the function of each screen without relying on lengthy verbal instructions. The use of icons, colors, illustrations, sign language videos, and concise information arrangement became an important part of ensuring that the prototype was more accessible to deaf individuals.

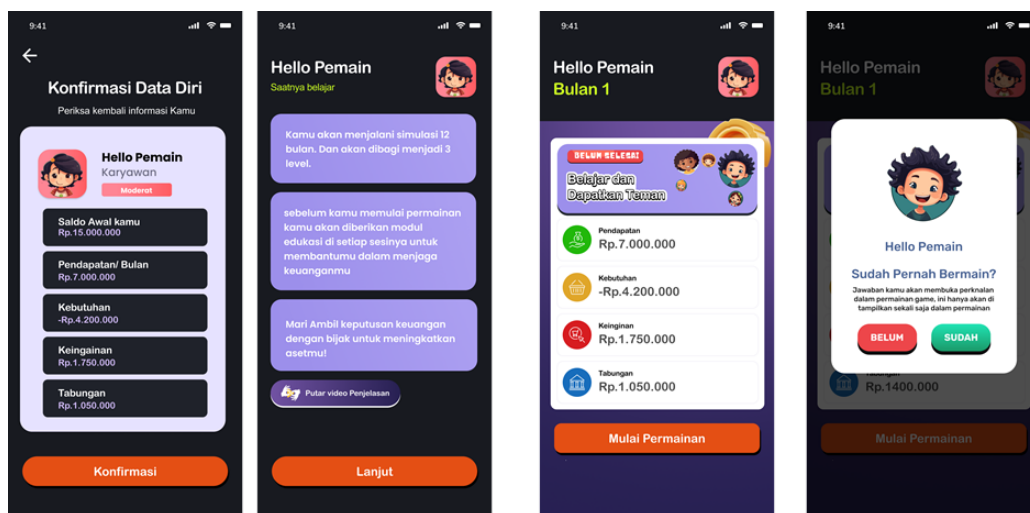


Figure 1. Cash Hero Prototype Display
Source: Processed data, 2025

Based on Table 4 and Figure 1, the Cash Hero prototype functions not only as a game media but also as an experience-based financial learning media. Each component is designed to transform abstract financial concepts into more concrete learning experiences through simulation and feedback. Thus, Cash Hero is directed to help deaf individuals understand financial literacy through a visual, interactive, and contextual approach.

User Experience Evaluation

User experience evaluation was conducted to assess the quality of the Cash Hero prototype from the user's perspective. Testing was conducted using the User Experience Questionnaire (UEQ) covering six dimensions: attractiveness, perspicuity, efficiency,

dependability, stimulation, and novelty. In UEQ interpretation, negative values indicate a less favorable user experience, values approaching zero indicate neutral assessment, while positive values indicate a favorable user experience. User experience evaluation was conducted in three stages: initial evaluation of the prototype design, iteration 1 after the first design improvement, and iteration 2 after advanced design improvements. The UEQ processing results are presented in Table 5.

Table 5

Comparison of UEQ Evaluation Results

No	Dimension	Initial	Iteration 1	Iteration 2
1.	Attractiveness	-1.006	-0.044	1.106
2.	Perspiciuity	-1.650	-0.067	1.725
3.	Efficiency	-0.800	-0.033	0.658
4.	Dependability	-1.375	0.100	1.442
5.	Stimulation	-1.600	0.067	1.492
6.	Novelty	-1.583	-0.125	1.633

Source: Processed data, 2025

Based on Table 5, all user experience dimensions showed improvement from initial evaluation to iteration 2. In the initial evaluation, all dimensions were in negative values, indicating that the prototype design had not yet provided optimal user experience. After design improvements in iteration 1, all dimension values moved toward zero and some began to reach positive values. This improvement indicates that refinements to information structure, navigation, visual display, and interaction flow began to reduce usage barriers.

In iteration 2, all dimensions experienced stronger improvement. Applying the UEQ benchmark standard (Hendrian et al., 2024; Laugwitz et al., 2008), which classifies scores below -0.8 as "bad," -0.8 to 0.8 as "neutral," above 0.8 as "good," and above 1.75 as "excellent," the final iteration results can be interpreted as follows: Perspiciuity (1.725) approached the "excellent" threshold, indicating that the prototype became highly learnable and easy to understand for users; Novelty (1.633) and Dependability (1.442) reached the "good" category, suggesting that users found the prototype innovative and reliable; Attractiveness (1.106) and Stimulation (1.492) also fall in the "good" category, reflecting positive user appeal and motivational quality; while Efficiency (0.658), though improved, remains in the "neutral" range, indicating that the task completion flow may still require further optimization in subsequent development. The perspiciuity dimension achieved the highest value, indicating that the prototype became increasingly easy to understand and learn for users. Improvements in the stimulation and novelty dimensions show that the prototype was assessed as more attractive, motivating, and having a sense of newness. Overall, the UEQ evaluation results show that the design improvement process successfully enhanced user experience of Cash Hero. The improvement across all dimensions demonstrates that the final prototype is more suitable for the needs of deaf individuals, particularly in terms of clarity, visual appeal, engagement, reliability, and ease of use.

Financial Literacy Measurement Results

In addition to evaluating user experience, this study also mapped respondents' financial literacy as supporting information for educational media development. Measurement was conducted using a descriptive questionnaire covering three aspects: financial knowledge, financial attitudes, and financial behavior. These three aspects were chosen because they relate to the learning objectives in the Cash Hero prototype, especially in helping users understand basic personal financial management concepts.

The analysis results show that the average respondent responses ranged from 3.43 to 3.90 on a 1-5 Likert scale. These values are above the midpoint of the scale, indicating that respondents already have a basic understanding of financial literacy concepts. Based on the financial literacy index calculation, an average value of 72.0% was obtained. The financial literacy categories in this study were used for descriptive purposes, with low for scores less than

60%, moderate for scores 60% to less than 80%, and high for scores 80% or above.

Based on the mapping results, 4 respondents or 13.3% were in the low financial literacy category, 18 respondents or 60.0% were in the moderate category, and 8 respondents or 26.7% were in the high category. The majority of respondents in the moderate category indicate that they already have a basic understanding of financial concepts but have not fully achieved high literacy levels. This condition reinforces the importance of educational media that not only conveys financial information but also helps users understand financial concepts through more visual, simple, and contextual presentation.

This mapping result shows that Cash Hero is relevant for development as an educational media for deaf individuals. The presence of the majority of respondents in the moderate category indicates room for strengthening financial literacy through learning media capable of bridging abstract financial concepts with more concrete and accessible learning experiences.

The financial literacy mapping results directly inform the evaluation of Cash Hero as a financial education medium. The finding that 60.0% of respondents fall in the moderate literacy category (index score 72.0%) indicates that the target user group possesses sufficient foundational understanding to engage meaningfully with game-based financial content, yet has not achieved the level of financial literacy that would render educational media unnecessary. This positions Cash Hero as an appropriate intervention for users who are ready to engage with financial decision-making scenarios but benefit from structured, visual, and interactive presentation. Furthermore, the distribution of literacy categories (13.3% low, 60.0% moderate, 26.7% high) confirms that the heterogeneous literacy levels of target users necessitate media that accommodates varying levels of prior financial knowledge, which is supported by Cash Hero's design of providing contextual explanations and direct feedback for every financial decision made in the game. This linkage between financial literacy levels and media design requirements strengthens the argument that accessible game-based media is not only appropriate but necessary for this population.

Discussion

Visual Accessibility as the Key to Financial Literacy for Deaf Individuals

From a technical perspective, it is relevant to position Cash Hero in relation to existing educational applications designed for similar accessibility purposes. Compared to general financial literacy applications such as those studied by Cannistrà et al. (2024) which rely primarily on text-based and audio-supported interfaces Cash Hero's design distinguishes itself through the explicit integration of sign language video support, purely visual feedback mechanisms, and a navigation structure designed to function without any audio dependency. While a direct benchmarking comparison with existing disability-specific applications was beyond the scope of this study, the UEQ evaluation results demonstrate that the Cash Hero prototype achieved positive user experience scores across all dimensions in Iteration 2 (ranging from 0.658 to 1.725), which compares favorably with UEQ benchmark data from educational application studies (Nouriska et al., 2023; Schrepp et al., 2017). Future studies should incorporate a formal comparative evaluation between Cash Hero and existing financial or educational applications, using both UEQ data and task-completion performance metrics, to provide a more rigorous technical assessment of the prototype's relative contribution.

The user needs identification results show that the main barrier for deaf individuals in accessing financial education is not only related to information availability but also to how that information is delivered. Financial education materials predominantly in the form of lengthy text, technical terms, and verbal explanations have not fully aligned with the visual communication characteristics of deaf individuals who rely more heavily on visual information. This finding aligns with Thohari and Rizky (2021) who affirm that persons with disabilities still face barriers in accessing financial literacy and services (Bhat et al., 2026). Engel et al. (2023) also emphasize the importance of financial education programs tailored to the needs of persons with disabilities, not merely providing general materials.

In the context of financial literacy, accessibility is not sufficient to be understood merely as the availability of financial material but also as the media's ability to present information in an easily understandable, relevant, and usable manner for target users. Financial concepts such

as money management, savings, investment, protection, and financial risk are relatively abstract concepts. Therefore, presentation through icons, illustrations, sign language videos, colors, simple flows, decision simulations, and visual feedback becomes important to help users understand the meaning of each piece of financial information conveyed. Khan et al. (2024) also emphasize that financial education for individuals with hearing impairments requires approaches that consider their communication needs.

The improvement in the perspicuity dimension in the UEQ results shows that design improvements made the Cash Hero prototype increasingly easy to understand and learn for users. This indicates that designs prioritizing visual clarity can reduce barriers to understanding financial information. Thus, this finding addresses the main research problem that barriers to financial literacy for deaf individuals are not only due to limited knowledge but also to the unavailability of educational media suited to their visual communication characteristics. Cash Hero addresses this problem by transforming abstract financial information into more visual, concise, and easily followed material.

The Role of Game-Based Learning in Enhancing User Engagement

The user experience evaluation results show improvement across all UEQ dimensions from initial evaluation to iteration 2. This improvement demonstrates that design refinements based on user feedback successfully enhanced the quality of learning experiences through Cash Hero. Specifically, improvements in the stimulation and novelty dimensions show that the prototype became not only easier to use but also more attractive, motivating, and provided a new experience for users.

This finding aligns with the concept of game-based learning that places users as active participants in the learning process. Sun et al. (2023) show that educational games can enhance engagement and learning processes because users do not merely receive information but also interact with learning materials. In the context of financial literacy, Cannistrà et al. (2024) and Estima and Peguinho (2024) show that game-based approaches can be used to support financial education through more active and engaging learning experiences. Additionally, Adeniyi & Kuku (2020) show that gamification has the potential to support learning for learners with hearing impairments, although the study context is not specifically on financial literacy (Akanni, 2026).

Cash Hero transforms financial material into decision-based learning experiences. Users are not only introduced to financial concepts but are also guided to understand the impact of financial choices on cash flow, savings, protection, investment, and net worth. This is important because financial literacy cannot be adequately built through the delivery of definitions alone but needs to be reinforced through decision-making practice close to daily life. In this way, game elements serve as a pedagogical strategy to bridge abstract financial concepts with more practical and easily understood learning experiences.

Thus, the use of game-based learning in Cash Hero addresses the need for financial education media that is not only informative but also interactive and engaging. This finding shows that game elements can be a strategy to reduce the rigid impression in financial learning and increase deaf individuals' engagement in understanding basic financial concepts. The contribution of this study lies not only in the use of games as educational media but in the integration between games, visual accessibility, and the communication needs of deaf individuals.

It is important to acknowledge, however, that not all empirical evidence unequivocally supports the effectiveness of game-based learning in financial literacy contexts. Some studies have noted that game-based interventions do not always produce significant learning gains, particularly when game engagement overshadows educational objectives, or when the game environment does not adequately reinforce the specific financial decision-making skills intended to be taught (Cannistrà et al., 2024). In the specific context of deaf individuals, there remains a limited body of research on game-based financial education, making direct cross-study comparisons challenging and indicating a need for further empirical investigation to confirm or challenge the findings of this study. Furthermore, Schrepp et al. (2017) note that user experience perceptions may vary significantly across user groups with different abilities and digital literacy levels, suggesting that the UEQ results obtained in this study may not be generalizable to deaf

communities in different regions or with different technological backgrounds (Nouriska et al., 2023). These contradictory and qualifying findings highlight the importance of interpreting the results of this study within its specific contextual boundaries, and reinforce the need for expanded longitudinal research on game-based financial education for deaf individuals.

Implications of Findings for Inclusive Financial Literacy from a Behavioral Accounting Perspective

From a behavioral accounting perspective, the results of this study show that the way financial information is presented can influence individuals' understanding processes and economic decision-making. Financial literacy is not only about the ability to know financial concepts but also about the ability to interpret information, assess consequences, and use that information as a basis for making decisions. Therefore, financial education media needs to be designed by considering how users receive, process, and respond to financial information.

In Cash Hero, users learn through financial decision-making processes accompanied by direct consequences within the game. Each decision taken impacts the player's financial condition, such as cash flow, savings, protection, investment, and net worth. This mechanism shows that educational games can help users understand the relationship between financial actions and their impact on financial conditions. In the behavioral accounting context, this is relevant because users not only receive information but also experience the processes of assessment, alternative selection, and evaluation of decision consequences.

The financial literacy mapping results showing the majority of respondents in the moderate category also reinforce the importance of inclusive educational media. This condition shows that respondents already have basic financial understanding but still require learning media that can strengthen understanding more evenly. In other words, the issue of financial literacy for deaf individuals cannot be understood merely as a problem of lack of knowledge but also as a problem of access to appropriate learning media. This expands the understanding in the financial literacy literature that financial inclusion is not sufficient by merely providing access to financial services but must also ensure that financial information can be understood by user groups with different communication needs.

The design thinking approach in this study also provides an important contribution because the media development process was conducted based on actual user needs. Patrício et al. (2021) emphasize that design thinking can support innovation through a user-needs-oriented process (Bhatt & Chakrabarti, 2022). In this study, the involvement of deaf individuals in the needs identification, development, and prototype evaluation processes made Cash Hero not only oriented toward financial material content but also toward user experience. This shows that the design of inclusive financial education media needs to be built through a participatory, iterative, and user-centered process.

Thus, this study addresses the gap in the financial literacy literature by showing that educational media accessibility is an important factor in the process of understanding and financial decision-making. From a behavioral accounting perspective, these findings affirm that financial information is not sufficient to be correct in content but must also be presented in a form that can be processed, interpreted, and used by users according to their cognitive and communication characteristics. Hellmann (2016) emphasizes that behavioral accounting theory is concerned with how individuals interact with financial information and the psychological, emotional, and cognitive factors that influence decision-making a process that is fundamentally shaped by the accessibility and comprehensibility of information presentation (Shank, 2026). This study provides empirical evidence that when financial information is presented through visual, interactive, and experiential media (as in Cash Hero), deaf individuals demonstrate engagement with financial decision-making processes that mirrors the judgment and decision-making frameworks described in behavioral accounting theory: users assess alternatives (financial choices), evaluate consequences (game feedback), and update their understanding of financial relationships (changes in cash flow, savings, debt, protection, and net worth). This mechanism operationalizes the behavioral accounting concept that the quality and accessibility of financial information presentation directly mediates the quality of financial judgments made by individuals. In Cash Hero, information about cash flow, savings, debt, protection, investment,

and net worth is not presented as abstract concepts but as consequences of decisions directly experienced by users. This mechanism strengthens the judgment and decision-making process because users learn to assess alternatives, see the impact of choices, and understand the relationship between financial decisions and financial conditions. The main contribution of this study is showing that inclusive financial literacy for deaf individuals needs to be built through visual, interactive, accessible, and experience-based media so that financial information can truly be understood and used in economic decision-making, understand the relationship between financial decisions and financial conditions. The main contribution of this study is showing that inclusive financial literacy for deaf individuals needs to be built through visual, interactive, accessible, and experience-based media so that financial information can truly be understood and used in economic decision-making.

CONCLUSION

This study demonstrates that accessible financial education for deaf individuals requires learning media that accommodates their visual communication characteristics through simple language, clear visual elements, intuitive navigation, contextual examples, sign language videos, interactive simulations, and direct feedback. Through the design thinking approach, these requirements were incorporated into the development of Cash Hero as a game-based financial education medium. The findings indicate that accessibility-oriented design can improve the user experience across the evaluated dimensions, with the final UEQ scores ranging from 0.658 for efficiency to 1.725 for perspicuity, while the average financial literacy index reached 72.0%, with the majority of respondents classified in the moderate category. These findings reinforce the relevance of integrating visual, interactive, and experiential elements into inclusive financial education and highlight the importance of information presentation in supporting financial understanding and decision-making among deaf individuals.

This study is subject to several limitations that should be considered when interpreting the findings. The respondents were limited to deaf individuals in Bali, which limits the generalizability of the results to deaf communities in other regions with potentially different communication and educational characteristics. In addition, data collection required communication adjustments and interpreter assistance, while the evaluation was conducted using a prototype rather than a fully functional application, limiting the assessment to short-term user experience. Future research should therefore involve more diverse deaf populations, develop Cash Hero into a functional mobile application, and employ longitudinal or experimental designs to evaluate its longer-term effects on financial knowledge, attitudes, and behavior.

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AUTHOR CONTRIBUTION STATEMENT

I Gst. Agung Pramesti Dwi Putri: Conceptualization, Methodology, Investigation, Data Collection, Formal Analysis, and Writing Original Draft Preparation. A.A. Istri Ita Paramitha: Conceptualization, Methodology, Data Collection, and Writing Original Draft Preparation. Ni Wayan Nanik Suaryani Taro Putri: Investigation, Data Collection, Formal Analysis, and Writing Original Draft Preparation. Ni Putu Setia Pratiwi: Visualization, Data Collection, Investigation, and Writing Original Draft Preparation. Kadek Bagastya Adi Widyadhana: Data Collection, Visualization, and Writing Original Draft Preparation. All authors have read and approved the final version of the manuscript.

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