

A Study on the Effectiveness of Disaster-Prevention-Design-Based Fall Prevention Education for Older Adults: Focusing on Game-Based Teaching Tools

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Abstract: With the advent of aging societies, fall-related injuries among older adults have emerged as a critical public health challenge. Conventional fall prevention education has predominantly relied on traditional, lecture-based approaches, which exhibit limited effectiveness in engaging older adult learners and facilitating knowledge retention. This study developed a card-based, gamified educational tool for fall prevention among older adults, grounded in Atkinson-Shiffrin's Multi-Store Model of Memory, Dual Coding Theory, and Cognitive Load Theory. To evaluate immediate educational efficacy, a between-subjects posttest-only comparative design was employed. An experimental group (A) receiving card-based gamified instruction was compared with a control group (B) receiving traditional lecture-based education. The study included 18 participants aged 65 years and older. Educational outcomes were assessed using a fall prevention knowledge test and the RIMMS-12 scale, an ARCS-based measure of Attention, Relevance, Confidence, and Satisfaction. Results demonstrated that the card-based gamified group achieved significantly higher total RIMMS-12 scores compared to the traditional lecture group (A: 51.44 ± 3.50 , B: 38.22 ± 4.43 , $t=7.02$, $p<.001$). Furthermore, the card-based group significantly outperformed the lecture group across all four RIMMS subscales (attention, relevance, confidence, and satisfaction) and demonstrated superior performance on the knowledge assessment (Welch's $t=2.88$, $p=.0145$, Hedges' $g=1.29$). These results indicate higher immediate posttest motivational and knowledge scores for the gamified approach, rather than definitive overall educational superiority. These findings suggest that interactive, game-based educational approaches may improve immediate learning outcomes among older adults. As this was a small-scale, posttest-only comparative experiment, the findings should be interpreted as preliminary evidence and verified in larger studies with follow-up assessments. This study is expected to contribute to the development of effective safety education content for older adult populations.

Keywords: Falls in Older Adults; Fall Prevention Education; Disaster Prevention Design; Cognitive Engagement; Game-based Teaching Tools

1. Introduction

1.1 Research Background and Objectives

South Korea is experiencing a rapid demographic transition toward an aged society. Concurrent with population aging, fall-related injuries have become a major threat to older adult health. According to the World Health Organization (WHO), approximately 28%-35% of individuals aged 65 years and older worldwide experience at least one fall annually, with this proportion increasing to 32%-42% among those aged 70 years and above [1]. Domestic safety-accident and injury-surveillance data also indicate that falls are a major cause of injuries among older adults, with frequent fall locations including living rooms, bathrooms, bedrooms, and stairways [2, 3]. Fall-related injuries, including fractures and traumatic brain injuries, result in pain, disability, reduced quality of life, and escalating healthcare costs, imposing substantial burdens on both individuals and

society. These statistics underscore the urgent need for educational interventions and environmental modifications to prevent falls among older adults [3].

Conventional fall prevention education for older adults often relies on handouts, slide-based explanation, or other one-way information-delivery formats [4, 5]. This traditional pedagogical approach, characterized by unidirectional information transmission, exhibits limited capacity to sustain attention among older adult learners and does not always promote active engagement. Notably, age-related declines in sensory processing, attention, and memory may further reduce the effectiveness of such passive learning modalities [6]. Consequently, there is an urgent imperative to develop innovative educational methodologies and tools that carefully account for the physical and cognitive characteristics of older adults, enhance learning motivation and engagement, and facilitate long-term retention of educational content.

The objective of this study is to design and develop an interactive card-based gamified educational tool for fall prevention that is optimized for the cognitive characteristics of older adults, and to empirically validate its effectiveness through comparison with traditional lecture-based education. Through this investigation, we aim to establish evidence-based guidelines for developing educational tools that maximize engagement and learning outcomes among older adult learners.

1.2 Research Scope and Methods

The scope of this research encompasses fall prevention education targeting five primary indoor fall-risk locations: living rooms, bathrooms, bedrooms, stairways, and kitchens. The research methodology comprises four sequential phases. First, age-friendly design guidelines are established through a literature review and theoretical analysis. Second, based on the established design guidelines, a card-based gamified educational tool is developed, focusing on major indoor fall-risk environments. Third, a controlled experiment involving older adult participants is conducted to validate the educational effectiveness (knowledge acquisition) and ARCS-based motivational responses (attention, relevance, confidence, and satisfaction) of the developed tool. Finally, experimental results are analyzed to evaluate the efficacy of the game-based educational tool and to derive practical and theoretical implications that can inform the development of future safety education programs for older adults.

2. Theoretical Framework

2.1 Disaster Prevention Design

Disaster prevention design is defined as a design approach that proactively prevents various forms of disasters or, when disasters occur, protects human life and property to minimize damage and facilitate rapid and effective disaster recovery. Based on disaster response phases, it can be categorized into four types: ① mitigation and prevention design, ② preparedness design, ③ response design, and ④ recovery design [7]. The present study falls within the domain of ‘preparedness design,’ as it proposes an approach to enhance awareness of fall-risk factors among older adults and strengthen their fall response capabilities and preparedness through game-based cognitive training.

Recent developments in disaster education have increasingly integrated gamification and other interactive modalities to enhance learning outcomes. Gamified platforms create immersive learning environments that enhance learner engagement and promote knowledge retention in safety-related education by simulating realistic scenarios at minimal cost [8]. Consequently, such gamified educational design strategies are now widely recognized in disaster prevention pedagogy and are informing the development of next-generation educational tools [8, 9].

2.2 Relationship Between Older Adult Characteristics and Fall Incidents

Accumulated evidence in fall-related research among older adults indicates a strong association between the physical and cognitive characteristics of older adults and fall risk [10]. Characteristics of older adults can be classified into two principal domains: physical aging and cognitive aging [6]. Older adults with cognitive impairment exhibit substantially higher fall incidence rates, with some studies reporting fall rates approximately eight times higher compared to cognitively intact older adults [11]. These findings underscore the critical need to design fall prevention interventions that account for these age-related characteristics.

Table 1. Age-related characteristics of older adults and their associations with falls

Category	Characteristics	Causes of falls
Sensory and physical aging-related characteristics	· Reduced visual function	· Reduced visual function may make it difficult to judge the height of steps or the slope of floors accurately.
	· Reduced hearing function	· Reduced hearing function may make it more difficult to notice warning sounds or dangerous situations.
	· Reduced muscle strength	· Reduced muscle strength may impair stable walking and increase the risk of losing balance.
Cognitive aging-related characteristics	· Slower response speed	· Slower response speed may delay appropriate reactions to sudden environmental hazards.
	· Reduced memory	· Reduced memory may make it more difficult to remember risk factors or preventive actions.
	· Reduced attention	· Reduced attention may increase distractibility and reduce efficient hazard detection.
	· Reduced learning ability	· Reduced learning ability and slower information processing may delay understanding and application of preventive information.

2.3 Literature Review

Previous research on fall prevention education for older adults has primarily focused on evaluating the effectiveness of educational programs or developing interventions utilizing digital technologies and games. Numerous researchers have implemented educational interventions targeting community-dwelling or hospitalized older adults, reporting positive changes in fall-related knowledge, attitudes, and preventive behaviors [4, 5], [12]. Meanwhile, there has been growing interest in health education for older adults employing gamification and interactive technologies. For instance, studies on physical and cognitive training using motion-sensing games have demonstrated high usability and engagement among older adult participants [13]. However, evidence regarding the extent to which these novel approaches provide additional learning benefits compared to traditional education remains limited. Seven recent studies were selected, and their research populations, methodologies, and key findings are summarized in Table 2.

Table 2. Trends in prior research on fall prevention education for older adults in the past five years (KCI or SCI-level papers)

Author (Year)	Study population and setting	Study design	Main findings and implications
Lee et al. (2023)	Community-dwelling older adults	Secondary data analysis	Among older adults with low cognitive function, the incidence of falls was significantly higher, underscoring the need for assessment and prevention from a cognitive perspective [10].
Minta et al. (2023)	Older adults with mild cognitive impairment or dementia versus cognitively normal older adults	Cohort comparison study	Because cognitive decline is a strong risk factor for falls, fall-prevention education should integrate cognitive training and environmental safety supports [11].
Ong et al. (2021)	Community-dwelling older adults	Systematic literature review and meta-analysis	Fall-prevention educational interventions tend to improve older adults' knowledge about falls, risk perception, and preventive behaviours. Standardisation of educational programmes and evaluation of their long-term effects are required [4].
Oh et al. (2024)	Older adults hospitalised in an acute-care hospital	Comparison between experimental and control groups (2-week programme)	Demonstrated the effectiveness of a multimedia education programme for hospitalised older adults and proposed its use as standard education at the time of admission [12].

Kannardsiri et al. (2021)	Community-dwelling older adults (mean age 71 years; n = 10)	Development of Kinect-based game training and usability evaluation	Confirmed the acceptability and enjoyment of digital game-based fall-prevention training among older adults [13].
Bai et al. (2024)	Previous research in the field of disaster and safety education	Scoping review (gamification)	Gamification strategies have the potential to enhance the effectiveness of safety education; however, designs tailored specifically to older adults are needed [8].
Arakawa et al. (2024)	Mixed sample of adults and older adults (Japanese community, n = 30)	Development of a board game and pilot testing	Suggests that participatory games may provide sustained motivation for disaster and fall-prevention education [9].

These prior studies yield several important implications. First, participatory education, multimedia approaches, and game-based tools may offer advantages over simple one-way knowledge transmission in fall prevention education for older adults [4, 5], [8, 9], [12, 13]. However, further comparative validation against traditional education is still needed with respect to actual learning outcomes, including knowledge acquisition and behavioral change. Second, because age-related cognitive decline may influence educational effectiveness, the development of educational tools for older adults should systematically incorporate design principles grounded in cognitive aging and cognitive psychology theories [6], [14-16].

Accordingly, the present study established the following research questions and hypotheses:

(1) Research Question 1: Compared to traditional lecture-based education, does a card-based gamified educational tool demonstrate higher ARCS-based motivational responses among older adult populations?

Hypothesis 1: The card-based gamified education group will exhibit significantly higher scores on the RIMMS-12 (an ARCS-based measure of attention, relevance, confidence, and satisfaction) compared to the traditional lecture-based education group.

(2) Research Question 2: Compared to traditional lecture-based education, does a card-based gamified educational tool significantly enhance fall prevention knowledge acquisition among older adults?

Hypothesis 2: The card-based gamified education group will achieve significantly higher scores on fall prevention knowledge assessments compared to the traditional lecture-based education group.

3. Development of Disaster Prevention Design-Based Educational Tools for Fall Prevention Among Older Adults

This study developed a card-based interactive educational tool for fall prevention among older adults and employed both experimental and survey research methodologies to validate its educational effectiveness. The research was conducted from May 28 to August 24, 2025.

3.1 Design Guidelines for Fall Prevention Educational Tools for Older Adults

During the design development phase, the content and format of the cards were designed to reflect the previously reviewed cognitive characteristics of older adults and three core theoretical frameworks: the Multi-Store Model of Memory, Dual Coding Theory, and Cognitive Load Theory. Effective educational design for older adult populations requires systematic incorporation of cognitive psychology learning theories. This study adopted Atkinson-Shiffrin's Multi-Store Model of Memory, Dual Coding Theory, and Cognitive Load Theory as the primary theoretical foundations for tool design [14-16]. These theories provide design principles for maximizing learning effectiveness while accounting for age-related reductions in attention span and limited working memory capacity. Accordingly, educational materials should present information clearly and concisely to minimize extraneous cognitive load that induces unnecessary mental effort. Furthermore, by employing dual coding approaches that organically integrate text and images, comprehension and retention of information can be enhanced, and repeated interactions should facilitate successful transfer of learning content from short-term to long-term memory. Specific design guidelines are presented in Table 3.

Table 3. Design Guidelines

Design domain	Guideline	Specific implementation	Relevant characteristics of older adults	Theoretical rationale
Text design	Large font size	Body text: 20 pt; Title: 90 pt	· Reduced visual function	· Cognitive Load Theory: minimise unnecessary perceptual (extraneous) load. · Atkinson–Shiffrin memory model: simplify information in consideration of limited working-memory capacity.
	Use of Gothic font	Highly legible font	· Decreased working-memory capacity	
	Key terms / keywords	Construct concise sentences	· Slower information-processing speed	
Colour design	High luminance contrast	Strengthen distinction between text and background	· Reduced ability to detect contrast	· Atkinson–Shiffrin memory model: enhance visual information processing at the sensory-memory stage.
	Vivid red	Emphasise warning messages	· Decreased ability to discriminate colours	
	Warm colours	Use a familiar, comfortable colour palette	· Need for emotional stability	
Image design	Simple illustrations	Use intuitive images	· Difficulty processing complex information	· Dual Coding Theory: improve memory through concurrent processing of verbal and visual information.
	Depiction of real-world settings	Provide a sense of realism through illustrations	· Preference for linking content to lived experience	
	Emphasise key behaviours	Visually highlight critical elements	· Reduced sustained attention / distractibility	
Physical specifications	A6 size	105 × 149 mm	· Reduced fine motor ability	· Cognitive Load Theory: minimise burden attributable to physical discomfort.
	Coated white paper	Increased thickness; anti-glare (reduced reflection)	· Sensitivity to glare	

3.2 Design Development of Fall Prevention Educational Tools for Older Adults

Following the established design guidelines, five sets of fall prevention cards were developed, targeting five distinct living environments: living rooms, bathrooms, bedrooms, stairways, and kitchens. Each card addresses risk factors and preventive behaviors commonly encountered in the respective location. The front side features keywords associated with situational illustrations, while the reverse side provides solutions for addressing the identified risk factors.

Table 4. Fall Prevention Education Card Design Development

Location	Front-side design	Back-side design	Measures to reduce fall risk
Living room			• Arrange electrical cords along the wall so that they do not create a tripping hazard. • Secure the edges of carpets with non-slip tape. • Remove clutter and other objects from the floor.
Bathroom			• Install grab bars at the bathtub. • Place non-slip mats on the bathroom floor. • Maintain bright lighting in the bathroom. • Remove standing water from the bathroom floor.
Bedroom			• Install a small lamp next to the bed to facilitate safe movement at night. • Do not leave objects on the bedroom floor. • Install bed rails to prevent falls from the bed. • Install assisting grab bars on the wall.
Stairway			• Install handrails along the stairs. • Encourage users to hold the handrail whenever using the stairs. • Attach anti-slip tape to the edges of the steps. • Ensure that the stairway is sufficiently well lit.
Kitchen			• Wipe up any water or spills on the floor immediately. • Use a stable step stool when reaching for items stored at height. • Store frequently used items at a height that can be reached comfortably by hand. • Maintain bright, adequate lighting in the kitchen.

These cards employ a consistent structure of title-illustration-key question-and-answer format, enabling older adult learners to gradually develop familiarity through repeated exposure. The cards were designed to facilitate an interactive learning process whereby the facilitator poses questions based on the front-side content, and upon correct participant responses, the reverse side is revealed to provide correct answers along with supplementary explanations. The developed prototypes were refined through consultation with design experts prior to experimental implementation.

3.3 Effectiveness Validation Experiment

3.3.1 Experimental Procedure

This study employed a small-scale between-subjects posttest-only comparative design to examine immediate educational effects. The independent variable was ‘educational method’ (Experimental Group A: card-based gamified education; Control Group B: traditional lecture-based education), while the dependent variables were ARCS-based motivational responses (RIMMS scores) and educational effectiveness (fall prevention knowledge assessment scores). Participants comprised 18 older adults aged 65 years and above (N=18) recruited from the Mihak Senior Center in Yuseong-gu, Daejeon. Participants were randomly assigned to either the experimental group (n=9) or the control group (n=9).

The experimental procedure, as outlined in Table 5, consisted of three sequential phases: introduction (5 minutes), educational intervention (20-30 minutes), and post-assessment (10 minutes). Both groups received the same core instructional content, and the intervention duration was kept approximately comparable across groups.

Table 5. Implementation of the educational sessions for Group A (Card Game) and Group B (PPT Lecture)

Study procedure	Description	Photographs	
Introduction (5 min)	- The researcher explained the study purpose and the sequence of procedures. - Participants were divided into two groups and seated in separate spaces.		
Education delivery (20–30 min)	- Group A (experimental group): The session was conducted as a card-based game using the developed materials; the facilitator posed questions and participants discussed to identify the correct answers. - Group B (control group): The same content was delivered in a traditional lecture format using PPT slides.	Group A (card game)	Group B (PPT lecture)
Post-intervention assessment (10 min)	Immediately after the education session, all participants were given the RIMMS-12 questionnaire and a fall-prevention knowledge test and were instructed to complete them.		

3.3.2 Measurement Instruments

Two instruments were employed to assess educational effectiveness. The RIMMS-12 scale used in this study was adapted on the basis of the instructional motivation survey framework reported by Loorbach et al. (2015) and organized as a 12-item ARCS-based measure for the purposes of the present research [17]. As an ARCS-based motivational response measure, this scale comprises 12 items across four subscales: attention (3 items), relevance (3 items), confidence (3 items), and satisfaction (3 items). Each item is rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The fall prevention knowledge test consisted of a researcher-developed multiple-choice questionnaire based on the educational content, comprising 10 items with two questions per living environment (five environments total). Each item was scored as 1 point, yielding a maximum total score of 10 points.

Table 6. RIMMS-12 item statements for assessing ARCS-based motivational responses

Evaluation domain	Item	Item statement
Attention	1	The educational materials captured my interest.
	2	The illustrations and phrasing helped me maintain my attention.
	3	The activities/tasks were interesting, and I wanted to continue participating.
Relevance	4	I felt that what I learned would help prevent falls in my daily life.
	5	I felt that the example cases were relevant to my own situation.
	6	The connection between the learning objectives and the activities was clear.
Confidence	7	I was able to follow the education session well.
	8	Practice and feedback increased my confidence in identifying the correct answers.
	9	After the education session, I feel I can carry out preventive behaviours on my own.
Satisfaction	10	Overall, I am satisfied with this education session.
	11	I would like to take a similar education session again or recommend it to others.
	12	The learning process was enjoyable.

3.3.3 Experimental Results

(1) Hypothesis 1 Testing: Comparison of ARCS-based Motivational Responses (RIMMS-12)

The card-based gamified Group A ($M=51.44$, $SD=3.50$) achieved significantly higher total RIMMS-12 scores than the traditional lecture-based Group B ($M=38.22$, $SD=4.43$). This between-group difference was statistically significant (Welch's $t=7.02$, $p<.001$, Hedges' $g=3.15$). Although Welch's t -test results for individual items also revealed statistical significance across all items ($p<0.05$), these item-level comparisons should be interpreted as exploratory because multiple individual tests were conducted. Specifically, items Q1, Q2, Q5, Q9, Q10, Q11, and Q12 demonstrated significant differences at the $p<.001$ level (see Table 7). Across all four subscales, Group A exhibited significantly higher scores than Group B in attention (Group A: 12.89 ± 0.78 vs. Group B: 9.56 ± 1.13), relevance (Group A: 12.89 ± 1.17 vs. Group B: 9.78 ± 0.67), confidence (Group A: 12.44 ± 0.73 vs. Group B: 9.56 ± 0.73), and satisfaction (Group A: 13.22 ± 0.83 vs. Group B: 9.33 ± 0.87), with all differences reaching statistical significance (all $p<.001$). Because the item-level means in Table 7 are rounded to two decimals, they may not sum exactly to the reported group totals. Therefore, Hypothesis 1, which posited that 'the card-based gamified education group will achieve higher total RIMMS-12 scores than the traditional lecture-based education group,' was supported.

Table 7. Comparison of mean scores for each RIMMS-12 item (Attention, Relevance, Confidence, and Satisfaction)

Question	Group A ($M\pm SD$)	Group B ($M\pm SD$)	p
Q1	4.22 ± 0.44	3.11 ± 0.60	<0.001
Q2	4.56 ± 0.53	3.00 ± 0.50	<0.001
Q3	4.11 ± 0.33	3.44 ± 0.53	0.007
Q4	4.22 ± 0.67	3.44 ± 0.53	0.015
Q5	4.33 ± 0.50	3.00 ± 0.50	<0.001
Q6	4.33 ± 0.71	3.33 ± 0.71	0.008
Q7	3.89 ± 0.33	3.11 ± 0.60	0.005
Q8	4.22 ± 0.44	3.33 ± 0.71	0.007
Q9	4.33 ± 0.50	3.11 ± 0.33	<0.001
Q10	4.44 ± 0.53	3.33 ± 0.50	<0.001
Q11	4.44 ± 0.53	2.89 ± 0.60	<0.001
Q12	4.33 ± 0.50	3.11 ± 0.33	<0.001

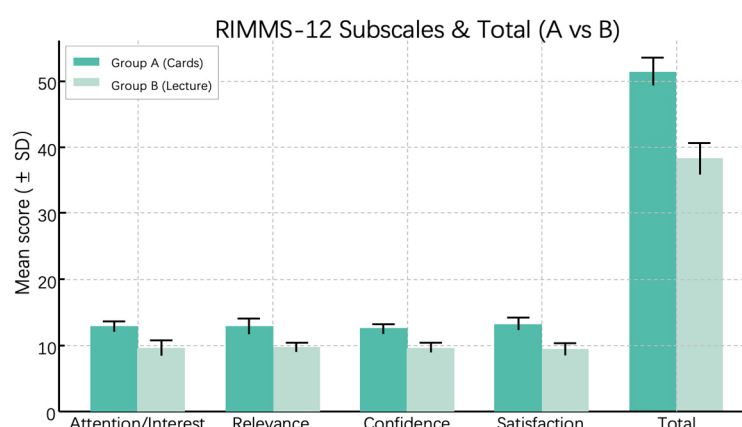


Figure 1. Comparison of the four RIMMS subscales

(2) Hypothesis 2 Testing: Comparison of Fall Prevention Knowledge Acquisition Effects

Fall prevention knowledge test score comparisons are presented in Table 8. The card-based gamified group (A) achieved a mean score of $M=9.00$ ($SD=1.32$) out of 10 points, while the lecture-based group (B) attained a mean score of $M=6.00$ ($SD=2.83$). The card-based gamified group demonstrated significantly superior

performance, with the between-group difference reaching statistical significance (Welch's $t=2.88$, $p=.0145$, Hedges' $g=1.29$). Consequently, Hypothesis 2, which predicted that “the card-based gamified education group will achieve significantly higher fall prevention knowledge assessment scores than the traditional lecture-based education group,” was also supported.

Table 8. Comparison of mean scores on the fall-prevention knowledge

Measure	Group	Mean	SD	Statistics
Fall-prevention knowledge assessment (0–10)	Group A (Card game)	9.00	1.32	$t = 2.88$ $g = 1.29$
	Group B (Lecture)	6.00	2.83	$p = .0145$

Table 9. Comparison of item-by-item score accuracy on the Fall Prevention Knowledge Test

Item	Test item	Accuracy— Group A (Card game)	Accuracy— Group B (Lecture)
1	Which action helps prevent falls in the living room?	0.78	0.44
2	Which bedroom situation should be avoided to prevent falls?	0.89	0.44
3	Which bathroom situation should be avoided to prevent falls?	0.89	0.44
4	Which living room situation increases fall risk?	0.89	0.56
5	Which action helps prevent falls in the bedroom?	1.00	0.67
6	Which stairway behavior should be avoided to prevent falls?	1.00	0.56
7	Which action helps prevent falls in the kitchen?	0.89	0.89
8	Which bathroom safety measure helps prevent falls?	0.78	0.56
9	Which stairway safety measure helps prevent falls?	1.00	0.67
10	Which measure is not necessary for fall prevention in the kitchen?	0.89	0.78

3.3.4 Discussion

This study examined whether card-based interactive educational tools that reflect the cognitive characteristics of older adults simultaneously enhance ARCS-based motivational responses (attention, relevance, confidence, and satisfaction) and fall prevention knowledge compared to traditional lecture-based instruction. The results supported both Hypotheses 1 and 2; however, because this study used a small-scale post-test-only design and did not directly measure the proposed cognitive mechanisms, despite the large standardized mean differences, the following discussion should be understood as offering plausible interpretations rather than definitive causal conclusions. In addition, the intervention differed from the control condition not only in material format but also in questioning, peer discussion, and immediate feedback; therefore, the observed differences should not be attributed solely to the card format itself.

First, viewed through the lens of Atkinson-Shiffrin's Multi-Store Model of Memory, the ‘one card-one information’ principle, repeated question-answer format with front-side keywords and reverse-side answers with explanations, and large fonts with high-contrast formatting may have provided cognitively accessible stimuli that better accommodated older adults' limited working memory capacity and slower processing speed [15]. This may plausibly explain the superior attention and relevance scores observed in the RIMMS assessment. Second, the proximal placement of text and intuitive illustrations may have enhanced recall and recognition by expanding encoding cues through dual verbal-visual pathways [16]. This contextualization may have contributed to improvements in relevance and confidence as well as post-intervention knowledge scores. Third, the elimination of extraneous decorative elements, information segmentation, immediate feedback, and peer discussion may have reduced extraneous cognitive load and may have supported schema formation [14], which in turn may have contributed to higher confidence and satisfaction. Fourth, the item-level accuracy pattern suggests that the experimental group achieved higher accuracy across several living environments; however, the differences were not concentrated exclusively in bathrooms and stairways, and therefore this pattern should be interpreted cautiously.

4. Conclusion

This study developed a card-based gamified fall prevention educational tool that integrates core cognitive psychology theories—the Multi-Store Model of Memory, Dual Coding Theory, and Cognitive Load Theory, —and compared its immediate educational effects with those of traditional lecture-based instruction for older adults. The results showed that the card-based condition produced higher immediate posttest motivational responses and higher immediate posttest knowledge scores than the lecture-based condition, suggesting the practical promise of age-friendly, interactive safety education.

At the same time, these findings should be interpreted as preliminary evidence from a small-scale posttest-only comparative experiment rather than as proof of definitive educational superiority. The very small total sample size ($N = 18$; 9 per group), single-site recruitment, and immediate post-intervention assessment limit statistical precision and generalizability. In addition, because the intervention differed from the control condition not only in material format but also in questioning, peer discussion, and immediate feedback, the observed advantages should not be attributed solely to the card format itself.

Accordingly, larger and more diverse multi-site studies with follow-up assessments are needed before broader generalization. Future research should examine whether the observed immediate benefits are maintained over time and whether they translate into stronger knowledge retention, behavioral change, and fall-related outcomes.

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