



Development of innovative mobile applications for dementia prevention in at - risk elders

Renu Kwanyuen[†], Orranuch Chusri^{*}, Doungnetre Thummakul,
Sresuda Wongwisetkul, Natrapee Jaingam

Faculty of Nursing, Suan Dusit University, Bang Phlat, Bangkok 10700, Thailand

Article Info

Article history:

Received 27 September 2024

Revised 25 February 2025

Accepted 17 April 2025

Available online 01 September 2026

Keywords:

at-risk of dementia,
dementia prevention,
innovative,
mobile application

Abstract

Social isolation has been associated with negative health outcomes. In response, we developed and implemented a mobile application to promote social engagement among older adults living in their communities. This research and development (R&D) study aimed to 1) develop a dementia prevention mobile application called SDU Brain Training for older adults at risk of dementia and 2) examine the application's quality among a sample of 35 older adults who were at risk of dementia and living in Bang Len, Song Phi Nong, Suphan Buri. Data were collected through the Dementia Prevention Mobile Application Effectiveness Evaluation Survey and analyzed using descriptive statistics.

The SDU Brain Training application comprised two modules: 1) a 40-item self-assessment test with immediate result interpretations and recommendations and 2) cognitive rehabilitation exercises consisting of brain exercise, meditation exercise, food tips for brain health, 4-step brain development, brain-healthy environment tips, and brain training games, e.g. Sudoku and photo hunt games. The application was evaluated for content validity by three experts using the index of item-objective congruence (IOC), resulting in IOC scores ranging from 0.67 to 1. The experts' feedback on format, content, and images was incorporated into the application development for Android and iOS operating systems. The application achieved a β value of .78 and was found compatible with devices running iOS 12 or Android 8 or higher through α testing. Additionally, the application effectiveness evaluation yielded an overall mean score at the highest level ($M = 4.84$, $SD = .38$). These results indicate that the SDU Brain Training application is an effective tool for assisting older adults in dementia prevention and cognitive rehabilitation.

© 2026 Kasetsart University.

* Corresponding author.

E-mail address: orranuch_chu@dusit.ac.th (Chusri, O.).

[†] Co-first authors.

Introduction

In the face of present challenges, technology has emerged as a powerful force improving the quality of life for both independent and dependent older adults. Driven by a rapidly ageing population, Thailand became an aged society in 2005 with its older population projected to reach 28 percent by 2031 (National Statistical Office, 2023). A survey by the Division of Strategy and Plan, Department of Older Persons reveals that the number of Thai older adults increased to 12.5 million (19%) and 12.6 million (19.21%) in 2021 and 2022, respectively, with the 60–69 age group being the largest, followed by those aged 70–79 (Department of Older Persons, 2023). Thailand's transitioning to a "complete aged society" raises concerns about ageing health issues, particularly physical decline, age-related memory loss, and dementia, a common chronic disease that can affect any older adults. In Thailand, dementia is found in 12.4 percent of individuals aged 60 and over, with more women affected than men (15.1% and 9.8%, respectively) and prevalence increasing with age from 7.1 percent in those aged 60–69 to 14.7 percent in the 70–79 age range to ultimately 32.5 percent in those over 80 (Saipany, 2022). The data from the Foundation of Thai Gerontology Research and Development Institute (2021) indicate that 651,950 Thai adults were living with dementia in 2020, with women constituting the majority. Worsening dementia places a heavier burden on families. However, it can be effectively prevented by regular exercise, regular socializing, stress management, annual health checks, and regular brain training (Ye et al., 2023). Due to limited social participation caused by the COVID-19 pandemic, a dementia prevention mobile application can offer an alternative solution for Thai older adults who are at risk of dementia by helping stimulate their cognitive function through exercises and games instead of social activities. This innovation tool will not only enhance the quality, effectiveness, and convenience of self-care practices, but will also improve the satisfaction and quality of life for older people and their families.

Literature Review

Dementia is a common public health issue among older adults that negatively impacts the physical, psychological, behavioural, social, and economic aspects of life for both individuals and families, including their quality of life (Suwan, 2017). In the meantime,

technology has become an integral part of people's life today serving the desires and needs of all genders and age groups, especially in medical care and public health. Digital technology and health innovations are playing an increasing role in supporting health operations to increase people's access to modern health services, while simplifying their daily activities for greater convenience and efficiency. In an ageing society, empowering current and future older adults to maintain their independence for as long as possible is crucial. This can be achieved by promoting their ability to take care of their own physical and mental health and use new technologies to communicate with their family members, leading to a happy, independent life within the community. To address the challenges of an aging society, technological advancements are being harnessed across various areas, including health, social connection, living environments, and economic security. In regard to health, they are being utilised to enhance older people's physical and mental well-being, improve their self-care ability and self-esteem, and reduce their risk of health problems, particularly dementia, that becomes more common with advancing age.

Dementia in Older Adults

Dementia is a decline in cognitive function commonly found in adults over 60, with a significant impact on the professional and personal lives of both those living with dementia and their caregivers. Most people with dementia typically display abnormal behaviours related to memory, calculation, decision-making, imagination, and language and exhibit personality changes as the disease progresses. There are three stages of dementia in older adults: early, middle, and late. In the early stage, individuals will experience mild memory loss, particularly regarding recent events, and frequently misplace objects. During the middle stage, they will have difficulty remembering the names of new people and places, forget their own personal history, and become confused about date, time, and place. Finally, in the late stage, they will stop recognising things and lose the ability to respond to their environment. To reduce older adults' risk of dementia, it is important to promote and stimulate their cognitive skills related to perception, thinking, and understanding to delay the decline of their brain function. In addition to memory, attention and focus skills should also be nurtured, as they affect an individual's overall perception, thinking, and understanding. Such skills can be improved by repeatedly reviewing information, doing brain exercises, and playing a variety of games, e.g.

memory games, sorting games to improve concentration, sequencing games to improve thinking skills, matching or hidden-object games to improve observation and visual discrimination skills, and chess, mah-jong, or puzzle games to improve problem-solving skills. Dementia risk in older people can also be minimised through moderate physical exercise and social activities that encourage older adults' active participation to help them stay socially connected and avoid feelings of isolation and being undervalued (Ye et al., 2023).

How to Prevent Dementia in Older Adults

Dementia prevention is crucial in safeguarding older adults' memory function, as dementia is caused by neurodegeneration and cannot be cured (Limsakul et al., 2023; Muangpaisan, 2021). To prevent dementia, the following actions should be taken: 1) avoiding substances or medications that damage the brain, e.g. alcoholic beverages, and unnecessary medications, particularly sleeping pills; 2) avoiding foods high in fat, sugar, and salt; 3) doing brain exercise regularly to improve thinking skills, memory, concentration, and problem-solving skills by reading, writing, calculating, taking quizzes, learning new tools, playing mind-sharpening games that are not overly complicated or stressful (individual and/or group games played on paper, computers, tablets, etc.), and more importantly, doing new activities; 4) doing physical activity, e.g. strolling and Tai Chi, for 30 minutes 3–5 times a week to slow dementia and enhance brain function; 5) participating in social activities, e.g. visiting temples, attending social gatherings, and joining social clubs; 6) having annual health checks or regular

health checks for monitoring and ongoing treatment in cases of chronic diseases, e.g. hypertension and diabetes; 7) taking precautions to prevent falls, accidents, etc. that can result in brain injuries; 8) paying attention to the present moment and maintaining constant focus; and 9) minimising stress by doing relaxation activities, as stress and depression can impair memory (Livingston, et.al.,2024). As indicated above, regular physical exercise and cognitive training can help reduce older adult's risk for developing dementia. This can be explained by Atkinson and Shiffrin (1968)'s multi-store memory model illustrated in [Figure 1](#).

According to a study on technology learning by Suthatipkul and Siriwong (2018), most older adults start using smartphones to enjoy everyday convenience and fulfill their desires to communicate with others and learn how to use the devices which are playing an increasingly important role across all ages. Health system agencies are adopting medical communication technology as a tool for enhancing the efficiency of public health services in communities to reduce disease transmission and health problems, promote self-reliance, and ultimately alleviate hospital overcrowding. A study by Ali et al. (2024) and Ye et al. 2023 suggests that playing brain training games at least 3 days a week can help relieve stress and stimulate cognitive function in older adults with dementia risk. These indicate that mobile applications can be a suitable tool to assist older people in preventing dementia. The researchers therefore developed a dementia prevention mobile application called SDU Brain Training to help at-risk older adults identify their signs of dementia through a self-assessment test and enhance their cognitive abilities, i.e. memory, learning, visual perception, reaction time,

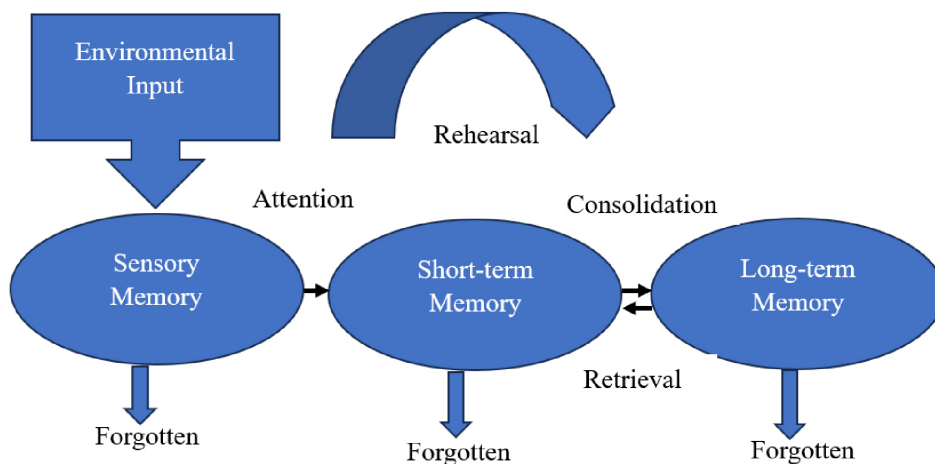


Figure 1 Multi-store memory model

planning, and decision-making, and their self-esteem through in-game challenges.

Mobile Learning Applications

This study employed the ADDIE model developed in 1967 by Reiser and Mollanda, a popular framework for instructional design, to create a mobile application suitable for older adults' learning (Fajrin et al., 2023). Following the model, the application development process consisted of five phases: 1) analysing application content, 2) designing content and image layouts, 3) developing the application, 4) implementing the application for testing, and 5) evaluating the results. Previous research has applied the ADDIE model to design computer lessons for a mobile application (Figure 2) (Khunsang & Khunsang, 2022) and develop mobile applications to help assess dementia and improve dementia prevention and care knowledge among village health volunteers (Magteppong et al., 2022; Pornudomthap et al., 2021).

Based on the ADDIE framework, the researchers developed a dementia prevention mobile application called SDU Brain Training to promote self-assessment and proactive engagement in preventative cognitive rehabilitation for older adults at risk of dementia. The application was expected to enable older people, despite ongoing social restrictions, to increase their self-care knowledge and skills and stimulate their cognitive abilities related to perception, thinking, and understanding, leading to successful dementia prevention and enhanced quality of life for both older adults and their caregivers in the community.

Methodology

Participants and Procedures

This research and development study aimed to: 1)

1. Dementia
 - 1.1 Self-assessment
 - 1.2 Self-prevention
 - 1.3 Prevention for older adults
2. Learning mobile application
3. The ISD Model featuring the ADDIE process



"SDU Brain Training"
Dementia Prevention
Mobile Application
for Older Adults
at Risk of Dementia

Figure 3 Conceptual framework

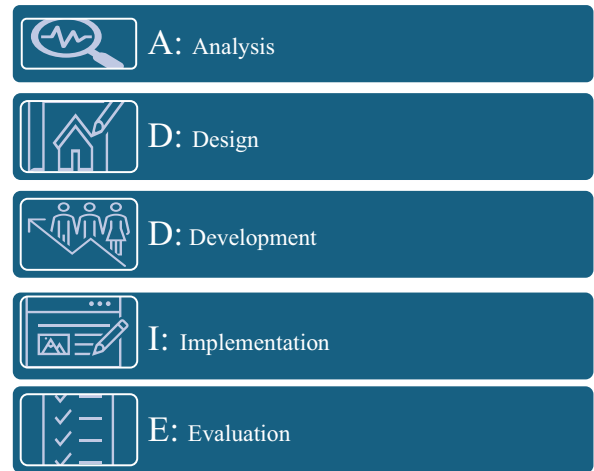


Figure 2 ISD model featuring the ADDIE process

develop a dementia prevention mobile application called SDU Brain Training for older adults at risk of dementia and 2) examine the application's quality. The study's conceptual framework emerged from a community-based dementia study and a review of relevant literature on dementia, self-assessment, preventative activities, mobile application development, and computer-assisted instruction lesson design. The SDU Brain Training application was developed based on the concept of cognitive training aimed at stimulating cognitive function. See Figure 3 below.

Participants

The study was conducted from September 2022 to September 2023 comprising an initial literature review and needs-analysis phase, followed by application piloting and data collection with human participants conducted under ethical approval SDU-RDI-HS 2023-013 (18 May 2023 – 17 May 2024). The data collection phase involved a sample 35 adults who were at risk

of dementia and living in Bang Len, Song Phi Nong, Suphan Buri. The sample was selected through purposive sampling based on the following criteria: 1) older adults diagnosed by a doctor with a non-communicable disease (i.e. hypertension, diabetes, hyperlipidemia, or stroke) and currently on medication, with a body mass index (BMI) classified as obese, 2) possession of a mobile phone compatible with the SDU Brain Training application, 3) willingness to participate in the study, 4) fluency in Thai, and 5) no mental health records (e.g. depression and schizophrenia). The exclusion criteria were: 1) development of complications from pre-existing conditions during the study, 2) inability to participate throughout the study, and 3) development of physical and mental conditions during the study. The research instruments consisted of application development tools and a data collection tool as detailed below.

Application development tools

Firestore was used to create the dementia prevention mobile application SDU Brain Training for Android and iOS operating systems by building, improving, and compiling tools for the application. The ADDIE model was employed to develop multimedia content through five phases: 1) analysis, 2) design, 3) development, 4) implementation, and 5) evaluation and to establish two application modules: self-assessment and cognitive rehabilitation.

Data collection tool

The SDU Brain Training Mobile Application Effectiveness Evaluation Survey was used to collect data in this study. The survey consisted of three parts: 1) general respondent information; 2) application effectiveness evaluation (five dimensions: features (9 items), design (5 items), result interpretation (4 items), instructions (5 items), and overview (4 items)); and 3) suggestions for the application (five-point rating scale: strongly agree (5), agree (4), not sure (3), disagree (2), and strongly disagree (1), with highest and lowest totals achieved = 135 and 27, respectively)

Instrument quality assessment

1. The SDU Brain Training application was evaluated for content validity by two geriatric nursing experts and one specialist in education and games using the index of item-objective congruence (IOC). The evaluation yielded IOC scores ranging from 0.67 to 1. The researchers modified the text, images, and content sequencing based on the experts' feedback and conducted a beta test resulting in a β value of .78.

2. The SDU Brain Training Mobile Application Effectiveness Evaluation Survey was evaluated for content validity by two geriatric nursing experts and one specialist in education and games using the index of item-objective congruence (IOC). The evaluation yielded IOC scores ranging from 0.67 to 1. The researchers modified the survey based on the experts' feedback and piloted it with a group of 30 older adults with similar characteristics to the target sample. The survey's reliability and internal consistency were assessed using Cronbach's alpha coefficient, resulting in a value of 0.946, which indicated sufficient reliability.

Procedures

The current study adopted a research and development (R&D) approach to create the dementia prevention mobile application SDU Brain Training for older adults at risk of dementia. Following the software development lifecycle (SDLC), the application was developed through a 3-phase process as described below.

Phase 1. The process begun with an analysis of the characteristics and application development needs of older people with dementia risk and a literature review on dementia, self-assessment tools, result interpretation, self-care and prevention methods, mobile application development, and lesson creation. The acquired data were synthesised to develop a framework for the application's content and modules. See Figure 4 for a process overview.

Phase 2. In this phase, the application was designed following the steps below.

1. Content, activities, and graphics were designed to enhance users' learning and cognitive training. The application consisted of two key modules: 1) a 40-item self-assessment test where users sorted colors, animals, fruits, and provinces to receive interpretations and basic recommendations and 2) cognitive rehabilitation exercises consisting of a "Brain Button Exercise" clip, a "Standing, Sitting, and Lying Down Meditation" clip, food tips for brain health, 4-step brain development (Step 1 – Build achievement motivation, dreams, hopes, and perseverance, Step 2 – Implant positive thoughts into the subconscious mind, Step 3 – Cultivate a self-image, and Step 4 – Align the brain with nature), brain-healthy environment tips, and brain training games, e.g. photo hunt games, math card games, and Sudoku. This activity will help stimulate the elderly's cognition.

2. The application was piloted with a group of 10 older adults to test its quality and identify areas for improvement. The β testing achieved a value of .78, while the α testing revealed that the application required mobile

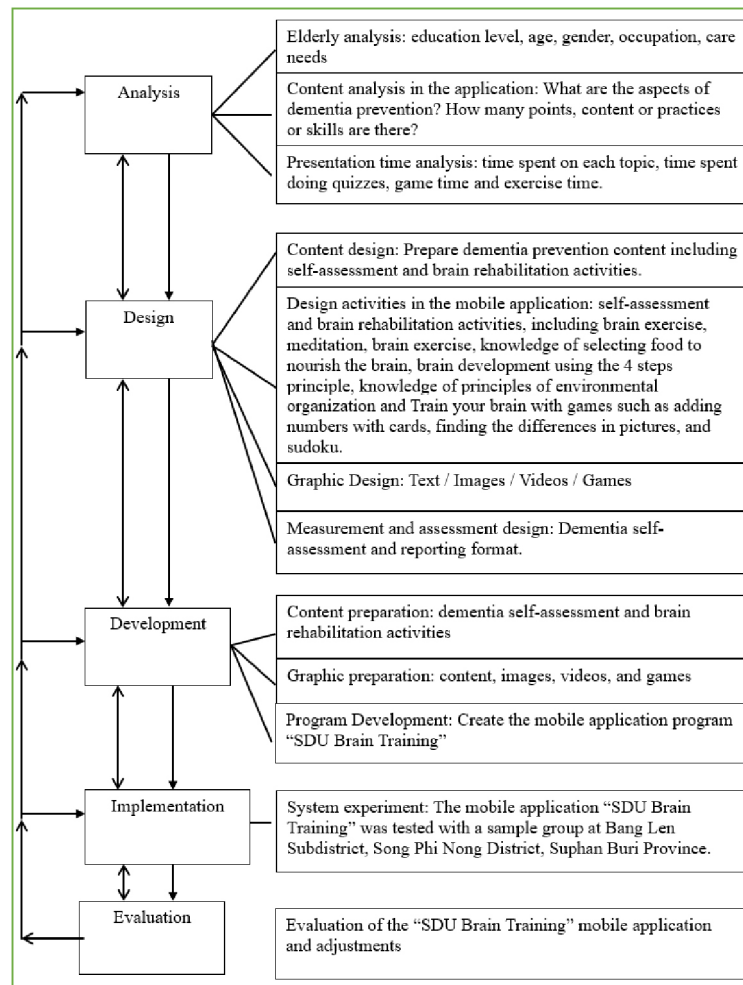


Figure 4 SDU brain training application development process based on the ADDIE model

devices running iOS 12 or Android 8 or higher for image display, especially when playing games. Additionally, the application could not be installed on mobile devices with lower performance than the minimum requirements.

3. A data collection tool called the SDU Brain Training Mobile Application Effectiveness Evaluation Survey was developed and assessed for quality.

Phase 3. To evaluate the application's effectiveness, a training workshop was conducted with 35 older adults who were at risk of dementia and living in Bang Len, Song Phi Nong, Suphan Buri, following the steps below.

1. A sample of 35 at-risk older adults was selected according to the inclusion criteria.

2. The participants received an explanation of the study procedures and signed informed consent letters.

3. The researchers conducted a training workshop to introduce the SDU Brain Training application to the

participants.

4. The participants tested the application with guidance from the researchers and assistants.

5. The researchers collected data through observation and a training checklist.

6. At the end of the workshop, the participants evaluated their experience using the SDU Brain Training Mobile Application Effectiveness Evaluation Survey.

7. The collected data were entered into the computer and analysed.

8. The results were used to fix the identified issues to improve the application.

Data Analysis

A data analysis was performed using descriptive statistics, i.e. mean and standard deviation, to assess the

application's quality.

Results and Discussion

Results of the SDU Brain Training Application Development

The results consisted of the application's modules and content relevance as described below. Modules of the

SDU Brain Training Application (Figure 5)

The Figure 6 below shows that a user had installed the SDU Brain Training application on their mobile phone.

In Figure 7, the mobile screen displayed a description of dementia and two modules: self-assessment and cognitive rehabilitation.

The self-assessment module consisted of a two-part set test: questions and result interpretation. In Part 1, the screen would display a memory challenge consisting of 10 animal names, 10 color names, 10 fruit names, and

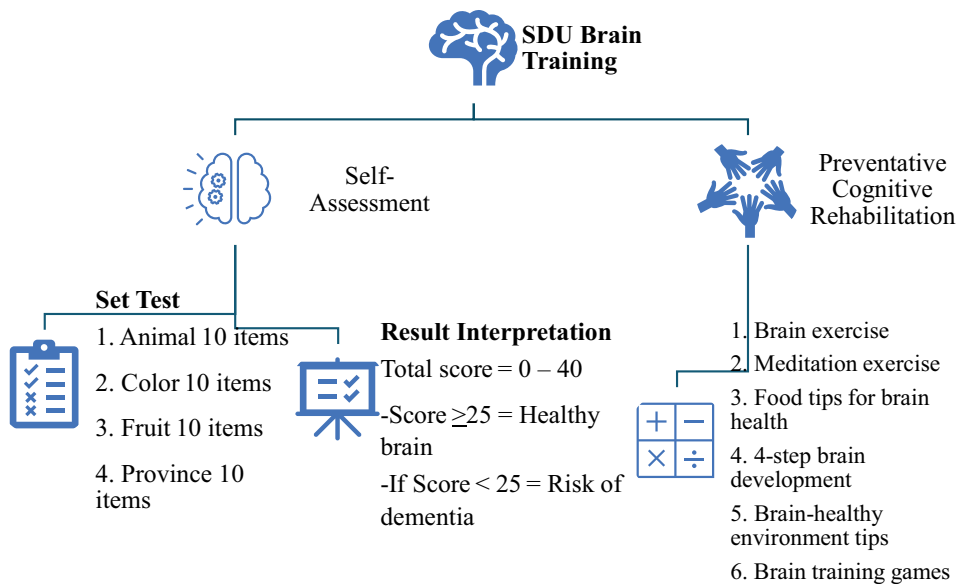


Figure 5 SDU brain training application development model

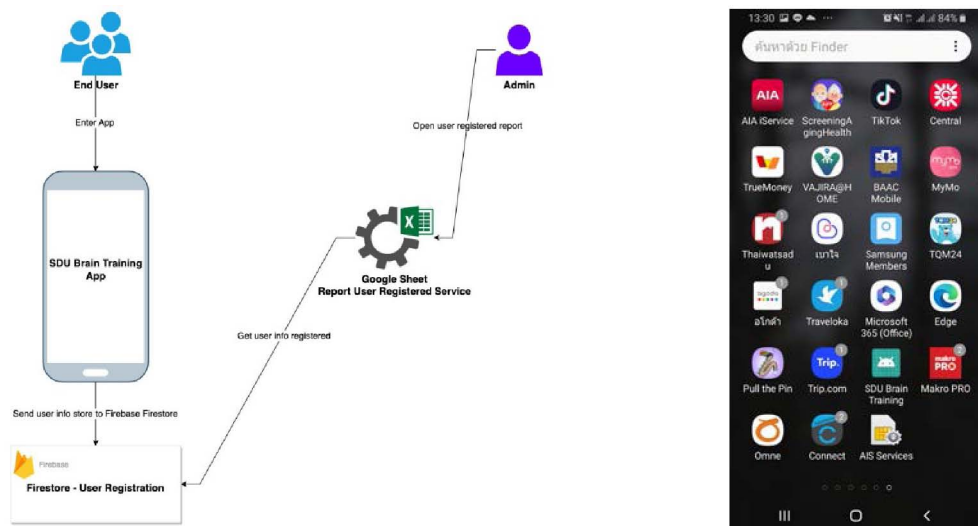


Figure 6 Installation of the SDU brain training application

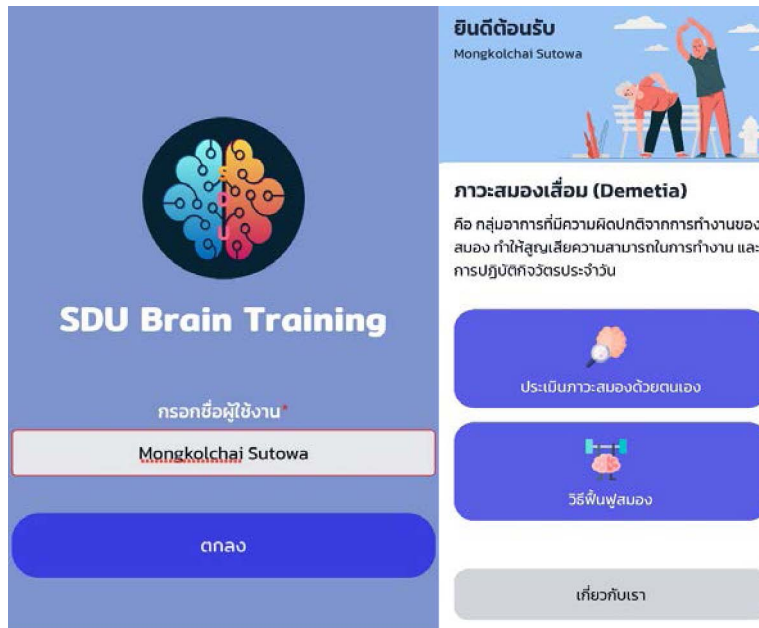


Figure 7 SDU brain training application home screen

10 province names. Each category contained more than 10 items to ensure random shuffling during each test, preventing users from relying on short-term memory. Test scores would be presented as an overall score and individual category breakdowns. In Part 2, a result interpretation would be provided for each category and overall. Users would be classified as healthy brain or at risk of dementia and receive basic recommendations for care practice. The scoring system was: 1 point for a correct answer and 0 point for an incorrect answer, with

the highest and lowest possible scores being 40 and 0, respectively. See Figure 8 below.

The cognitive rehabilitation module consisted of six parts: brain exercise, meditation exercise, food tips for brain health, 4-step brain development, brain-healthy environment tips, and brain training games for the elderly to participate in activities at least 1 time a day and 5 days a week to stimulate brain cognition in the elderly. See Figure 9 below.

2. Results of the Application Effectiveness Evaluation



Figure 8 Self-assessment screen of the SDU brain training application

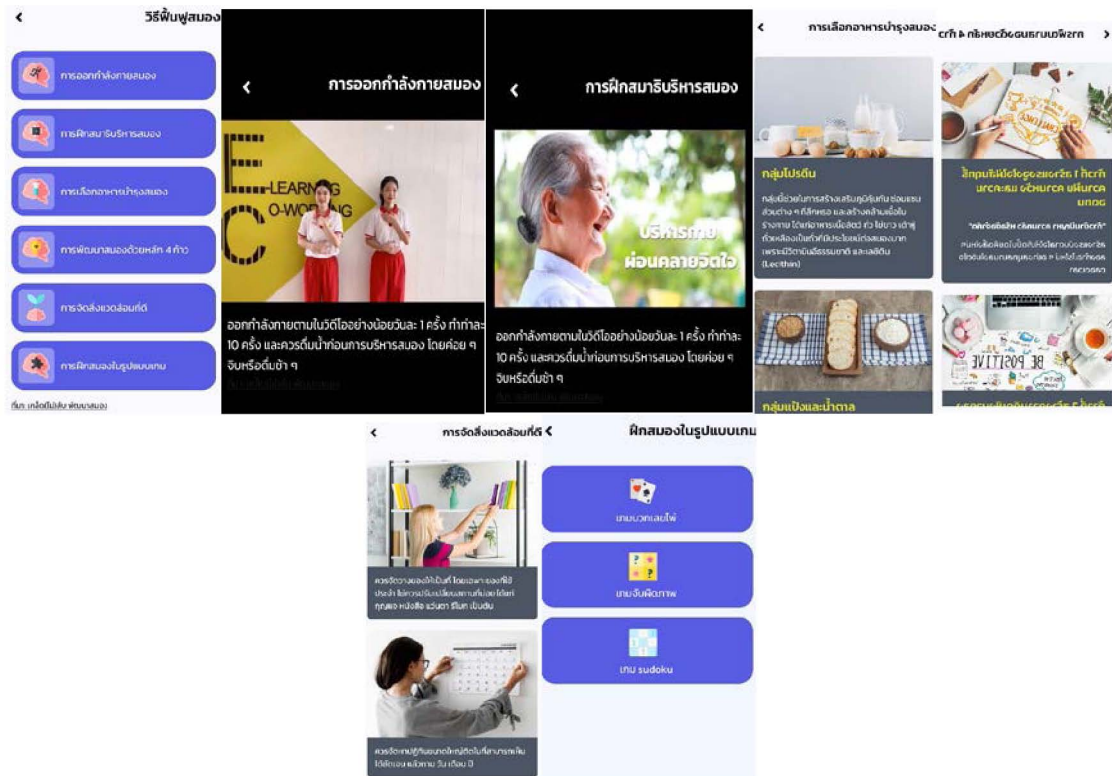


Figure 9 Cognitive rehabilitation screen of the SDU brain training application

The results showed that the participants were mostly female (88.57%), with an average age of 61.95 years, married (71.43%), and having a secondary level of education (52%). The evaluation achieved an overall mean score at the highest level ($M = 4.84$, $SD = .38$). Among all aspects, the propriety of the application had the highest mean score ($M = 4.90$, $SD = .30$), followed by the accuracy of the application and its score reporting ($M = 4.88$, $SD = .33$). On the contrary, the feasibility of the application ($M = 4.78$, $SD = .48$) had the lowest mean score ($M = 4.78$, $SD = .48$), followed by the utility of the application ($M = 4.80$, $SD = .41$). See [Table 1](#) for more

details.

Conclusion

Conclusion and Recommendations

The SDU Brain Training application for older adults at risk of dementia consisted of two modules: self-assessment and cognitive rehabilitation. The self-assessment module included a cognitive assessment where users identified the names of 10 animals, 10

Table 1 Mean Score (M), Standard Deviation (SD), and interpretation of effectiveness of the sdu brain training application

Evaluation aspect	Effective level		
	M	SD	Result interpretation
1. Utility of the application	4.80	.41	Most effective
2. Feasibility of the application	4.78	.48	Most effective
3. Propriety of the application	4.90	.30	Most effective
4. Accuracy of the application and its score reporting	4.88	.33	Most effective
Total	4.84	.38	Most effective

colors, 10 fruits, and 10 provinces. Users would receive 1 point for each correct answer and 0 point for each incorrect answer. The highest and lowest possible scores were 40 and 0, respectively. Scores >25 indicated healthy brain function, while those <25 suggested a risk of dementia and a recommended consultation with a health professional. The cognitive rehabilitation module incorporated knowledge and brain training methods consisting of brain exercise, meditation exercise, food tips for brain health, 4-step brain development, brain-healthy environment tips, and brain training games, e.g. photo hunt games, math card games, and Sudoku. The testing results showed that the application was compatible with iOS 12 and Android 8 and was usable (β testing = .78), with no installation or usage issues. However, users were required to have a communication device that meets the application's requirements for installation and image display. No delay in the application performance was found. To examine the application's effectiveness, a user evaluation was conducted using Stufflebeam et al.'s evaluation standards adopted by the Committee on Evaluation Standard Development for Educational Documents and Projects (Kanjanaawasee, 2021). The following aspects were evaluated: feasibility, accuracy, propriety, and utility. The application achieved an overall mean score at the highest level ($M = 4.84$, $SD = .38$), with propriety having the highest mean score ($M = 4.90$, $SD = .30$), followed by accuracy ($M = 4.88$, $SD = .33$), and feasibility having the lowest mean score ($M = 4.78$, $SD = .48$).

Discussion

The study's results demonstrate that the SDU Brain Training application is an effective and feasible tool to help prevent dementia in at-risk older adults, aligning with several previous studies. For instance, a study on cognitive stimulation in individuals with mild cognitive impairment by Kuha et al. (2016) suggests that cognitive activities can be beneficial to both preventing dementia and improving cognitive function in those already experiencing mild neurocognitive disorder (NCD) and mild cognitive impairment and early assessment can lead to approaches to preserving cognitive function. Another study Chansod and Kongtalin (2023) indicates that a brain training programme targeting attention, visuospatial function, memory, and executive function can improve older adults' scores on the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA). Ye et al. (2021) highlight the need

for dementia care support applications among older adults with dementia and their families and the usability and potential of smartphone applications for assessing dementia and stimulating cognitive function. This possibility is supported by Eggink et al. (2021)'s study, which demonstrates that mobile applications can be a viable and sustainable solution to dementia prevention based on their findings of an 18-month follow-up in at-risk older adults aged 55–75 years with more than two risk factors. In Tahmassebi (2018)'s interview with 50 older persons aged 65–90 years, most respondents expressed interest in playing games, but lacked technical knowledge and needed assistance in using devices and playing games. Integrating user-friendly technology into eldercare can help promote older adults' access to technology and enhance caregivers' experiences (Gately et al., 2020). A study by Bahar-Fuchs et al. (2020) confirms that computerised cognitive training can improve self-care practices among older people living with dementia.

The SDU Brain Training application is a practical innovation tool that can assist in dementia prevention among at-risk older adults. It can also be applied in other communities to effectively monitor and promote older people's health, leading to reduced healthcare costs, less burden on public health personnel, and enhanced eldercare systems for families and communities.

Acknowledgments

This research project was supported by Suan Dusit University (Fundamental Fund: Fiscal Year 2023 by the National Science Research and Innovation Fund (NSRF)) and received an ethics committee approval letter No. SDU-RDI-HS 2023-013 from the Research Ethics Review Committee for Research Involving Human Research Participants, Suan Dusit University.

References

- Ali, S., Alizai, H., Hagos, D. J., Rubio, S. R., Calabria, D., Serrano Jimenez, P., Senthil, V. A., & Appel, L. (2024). mHealth apps for dementia, Alzheimer disease, and other neurocognitive disorders: Systematic search and environmental scan. *JMIR Mhealth and Uhealth*, 12, e50186. <https://doi.org/10.2196/50186>
- Atkinson, R. C., & Shiffrin, R. M. (1977). Human memory: A proposed system and its control processes. In G. H. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory* (pp. 89–195). Academic Press. [https://doi.org/10.1016/S0079-7421\(08\)60422-3](https://doi.org/10.1016/S0079-7421(08)60422-3)
- Bahar-Fuchs, A., Martyr, A., Goh, A. M. Y., Sabates, J., & Clare, R. (2020). Computerised cognitive training for people with dementia: A systematic review and meta-analysis. *Journal of Clinical Pharmacy and Therapeutics*, 45, 1–12.

- L. (2019). Cognitive training for people with mild to moderate dementia. *Cochrane Database of Systematic Reviews*, 2019(3), CD013069. <https://doi.org/10.1002/14651858.CD013069.pub2>
- Chansirikarnjana, S. (2023). *A hot trend in aging society: Knowing about Alzheimer's disease and dementia can slow their progress*. Faculty of Medicine Ramathibodi Hospital, Mahidol University. <https://op.mahidol.ac.th/ga/thenation-10/>
- Chansod, W., & Kongtalin, O. (2023). The effectiveness of a brain training program for dementia prevention in older persons living in municipal areas, Ubon Ratchathani Province, Thailand. *Journal of Nursing Science & Health*, 45(1), 75–86. <https://he01.tci-thaijo.org/index.php/nah/article/view/252848/171852>
- Department of Older Persons. (2023). *Elderly statistics*. <https://www.dop.go.th/th/know/side/1/1/335>
- Eggink, E., Hafdi, M., Hoevenaer-Blom, M. P., Song, M., Andrieu, S., Barnes, L. E., Birk, C., Brooks, R. L., Coley, N., Ford, E., Georges, J., van der Groep, A., van Gool, W. A., Handels, R., Hou, H., Li, D., Liu, H., Lyu, J., van Marwijk, H., ... Richard, E. (2021). Prevention of dementia using mobile phone applications (PRODEMOS): Protocol for an international randomised controlled trial. *BMJ Open*, 11(6), e049762. <https://doi.org/10.1136/bmjopen-2021-049762>
- Fajrin, C. E., Ningsih, S. W. W., Kartini, Saputra, A., Khoiriyah, U., & Duma, M. (2023). Student and teacher collaboration in developing STEM-based learning modules and Pancasila student profiles. *JPI (Jurnal Pendidikan Indonesia)*, 12(1), 39–49. <https://doi.org/10.23887/jpiundiksha.v12i1.52704>
- Gately, M. E., Tickle-Degnen, L., Trudeau, S. A., Ward, N., Ladin, K., & Moo, L. R. (2020). Caregiver satisfaction with a video telehealth home safety evaluation for dementia. *International Journal of Telerehabilitation*, 12(2), 35–42. <https://doi.org/10.5195/ijt.2020.6337>
- Kanjanawasee, S. (2021). *Evaluation theory* (10th ed.). Chulalongkorn University.
- Khunsang, Y., & Khunsang, C. (2022). Designing online lessons on the Google Classroom network using the ADDIE model teaching system in elementary school. *Ramkhamhaeng University Journal: Graduate School*, 5(2), 70–81. http://www.rujogs.ru.ac.th/journals/14_1672817528.pdf
- Kuha, O., Duangdee, S., Chansirikarnjana, S., Nakawiro, D., Phatcharapisitgul, P., Vidhyachak, C., et al. (2016). *Cognitive stimulation in people with mild cognitive impairment* (1st ed.). CyberPrint Group Co., Ltd. https://sgh.go.th/uploads/book-2559-06_1.pdf
- Limsakul, W., Chansirikarnjana, S., & Chanead, W. (2023). A survey study on the status of older people in the integrated care for older people with dementia in Thai communities: Suratthani Province (ICOPE_D-Ts). *Journal of Health and Innovation*, 6(1), 3–13. <https://he02.tci-thaijo.org/index.php/jhri/article/view/261864>
- Livingston, G., Huntley, J., Liu, K. Y., Costafreda, S. G., Selbæk, G., Alladi, S., ... Mukadam, N. (2024). Dementia prevention, intervention, and care: 2024 report of the *Lancet* Standing Commission. *The Lancet*, 404(10452), 572–628. [https://doi.org/10.1016/S0140-6736\(24\)01296-0](https://doi.org/10.1016/S0140-6736(24)01296-0)
- Magteppong, W., Triamlumlert, S., & Kongsuwan, P. (2022). The development of a mobile application for assessing dementia and educating village health volunteers on the prevention and caring for dementia patients. *Thai Red Cross Nursing Journal*, 15(3), 87–103. <https://he02.tci-thaijo.org/index.php/trenj/article/view/254636>
- Muangpaisan, W. (2021). *Dementia: Prevention, assessment and care*. Department of Preventive and Social Medicine, Mahidol University.
- National Statistical Office. (2017). *Statistical yearbook Thailand 2017*. National Statistical Office, Ministry of Digital Economy and Society.
- Pornudomthap, S., Somthawinpongchai, C., & Piphitpakdee, P. (2021). The application development of dementia/Alzheimer patients in daily life. *Journal of Management Science, Ubon Ratchathani University*, 11(1), 60–87. https://so03.tci-thaijo.org/index.php/jms_ubu/article/view/252592
- Saipany, A. (2022). Prevalence and factors associated with dementia and mild cognitive impairment (MCI) among elderly in Na-Mafuang Subdistrict, Amphur Muang, Nongbua Lamphu Province. *Udonthani Hospital Medical Journal*, 30(3), 376–386. <https://search.asean-cites.org/article.html?b3BlbkFydGlibGUmWQ9NzA5NTc3>
- Suthatipkul, S., & Siri Wong, P. (2018). The problem and process of learning to use smartphone technology among elderly people in the surrounding area of Phra Pinklao, Bangkok Noi District, Bangkok. *Rajamangala University of Technology National Conference Proceedings*.
- Suwan, A. (2017). Role of nurses in caring for older persons with dementia. *Journal of Nursing and Health Care*, 35(1), 6–15. <https://he01.tci-thaijo.org/index.php/jnat-ned/article/view/84634>
- Tahmassebi, S. (2018). *Digital game design for elderly people* (Master's thesis, Malmö University, Faculty of Technology and Society, Department of Computer Science and Media Technology). <https://www.diva-portal.org/smash/get/diva2:1480001/FULLTEXT01.pdf>
- Thai Gerontology Research and Development Institute. (2021). *Situation of the Thai older persons 2021*. Institute for Population and Social Research, Mahidol University. https://www.dop.go.th/download/knowledge/th1663828576-1747_1.pdf
- Ye, B., Chu, C. H., Bayat, S., Babineau, J., How, T. V., & Mihailidis, A. (2023). Researched apps used in dementia care for people living with dementia and their informal caregivers: Systematic review on app features, security, and usability. *Journal of Medical Internet Research*, 25, e46188. <https://doi.org/10.2196/46188>
- Ye, B., How, T. V., Chu, C. H., & Mihailidis, A. (2021). Dementia care apps for people with dementia and informal caregivers: Asystematic review protocol. *Geriatrics and Gerontology International*, 67(5), 633–638. <https://doi.org/10.1159/000514838>