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Effectiveness of Game Technology Applied to Preclinical Training for Nurse Aides in Implementing Contact Isolation Precautions

Chiao-Hui Lin[1] and Yi-Maun Subeq [2,*]

[1] Department of Nursing, Chi Mei Medical Center, Liouying, Taiwan
susan891224@gmail.com
[2] Bachelor Program of Senior Health Promotion and Care Management for Indigenous People, College of Education, National Changhua University of Education,
Changhua City, Taiwan. subeq1214@gmail.com

Abstract. . The rapid spread of emerging infectious diseases poses significant challenges to elderly care in the healthcare system. Effective training in contact isolation protective measures is essential for nurse aides to reduce infection risks. This study integrates game technology and Scaffolding theory, utilizing mobile apps for interactive teaching to enhance the contact isolation protection capabilities of nurse aides. This study employed a quasi-experimental design and involved 60 students from the Department of Senior Citizen Services at a college in Taiwan. Participants trained with the game app Golden Cicada Escapes with Its Whole Body, and their learning outcomes were evaluated using SPSS 26.0 and multiple linear regression. The results showed that the experimental group demonstrated significant improvements in cognition, skills, and self-efficacy, proving the effectiveness of game technology in learning. We hope that the innovative teaching model combining game technology with Scaffolding theory can serve as a reference for strategies in training for emerging infectious disease clinical protection in medical education both domestically and internationally, offering broad prospects for application and value for dissemination.

Keywords: Elderly Care, Nurse Aides, Game Technology, Scaffolding Theory, Contact Isolation Measures, Medical Education.

1. Introduction

In the context of global aging, the rising costs of medical care have accelerated the shift towards an aging society. This transformation poses significant challenges, prompting rapid advancements in medical technology and dramatic changes in population demographics. According to data from Taiwan's National Development Council, the proportion of the elderly population is steadily increasing and is expected to exceed 20% of the total population by 2025. This rapid and notable growth further intensifies the impact of an aging society on the socioeconomic structure [1].

* Corresponding author

With the aging population, the demand for long-term care services has surged, exacerbating the shortage of nurse aides in schools and leading to an imbalance in the labor market, particularly within the medical and caregiving sectors, posing significant social challenges. Nurse aides in schools play a pivotal role in both medical and daily care, undertaking critical tasks in long-term care services. Their shortage not only impacts the well-being of the elderly and their families but also increases the burden on the healthcare system. It is imperative for governments to proactively cultivate more caregiving talent by providing systematic training and professional courses supported by modern technology. This approach ensures sufficient caregiving manpower in an aging society while enhancing the professional standards and quality of care provided by nurse aides in schools [2].

In the context of challenges in elderly care, the application of game technology has gradually become a crucial tool. With rapid advancements in technology, game technology has proven to offer engaging and highly interactive learning experiences, particularly in the fields of medical and caregiving training. It effectively stimulates learners' interest and motivation, helping them stay focused on their studies, which in turn enhances learning efficiency and outcomes [3]. In training for contact precautions and caregiving in schools, game technology can simulate real-life scenarios to improve trainees' practical skills. Game simulations of contact isolation scenarios immerse students in infection control knowledge, equipping them with the skills needed to handle emerging infectious diseases. This experience enhances their adaptability in actual work environments, reduces errors in medical settings, and is therefore essential [4, 5].

The value of game technology extends beyond academic and clinical training; it can also serve as a tool for broadly disseminating health protection knowledge and skills, aiding society in better responding to public health challenges. This approach leverages interactive simulations and game-based scenarios that mimic real-life situations, providing trainees with hands-on experience in managing elderly care, including emergency responses and daily caregiving tasks. With the frequent outbreaks of emerging infectious diseases and the acceleration of globalization, enhancing the prevention and control knowledge of healthcare professionals and the public has become increasingly important. Digital game-based learning (DGBL) has proven to be highly effective in boosting learning motivation and knowledge retention [6]. The challenge design, reward systems, and real-time feedback mechanisms in games enhance learner engagement, making medical knowledge more focused and facilitating a deeper understanding and practical application of these skills. Moreover, the integration of game technology with big data analytics, artificial intelligence (AI), and virtual reality (VR) technology can offer innovative and efficient solutions for medical education [7].

Adjusting the difficulty of the game based on learners' behavior and progress, and providing real-time, personalized feedback, can simulate real-world scenarios of infectious disease outbreaks. This enables learners to practice preventive measures and decision-making exercises without actual risk. Such technological applications enhance the clinical adaptability of healthcare professionals and make them more proficient in responding to various public health crises [8]. In the context of technological advancements, societies facing the dual challenges of aging populations and emerging infectious disease threats must comprehensively utilize medical technology to bolster their response capabilities. Integrating enhanced caregiver training with the application of game technology in education can improve the overall capacity of healthcare services and effectively address the increasing demand for medical care, ultimately fostering a healthier, safer, and more resilient society [9].

Infection control training for pre-clinical nurse aides often relies on passive learning methods, such as lectures or written manuals, which fail to engage learners or prepare them for practical, real-world applications. This gap in training methods has been highlighted by the growing need for innovative and interactive approaches, especially in the post-pandemic era. Integrating game technology and advanced deep learning models offers an effective approach to improving infection control during outbreaks. Game-based training and VR simulations enhance healthcare workers' response capabilities, while tools like MFMDet ensure correct PPE usage, reinforcing public health defenses. These innovations collectively strengthen the healthcare system’s resilience and its ability to respond efficiently to pandemics, ensuring safety in high-risk environments. Pre-clinical nurse aides’ students were chosen as study subjects because they are in the foundational stage of learning nursing skills and knowledge. And incorporating Scaffolding theory provides step-by-step support in the design of game technology scripts, helping students gradually master complex skills starting from foundational knowledge. This approach enables teachers to identify learning difficulties and adjust the curriculum, thereby enhancing nurse aides’ practical skills using interactive teaching via mobile apps. The purpose of this study is to explore the effectiveness of a teaching program that integrates scaffolding theory with gaming technology in contact isolation precautions, on the cognition, attitudes, skills, and self-efficacy of pre-clinical nurse aides.The preparation of manuscripts which are to be reproduced by photo-offset requires special care. Papers submitted in a technically unsuitable form will be returned for retyping, or canceled if the volume cannot otherwise be finished on time.

2. Manuscript Preparation

2.1. Challenges in Isolation Protection Training for Nurse aides

WHO proposed a preparedness and response plan to combat emerging infectious diseases, with the primary goal of suppressing virus transmission and preventing disease and death [1]. This makes it increasingly important for clinical healthcare personnel to adhere to infection prevention and control guidelines, which include strategies such as using personal protective equipment (PPE), like masks, face shields, gloves, and protective clothing [4]. With the aging population, the cost of providing medical care continues to rise, and the shortage of nurses leads to a lack of caregiving personnel. Thus, the role of nurse aides in long-term care facilities, nursing homes, and home care for the elderly has become a significant issue. In Taiwan, the training of nurse aides is divided into two main systems: formal educational institutions that cultivate students' abilities in health promotion, disability care, and service management, enabling them to apply professional knowledge and clinical skills effectively; and an informal educational system, where individuals attend short-term training programs organized by government entities to obtain certified nursing aide qualifications and learn elderly care knowledge.

Both systems teach students essential skills such as elderly bathing and dressing, vital signs measurement, correct patient positioning, infection control, effective team communication, and maintaining a clean and safe environment. All core courses are traditionally taught in lecture format, instructing students on common statutory infectious diseases and prevention principles; they learn various isolation measures and caregiving techniques, such as properly donning and doffing isolation gowns, wearing masks, and the basics of handwashing. However, there is a significant lack of practical application; this has led to low usage rates of isolation protection and compliance with PPE use among nurse aides prior to the COVID-19 pandemic, demonstrating a severe lack of infection control knowledge and attitudes toward using personal protective equipment [9].

2.2. Application of Game Technology in the Control of Emerging Infectious Diseases

During pandemics, healthcare systems are compelled to respond swiftly and allocate sufficient resources to protect both healthcare workers and patients. This includes providing adequate personal protective equipment (PPE) such as gloves, gowns, masks, and face shields, as well as strictly enforcing standard protective measures like hand hygiene and environmental disinfection [4, 10]. These measures enable healthcare institutions to effectively reduce the risk of infection and prevent the spread of pathogens [11, 12]. However, the practice and adherence to protective strategies often face numerous challenges, including insufficient training for healthcare workers and unstable equipment supplies. Game technology emerges as an innovative solution with potential, offering new ways to address these issues. By using game-based technology, virtual training scenarios can be created to strengthen healthcare workers' response capabilities in infection control and enhance their clinical adaptability. For instance, simulations that replicate the process of breaking infection chains allow learners to practice proper PPE usage and respond to various transmission routes in a risk-free virtual environment [13, 14].

Virtual reality (VR) technology can simulate real-life scenarios of infectious disease outbreaks, allowing trainees to practice standard protective measures in a risk-free environment. This includes learning how to effectively implement contact isolation, don protective equipment, and provide patient care. Such training enhances healthcare workers' response capabilities and reinforces their proficiency in correctly executing preventive measures in real-world settings [15].

With the rapid emergence of infectious diseases, enhancing the response capabilities of healthcare workers and the public has become a critical issue. Additionally, industrial development has led to environmental pollution and health risks that are closely linked to the spread of emerging infectious diseases. In response to these challenges, the development of game technology offers an innovative solution. By designing specialized educational games, players can learn and master infection prevention measures in a virtual environment, including the proper use of personal protective equipment (PPE), the implementation of contact isolation measures, and emergency responses during disease outbreaks. Furthermore, wearing masks in workplaces has become an effective way to prevent the inhalation of harmful gases and pathogens [16].

The outbreak of emerging infectious diseases has intensified the focus and challenges related to mask protection monitoring, particularly in medical facilities and high-risk workplaces. Research has introduced a deep learning-based mask detection model, MFMDet, which utilizes a recursive feature pyramid structure and deformable RoI pooling technology to enhance detection capabilities for targets of varying scales. Additionally, a mixed augmentation technique is implemented to increase sample diversity. MFMDet has shown improved accuracy across multiple datasets, providing strong support for the prevention and control of emerging infectious diseases. The application of this technology not only effectively detects whether personnel are wearing masks correctly but also enhances public health protection, especially during periods of high incidence of infectious diseases [17, 18].

In summary, integrating game technology with innovative medical training solutions enhances the ability of healthcare professionals to respond to emerging infectious diseases. Through simulated practice and real-time feedback, these tools enable effective handling of pandemic challenges in real-world scenarios. Additionally, advancements in mask technology ensure optimal preparedness for protective measures.

2.3. Game Design for Simulating Infectious Diseases

Based on infectious disease spread models, game developers can design simulation games that integrate sources of infection, transmission routes, and hosts. Players must make rapid decisions to prevent the spread of diseases, enhancing health awareness and familiarizing them with control strategies through real-time feedback [19, 20]. VR technology in medical education, particularly in training clinical skills for nurses and medical students, allows risk-free practice of protective measures and decision-making. Digital game-based learning (DGBL) has proven effective in boosting motivation and engagement, making complex academic concepts more accessible [21, 22]. By integrating big data analytics, games can track learners' progress and tailor content to individual needs, improving educational outcomes and practical application [23, 24]. Game scripts incorporating scaffolding theory and interactive teaching enable streamlined content adaptation for online learning [25, 26].

In summary, in the post-pandemic era, the integration of game technology with modern medical education on online learning platforms offers an innovative and effective approach for the prevention and control of emerging infectious diseases. Through advanced game design, virtual reality applications, and big data analytics, these technological tools will become essential for healthcare professionals and the public to learn infection prevention and control. This integration fosters a comprehensive improvement in health literacy and supports the advancement of global public health.

The integration of game technology into medical education represents a transformative approach for infection prevention in the post-pandemic era. Advanced tools such as virtual reality and big data analytics provide healthcare professionals and the public with accessible and effective learning platforms. These developments address the pressing need for enhanced infection control training, paving the way for innovative interventions like those explored in this study.

2.4. Purpose of Game Program Design

The framework of this study is based on the researcher’s adaptation of the isolation guidelines from the Centers for Disease Control in Taiwan and the United States to design a teaching program titled "Scaffolding Theory Combined with Game Technology Intervention for Contact Isolation Protective Measures.

This study employed a quasi-experimental design, dividing participants into a control group (n = 30) and an experimental group (n = 30). The participants were students aged 18 and older from the Department of Senior Citizen Services at a college in Taiwan. Participants were assigned to the groups through simple randomization using a random number generator, ensuring equal probability for each participant.

The study aimed to evaluate the learning outcomes of the experimental group, who learned contact isolation measures through the game-based intervention, "Golden Cicada Escape." The focus was on cognitive, attitudinal, technical skills, and self-efficacy improvements among nurse aides in training, as well as satisfaction levels within the experimental group. The study compared the learning effectiveness between the experimental and control groups

Scaffolding theory guided the design of the educational tasks by providing a structured framework. For instance, the intervention included progressively challenging scenarios within the game to help learners build confidence and competence step-by-step. Furthermore, the program incorporated real-time feedback and support, such as hints and prompts, tailored to each learner’s progress to ensure continuous engagement and effective skill acquisition. This study applies scaffolding theory [27, 28] to design an interactive and structured teaching program that integrates game technology. The specific steps and content are as follows:

A. Designing a Game Technology-Based Teaching Program for Contact Isolation Protective Measures:

(A) Analyze Learner Characteristics: Assess the learning preferences and characteristics of pre-clinical nurse aides.

(B) Set Learning Objectives: Establish clear learning goals aligned with the capabilities of pre-clinical nurse aides.

(C) Develop Teaching Guidelines: Create instructional guidelines for teaching contact isolation protective measures using game technology.

(D) Incorporate Scaffolding Theory: Design educational tasks that integrate scaffolding theory into the game technology script to support practical teaching.

(E) To create comprehensive instructional resources, we developed a set of materials, including written documents, draft illustrations, and audiovisual teaching content (Fig. 1).

Figure 1 presents a draft illustration of the instructional framework, depicting key elements of the teaching process.

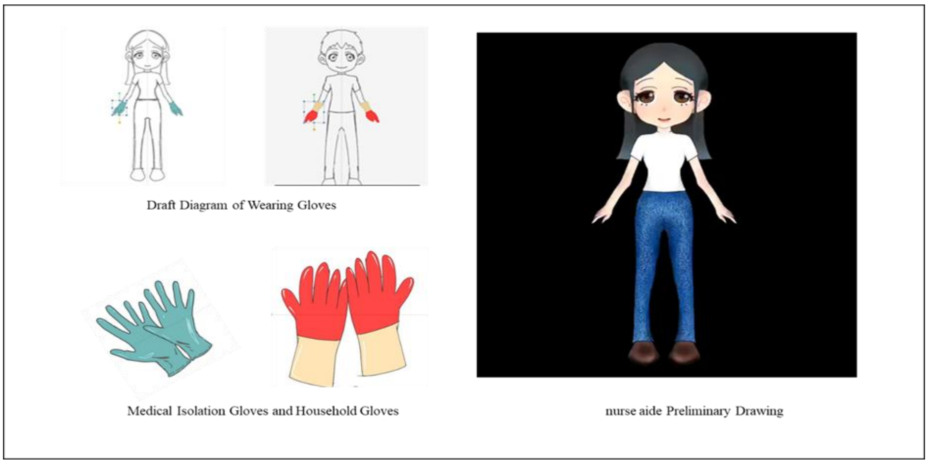

Fig. 1 Draft drawing

The instructional content includes: (A) Teaching handouts on contact isolation protective measures; (B) Short instructional videos on the proper use of personal protective equipment (PPE), including the correct procedures for donning and doffing gowns, masks, and gloves; (C) Evaluation of contact isolation protective measures and a gamified guide for PPE procedures.

2.5. Implementation of Game Technology-Based Teaching Methods for Contact Isolation Protective Measures

The course uses game technology to create engaging learning scenarios that spark students' interest in the practical application of contact isolation protective measures, including the correct use and donning/doffing of personal protective equipment (PPE). The experimental group participated in game challenges designed with content on infectious disease knowledge and the application of isolation measures, implemented as part of 10 online game levels in the teaching program. As is show in Fig. 2 illustrates the Game Startup Flowchart, depicting the sequence of game levels and the progression flow for participants.

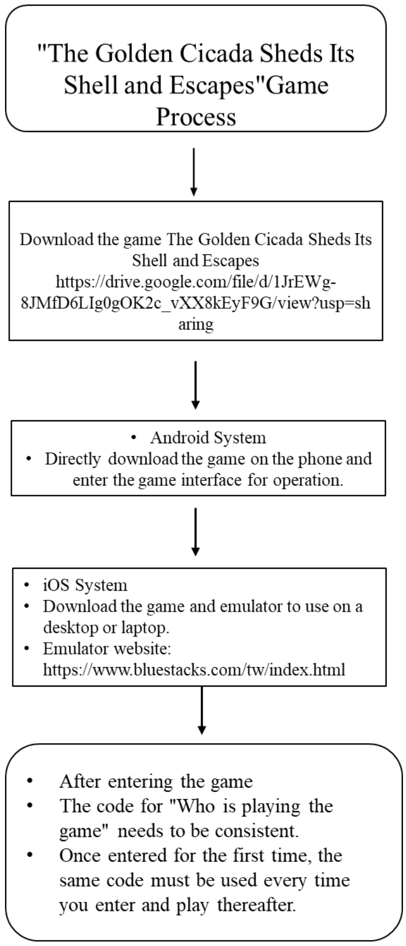

Fig. 2. Game Startup Flowchart

2.6. Game Program File Development and Design

The configuration files for research in Android Studio are written in XML format and encompass a variety of research settings and configurations. Fig. 3 presents the Design Thinking Diagram for 'Golden Cicada Escape,' illustrating the conceptual framework and workflow that guided the development of the research application.

These files primarily record various development environment settings for Android projects, such as auto-import configurations, layout management, execution targets, recent files, templates, and task management details. These configuration files are typically auto-generated and managed by the development environment, eliminating the need for manual editing by developers.

The research configuration files in Android Studio are created in XML format and serve as a record of various detailed development settings and configurations within the research projects. Fig.4 presents a code example of the app homepage with background music, demonstrating the implementation of user Interface components and audio integration in the "Golden Cicada Escape" application.

Managed and generated automatically by Android Studio, these files include comprehensive information about the project's layout, execution, and version control. Developers do not need to manually edit these files; instead, they can modify configurations through Android Studio. These configuration files coordinate multiple functions within Android Studio during research, facilitating a smoother process for application development, testing, and debugging.

The following outlines the main components of the file and their function descriptions:

Based on the content provided in the image, these code components are used to manage and describe various functionalities in Android development. Below is a description of the main components and their functions:

1. Adroid Layout Configuration (<component name="AndroidLayouts">):Manages the layout resources of the Android project and is responsible for handling and displaying different layout files.

2. Auto-Import Settings (<component name="AutoImportSettings">):Defines whether the auto-import feature is enabled for the project, facilitating the automatic import of required dependencies or packages.

3. Change List Management (<component name="ChangeListManager">):Manages change files and system change lists, controlling whether conflict changes are displayed and change lists are deleted.

4. Execution Target Management (<component name="ExecutionTargetManager">): Configures and manages the execution targets for the program, such as setting a test environment or an emulator for running the project.

5. External Project Management (<component name="ExternalProjectsData"> and <component name="ExternalProjectsManager">):Handles the reading and processing of external dependencies and tasks within the project.

6. Run Settings (<component name="RunManager">):Defines the run configurations for the program, such as whether it is in debug mode or release mode.

7. Recently Used Files and Templates (<component name="RecentsManager"> and <component name="FileTemplateManagerImpl">):Records recently used files and templates to facilitate quick access.

8. Task Management (<component name="TaskManager">):Configures and manages the settings related to tasks within the project.

Fig.3. Design Thinking Diagram for 'Golden Cicada Escape '

Fig. 4. App Homepage with Background Music: Code Example

2.7. Game Technology Applied Effect Analysis

This study was approved by the Institutional Review Board (IRB) of Chi Mei Medical Center (approval number: blinded).

The objective of this study was to evaluate the effectiveness of integrating scaffolding theory and game-based technology into teaching contact isolation protective measures. Participants were divided into a control group and an experimental group. The study design included pre-tests, classroom instruction, random group assignments, and a game-based learning intervention for the experimental group, followed by post-tests conducted one month later to assess learning outcomes. The target population consisted of fourth- and fifth-year students aged 18 and older who held nurse aide certificates. Data analysis was performed using SPSS version 26.0, with a significance level set at $p < .05$.

2.8. Basic Information of Study Participants

As shown in Tables 1 and 2, a total of 60 students participating in the contact isolation protective measures course, 30 were assigned to the experimental group and 30 to the control group. Homogeneity tests indicated no significant differences between the two groups in terms of age, gender, clinical experience, and related course background.

This study included 60 pre-clinical nurse aide students aged 18–20, with 78.3% aged 18–19 and 21.7% aged 19–20. The gender distribution was 75% female and 25% male. Most participants (86.7%) had no prior caregiving experience, while 63.3% had attended a contact isolation-related courses in the past year. A homogeneity test confirmed no significant differences between the experimental and control groups in age, gender, caregiving experience, or prior course participation. As shown in Table 2, we analyzed whether these factors influenced learning outcomes and found no significant differences ($p=0.108$) between participants with and without prior infection control training.

Table 1. Descriptive Statistics of Basic Information

Variable	Category	Frequency	Percentage
Age	18-19	47	78.3
	19-20	13	21.7
Gender	female	45	75.0
	male	15	25.0
Students with nurse aide work-study experience	No	52	86.7
	Half a year	7	11.7
	Over one year	1	1.6
Whether the student has taken courses related to contact isolation measures within the past year	No	38	63.3
	Yes	22	36.7

Table 2. Homogeneity tests

	Experimental Group	Control Group	Total	F/χ^2	p
	(n=30)	(n=30)	(n=60)		(Two-ailed)
Item	n (%)	n (%)	n (%)		
Age				χ^2=4.812	.028
18-19 years old	20 (66.6)	27 (90)	47 (78.3)		
19-20 years old	10 (33.4)	3 (10)	13 (21.7)		
Gender				χ^2=.800	.371
Female	21 (70)	24 (80)	45 (75)		
Male	9 (30)	6 (20)	15 (25)		
Students with nurse aide work-study experience				χ^2=1.220	.543
None	27 (90)	25 (83.3)	52 (86.7)		
Half a year	3 (10)	4 (13.3)	7 (11.6)		
Greater than one year.	0 (0)	1 (3.4)	1 (1.7)		
Whether the student has taken courses related to contact isolation measures within the past year				χ^2=2.584	.108
None	16 (53.4)	22 (73.4)	38 (63.4)		
Have	14 (46.6)	8 (26.6)	22 (36.6)		

2.9. Post-Test Learning Outcomes

This section discusses the learning outcomes of the game technology intervention in the teaching program for contact isolation protective measures. A paired-sample t-test was conducted to analyze the post-test differences between the control group, which received classroom-based teaching on contact isolation measures, and the experimental group, which underwent the intervention using game technology, As show in Table 3 presents the results of the Independent Samples t-Test for Technical Skills, Cognition, Attitudes, and Self-Efficacy in the Game Technology Intervention. A total of 56 participants (93.3%) completed the post-test, with 2 participants from each group failing to complete the test, leaving a total of 4 participants (6.7%) who did not fill out the post-test, but they were still included in the analysis.

The results are as follows:

2.9.1 Technical Skills

The post-test average scores for the experimental and control groups were 20.71 and 17.32, respectively. Both groups scored higher in the post-test compared to their pre-test scores. Statistical analysis showed a significant difference ($p < .001$) between the two groups **(Table 3)**.

2.9.2 Cognition

The post-test average scores for the experimental and control groups were 52.25 and 45.00, respectively. Both groups showed an increase in post-test scores compared to their pre-test scores, with statistical analysis revealing a significant difference ($p < .003$) **(Table 3)**.

2.9.3 Total Score (Technical Skills + Cognition)

The post-test average scores for the experimental and control groups were 72.96 and 62.32, respectively. Both groups' post-test scores were higher than their pre-test scores, and statistical analysis indicated a significant difference ($p < .001$) **(Table 3)**.

2.9.4 Attitude

The post-test average scores for the experimental and control groups were 21.75 and 21.39, respectively. While the post-test scores were higher than the pre-test scores, the difference was minimal, and statistical analysis showed no significant difference ($p = .597$) **(Table 3)** .

2.9.5 Self-Efficacy

The post-test average scores for the experimental and control groups were 43.46 and 40.68, respectively. After the intervention, both groups showed improved post-test scores compared to their pre-test scores, with statistical analysis showing a significant difference ($p < .024$) **(Table 3)**.

Results: After receiving different intervention measures, the learning outcomes of contact isolation protective measures in the experimental and control groups were compared. The experimental group, which used game technology intervention, showed significant differences in technical skills, cognition, total score (technical skills + cognition), and self-efficacy.

Table 3. Independent Samples t-Test for Technical Skills, Cognition, Attitudes, and Self-Efficacy in the Game Technology Intervention (n=60)

Variable	Group		t-value	p
	Control Group （n=30）	Experimental Group(n=30）		
	Mean±SD			
Post-test skills	17.32±4.234	20.71±3.230	3.371	0.001*
Post-test knowledge	45.00±9.978	52.25±6.731	3.187	0.003*
KA total score[1]	62.32±11.935	72.96±5.399	4.299	<0.001**
Post-test attitude.	21.39±2.544	21.75±2.238	0.558	0.597
Post-test self-efficacy	40.68±4.959	43.46±3.995	2.315	0.024*

*p<0.05
**p<0.001 Note 1: The total score refers to the sum of cognition (knowledge) and skills, with a maximum score of 100

.

A comparative analysis showed no significant differences in learning outcomes between participants with and without prior infection control training, indicating that previous exposure to infection control did not significantly affect performance in this study. This indicates that the game technology intervention significantly improved the learning outcomes and self-efficacy of pre-clinical nurse aides. Although there was an improvement in attitude in the post-test, it did not reach statistical significance. Although there was an improvement in attitude in the post-test, it did not reach statistical significance. This may be due to the participants being student care workers who have not yet entered the workforce. Their limited understanding of real-world scenarios could have affected their comprehension of certain questionnaire items. However, the experimental group, which received the gaming technology intervention, showed significant improvements in technical skills, cognitive understanding, total scores (technical skills and cognition), and self-efficacy. These results suggest that gaming technology effectively enhances learning outcomes, even if attitude changes may take longer to manifest.

3. Satisfaction Analysis of the Experimental Group after Game Technology Intervention

3.1. Descriptive Statistics of the Experimental Group's Satisfaction

As show in Table 4, after the experimental group learned contact isolation protective measures through the game "Golden Cicada Escape" designed by the researchers, the average satisfaction score was 22.04, with the lowest score being 19 and the highest score being the maximum of 25. The satisfaction survey consisted of 5 questions, using a Likert scale with five response levels, where 5 was "very satisfied" and 1 was "very dissatisfied." The survey covered game planning, time management, course content absorption, scenario design, and correct use of personal protective equipment. Detailed analysis showed that the highest score was for the game’s contribution to content absorption, with an average of 4.78, while the lowest score was for game time management, with an average of 4.03.

Table 4. Descriptive Statistics of the Experimental Group's Satisfaction (n=30)

Variable	Mean ± Standard Deviation	Minimum value	Maximum value
Post-test satisfaction	22.04±1.953	19	25

3.2. Correlation Analysis of Post-Test Scores and Satisfaction with Continuous Variables After Game Technology Intervention in the Experimental Group

As is show in Table 5, the total satisfaction score showed a high positive correlation with the overall game planning, game time management, game’s contribution to course content absorption, scenario design, and correct use of personal protective equipment, with statistically significant differences.

Results: The correlation analysis between satisfaction and various variables revealed that, after the game technology intervention, not only was the absorption of course content on contact isolation protective measures improved, but the correct use of personal protective equipment also aligned with the study's objectives.

Table 5. Correlation between Post-Test Continuous Variables and Satisfaction in the Experimental Group (n=30)

	Skills	Constant	KA Total	Attitude	self-efficacy	Game Planning	Game Arrangement	Game Absorption	Scenario Setting	Correct Protection	Satisfaction Total Score
Skills	1										
Knowledge	-.612**	1									
KAtotal註1	-.164	.881**	1								
Attitude	-.051	-.323	-.433*	1							
Self-efficacy	-.173	-.077	-.2	.581**	1						
Satisfaction Items											
Game Planning	.01	-.273	-.334	.427*	.615**	1					
Game Arrangement	-.054	-.365	-.488**	.553**	.507**	.583**	1				
Game Absorption	-.184	.072	-.02	.337	.372	.452*	.187	1			
Scenario Setting	-.033	-.163	-.223	.37	.35	.517**	.800**	.335	1		
Correct Protection	.089	-.147	-.13	.341	.431*	.549**	.438*	.471*	.403*	1	
Satisfaction Total Score	-.039	-.246	-.33	.536**	.596**	.812**	.822**	.600**	.824**	.740**	1

*Correlation is significant at the 0.05 level (two-tailed).

**Correlation is significant at the 0.01 level (two-tailed).

Note 1: The total score refers to the sum of cognition (knowledge) and skills, with a maximum score of 100.

3.3. Factors Related to the Learning Outcomes of Contact Isolation Protective Measures

A multiple linear regression analysis was conducted to examine the relationships between variables, and the results are presented in Table 6. The regression model used to test these relationships is illustrated in Fig. 5.

The attitude explained 33.1% of the variance in self-efficacy, making attitude the most influential factor on self-efficacy. Additionally, the combined explanation of attitude and the post-test total score (which includes cognition and skills) reached 38.4%, with the increase in explanatory power being statistically significant ($\Delta F = 18.401$, $p < 0.05$).

The results indicate that game-based learning not only improves cognitive understanding but also enhances self-efficacy, which is a critical factor in clinical decision-making. The practical significance suggests that integrating game technology into nurse aide training could lead to more confident and competent healthcare providers.

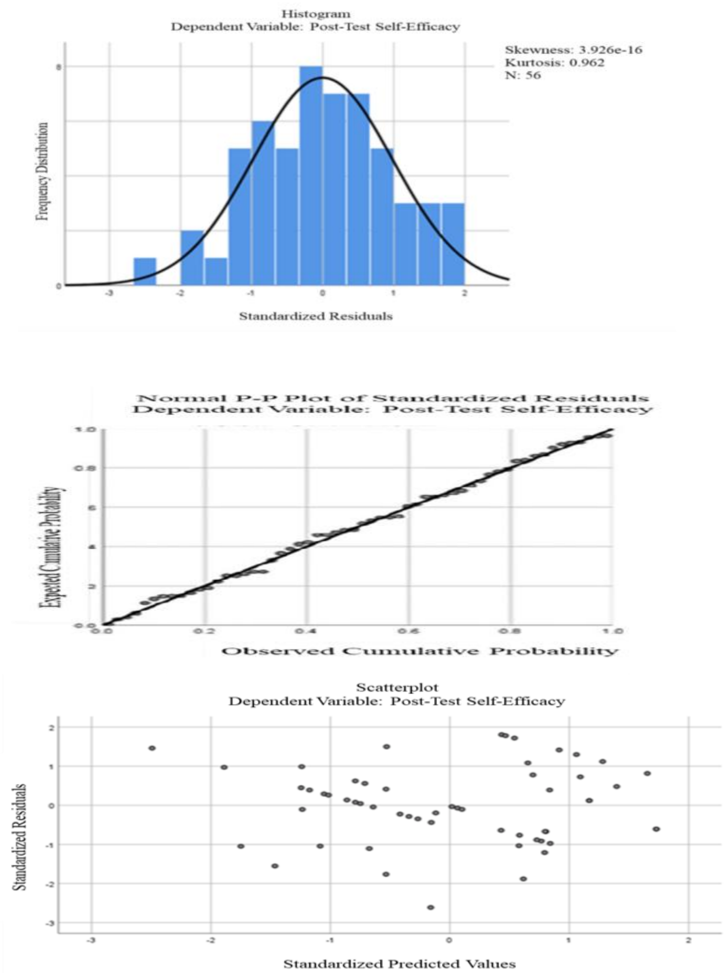

Fig. 5. Normal Distribution Chart

Table 6. Multiple Linear Regression Coefficients for Self-Efficacy Estimation (n=60)

Model		Unstandardized Coefficient B	Unstandardized Coefficient Standard Error	Standardized Coefficient Beta	T	Significance	Collinearity Statistics Tolerance	Collinearity Statistics VIF	ΔR^2	F
1	(Constant)	17.148	4.540		3.777	.000			0.331	28.184*
	Attitude	1.153	.210	.591	5.482	.000	1.000	1.000		
2	(Constant)	10.758	5.285		2.036	.047			0.384	18.164*
	Attitude	1.126	.204	.577	5.518	.000	.996	1.004		
	KA total[1]	.103	.047	.228	2.178	.034	.996	1.004		

*Correlation is significant at the 0.05 level.

Note 1: The total score refers to the sum of cognition (knowledge) and skills, with a maximum score of 100.

3.4. Discussion

This study employed a randomized controlled experimental design and surveyed 60 students from the Elderly Services Management program at Chiayi Specialized Medical School in Taiwan. In this study, Scaffolding theory was integrated with game technology to design a course focused on contact isolation protective measures. The application of scaffolding theory in nursing education aims to stimulate students' interest in theoretical knowledge while enhancing their problem-solving abilities [29]. The results show that through the integration of game technology and mobile apps, students were able to solve problems and apply effective strategies within the game, thereby enhancing their learning motivation, especially when solving challenging learning problems [30]. Furthermore, the combination of online learning with big data analysis brings new trends to nursing education, where game technology significantly enhances learning motivation and facilitates content absorption.

In Taiwan, the demand for long-term care has been increasing in recent years, leading universities to establish many departments of long-term care to cultivate talent. Although core courses in these schools include training on infection control and isolation measures, isolation techniques have not been integrated, resulting in the suspension or temporary cessation of services at long-term care medical institutions, nursing homes, and home services during critical periods of emerging infectious diseases outbreaks [2]. The results of this study show that 63% of the students had not taken any courses related to isolation techniques within the past year, highlighting the need for classroom teaching to be combined with technical practice. Applying Scaffolding theory in the curriculum engages students, enhances their problem-solving abilities, and ultimately transforms theoretical knowledge into practical clinical application [29].

The design of game technology includes elements that enhance the enjoyment of learning, learning objectives, rewards, and problem-solving, playing a crucial role in learning, lifestyle management, and disease awareness. However, few games have been developed for safety precautions against new infectious diseases [31]. Based on this argument, the experimental group in this study utilized online game technology to design a level-based game, sparking students' interest in the course and enabling self-learning about infectious diseases, contact isolation protective measures, and personal protective equipment. The study results indicated that after the intervention of game technology, there was a significant improvement in students' technical skills, cognition, and self-efficacy, especially in learning contact isolation protective measures. Previous scholars have discussed game technology and online learning courses, emphasizing flexibility and adaptability, using the gaming process for problem reasoning, decision-making, and problem-solving. This training helps students use games to find methods and inspire effective strategies to enhance learning motivation [26]; although attitude scores improved in the post-test, no significant differences were observed. This may be due to students not yet entering the workforce, leading to limited understanding of certain real-world situations.

This study highlights the effectiveness of integrating game technology and scaffolding theory in improving the understanding, technical skills, and self-efficacy of pre-clinical nurse aides. By addressing critical gaps in infection control training, the research contributes to the development of more interactive and engaging educational approaches in healthcare.

However, certain limitations should be acknowledged. The high cost of game design limited the inclusion of fully animated features, potentially affecting the immersive learning experience. Additionally, the platform's Android exclusivity posed accessibility challenges for iOS users, which may have influenced participation rates. Finally, the focus on pre-clinical students limits the generalizability of the findings to other healthcare worker populations.

4. Summary

In conclusion, the integration of game technology and mobile apps not only enhances students' learning motivation but also strengthens their skills and cognitive abilities, particularly in learning contact isolation protective measures. Future research could further explore how to combine game technology with big data to develop professional learning software and apply it to vocational education, thus enhancing the effectiveness of professional skills learning. Regarding the contributions and future potential of this study, they include: 1.Through scaffolding support and gamified learning, students can gain a deeper understanding of the principles and practical applications of contact isolation measures, which helps translate theoretical knowledge into practical operational skills. 2. Game technology creates interactive experiences that simulate real-life scenarios, allowing learners to practice and master contact isolation and infection control skills in a risk-free environment.3. Game elements can enhance the enjoyment and engagement of learning, thereby boosting students' motivation, which is particularly important for long-duration and potentially tedious medical education. Finally, game technology provides immediate feedback, enabling students to understand their performance and adjust their learning strategies based on the feedback.

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Chiao-Hui Lin, MSN, holds a Master's degree in Nursing from the Graduate Institute of Nursing at National Taichung University of Science and Technology, Taiwan. She is currently serving as a nurse practitioner at Chi Mei Medical Center, Liouying Branch, Tainan County, Taiwan. Her areas of expertise include geriatric nursing and the education and training of care attendants.

Yi-Maun Subeq received her Ph.D. from the Institute of Medical Science at Tzu Chi University, Hualien, Taiwan, in 2008. She is currently an Associate Professor at National Changhua University of Education, Taiwan. Her research interests include aging science, transcultural health, medical education and informatics, and Indigenous health issues. Dr. Subeq has authored or coauthored more than 60 publications in reputable academic journals. In recent years, she has actively contributed to the promotion of Indigenous Peoples' Health Law, served as a member of the Indigenous Peoples Health Committee under the Ministry of Health and Welfare, and established the Consultation Project Management Center for Indigenous Peoples under the Human Body Research Law.

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