



Research Article

Development of a Health Promotion Application on Cancer Survivorship as an Educational Content for Nursing Students

Yoonhee Seok,¹ Eunyoung E. Suh^{2,*}¹ Center for Human-Caring Nurse Leaders for the Future By Brain Korea 21 (BK 21) Four Project, College of Nursing, Seoul National University, Seoul, Republic of Korea² Center for Human-Caring Nurse Leaders for the Future by Brain Korea 21 (BK 21) Four Project, College of Nursing, Research Institute of Nursing Science, Seoul National University, Seoul, Republic of Korea

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SUMMARY

Purpose: This study aimed to develop a health promotion application for cancer survivorship (CS app) based on the adult learning and self-efficacy theories and evaluated its usability as an educational tool for nursing students.**Methods:** The CS app was developed according to ADDIE (analysis, design, development, implementation, and evaluation) model. It consisted of interventions involving medication, diet, exercise, stress management, symptom management, and regular medical checkup for cancer survivors on three different levels in terms of difficulty and complexity. It was designed to teach nursing students how to provide tailored care to cancer survivors as well as help survivors with their repetitive and regular health management. The Mobile App Rating Scale and the user version of the Mobile App Rating Scale were used for a heuristic evaluation of the CS app by the experts and student users.**Results:** The CS app was developed based on literature reviews and cancer survivorship guidelines. It was evaluated by 20 student users and five experts based on a 5-point scale and obtained a score of 3.97 and 3.66, respectively. Nursing students rated the CS app positively, mentioning that they were able to “learn about appropriate nursing interventions for patients in various cases” and that they became interested in caring cancer survivors’ health using the CS app.**Conclusions:** The CS app is an effective and user-friendly educational tool to increase the motivation of nursing students in learning cancer survivorship care. This highlights the potential of CS app as a useful learning tool for nursing students.© 2022 Korean Society of Nursing Science. Published by Elsevier BV. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

The World Health Organization has estimated the number of 5-year cancer survivors to be 43.80 million worldwide [1]. The US Centers for Disease Control and Prevention has forecast the number of cancer survivors to reach 22 million by 2030 [2]. An increased cancer survivor rate means that there are more cancer survivors in need of continuous lifetime management. Cancer survivors who complete their treatment regimen and begin the long-term management phase of their life face an array of potential physical,

mental, and practical problems [3]. To solve and prevent these problems, cancer survivors need lifelong management of chronic diseases, nutrition, lifestyle, and psychological well-being [4]. Failure to prevent and manage cancer survivors’ health problems can result in escalated medical costs for treating these problems, as well as diminished productivity [5].

Nurses play a key role in helping cancer survivors manage and improve their health. Therefore, educating nursing students on how to take care of cancer survivors is important for them to develop their nursing competencies. During nursing practicum, students generally learn about the care provided to patients hospitalized with an acute disease or for diagnostic testing. Teaching nursing students to care for cancer survivors in a hospital setting is difficult not only because of differences in health care services but also because of patient safety and risk of infection [6]. This suggests that during their clinical practicum, students face limitations in learning about nursing care for cancer survivors who require

Yoonhee Seok: <https://orcid.org/0000-0001-8659-9250>; Eunyoung E. Suh: <https://orcid.org/0000-0002-2866-0911>

* Correspondence to: Eunyoung E. Suh, Center for Human-Caring Nurse Leaders for the Future by Brain Korea 21 (BK 21) Four Project, College of Nursing, Research Institute of Nursing Science, Seoul National University, Room No.513, 103, Daehak-ro, Jongno-gu, 03080, Seoul, Republic of Korea.

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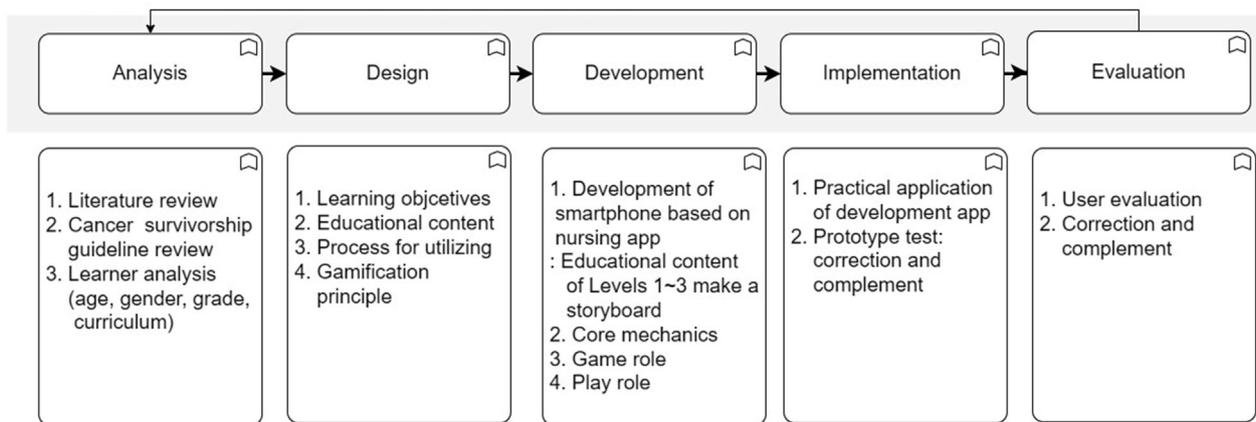


Figure 1. The Process of the Mobile App Development.

continuous management and care mostly within the context of living. To address such issues, various educational contents beyond clinical practicum courses need to be developed to boost nursing students' competency in caring for cancer survivors.

The accelerated digitalization of the world and consequent technological advances have led to the development of various teaching modalities that enhance learning outcomes among students. Thus, instructors now face demands to be creative and formulate various educational methods by incorporating information communication technology into learning. In particular, mobile applications have the benefit of engaging students and enhancing their clinical competence [7].

Computer-based learning, online learning, and educational apps are widely used in nursing education as well, and their effectiveness has been validated in many studies [8,9]. However, previous studies that developed nursing educational apps simply focused on a single skill, such as high-risk drug dosage calculation, basic nursing skills (vital signs, intravenous insertion, tube feeding, and tracheal suction), and tracheostomy care [10–12]. For example, Kang and Suh reported that using an app for hypertension and diabetes mellitus care increased the nursing students' knowledge and self-efficacy for chronic disease management [13]. However, the developed app was limited in that it only enabled unidirectional implementation of nursing intervention, as opposed to allowing interactions with patients.

Nurses evaluate, diagnose, intervene, and assess patients by communicating and interacting with them, which are active decision-making processes that change in accordance with patients' needs and values. To our knowledge, no study to date has attempted to develop an educational app for nursing students that boosts their nursing competencies while enabling appropriate patient interactions by specific cases involved.

This study was aimed to develop a cancer survival application (CS app) for nursing students and to evaluate its usability. Furthermore, it was to enable nursing students to acquire knowledge and nursing competency to improve the health of cancer survivors through the CS app.

Methods

Theoretical framework for the development of the CS App

The CS app for nursing students was developed based on Knowles' adult learning theory [14] and Bandura's self-efficacy theory [15] to increase students' knowledge and nursing self-efficacy. Cancer survivors were categorized based on the conceptual

framework for three-dimensional nursing simulation education (3D Simulation Framework) [16].

We applied the six principles of Knowles' adult learning theory to boost the effectiveness of education as follows: (1) Need to know: The participants of this study, nursing students, strive to enhance their competence as nursing professionals. (2) Experience: It is important to design a program tailored to nursing students' knowledge and competence. As such, in the analysis stage, we analyzed the nursing curriculum and developed a program with three levels based on basic knowledge about cancer survivorship to an advanced level. (3) Self-concept: The program was developed as a mobile application such that students could access the program without temporal and spatial limitations. They were allowed to choose from levels 1 to 3 at the program design stage. (4) Readiness: Nursing students have or are scheduled to undergo clinical practicum; they have high enthusiasm and are ready for clinical practice. (5) Problem oriented: In the symptom management tab, students can acquire problem-oriented thinking through conversations about health-related information for cancer survivors. (6) Intrinsic motivation: The program encompasses both extrinsic learning motivation, such as feedback, leaderboard, and heart rewards, and intrinsic learning motivation, such as quality of life score among cancer survivors. In the CS app, the patient's quality of life score must be 70 or higher to move to the next level, making nursing students more motivated to improve the patient's quality of life.

Bandura's self-efficacy theory was applied as follows: (1) As a strategy to help students obtain an enactive mastery experience, the program was divided into levels 1–3 such that students gain mastery experience as they advance to the next level. Furthermore, as patients' quality of life score increased or decreased based on the outcome of nursing interventions performed within the CS app, the CS app background also changed to provide visual stimulation. In addition, words of encouragement and challenge quizzes were given through pop-ups to help students accumulate mastery experiences. (2) To provide a vicarious experience, the latest knowledge and information were provided through videos and other educational materials prepared based on health guidelines for cancer survivors [17]. (3) For verbal persuasion, the patient icon in the CS app provided positive feedback, such as "I like it that I'm controlling my weight" and "I feel like I'm getting healthier with balanced meals" when the nursing student performed appropriate interventions. (4) Regarding physiological and affective status, nursing students' psychological anxiety was minimized, as they were able to access the CS app at a time and place of their convenience.

The CS app consisted of three levels. Each level was developed based on the 3D simulation framework [16]: the X-axis represented the scope

of practice, the Y-axis represented the complexity of simulation, and the Z-axis represented the student competency (determining which competency should be assessed based on which level).

The game elements of the program were the storyline (nursing storyboard), choice of level (three levels), feedback (visual and verbal feedback for care, including patient's comments and changes in quality of life score and app background), point system (heart reward), and leaderboard (scoreboard) [18].

CS app development

The CS app was developed based on the ADDIE (analysis, design, development, implementation, and evaluation) model [19] and the gamification principle [20]. In the analysis stage, we reviewed existing cancer survivorship care guidelines and studies, as well as the current nursing curriculum. In the design stage, we established learning objectives and incorporated learning content and game design elements. In the development stage, we collaborated with an IT company (TGRAM: AR/VR content studio) for CS app development. We also used an administrator server (www.lvvyro.net) for data management. Through the server, administrators can check users' app usage time and consultation answers. In the application and evaluation stage, expert and user evaluations were performed, and the CS app was modified and updated accordingly. A plot and algorithm were created, and the details of the digital algorithm to calculate the students' final scores were also written (Figure 1, Appendix 1).

CS app usability evaluation

Sample

Based on previous studies that evaluated usability after recent app development, the expert evaluation ranged from 2 to 69 people, and the user evaluation ranged from 5 to 35. In this study, five experts and 20 users were obtained in consideration of previous studies [13,21].

A panel of experts comprising two oncology nurse specialists, one nursing informatics expert, one professional app developer, and one nurse with more than 5 years of clinical experience evaluated the usability of the CS app. The CS app developer was different from the app developer in the panel of experts. We provided an explanation of the developed CS app and Mobile App Rating Scale (MARS) to the expert panel and asked them to use the CS app and evaluate it from March 15 to March 19, 2021. Five experts participated in the evaluation.

For user evaluation, 20 third-year and fourth-year nursing students who owned Android smartphones and had completed basic nursing and therapeutic communication were recruited. The recruitment announcement was posted on the school bulletin board and in an undergraduate group chat room from March 15 to March 19, 2021. After they were introduced to the CS app and user version of the MARS (uMARS), the nursing students were asked to use the CS app for 1 day (try out levels 1–3) and evaluate it.

After installing the CS app on their Android mobile phones, experts and nursing students directly ran the CS app to give patients in levels 1–3 appropriate nursing interventions according to the patient's condition; these interventions involved medication, diet, exercise, stress management, symptom management, and regular medical checkup.

Instruments

The expert usability evaluation was measured using the MARS tool after permission was obtained from the original developers and translator [21,22]. The MARS consists of 23 items for engagement (five items), functionality (four items), aesthetics (three items), information (seven items), and subjective quality of the app (four

items). It was evaluated on a 5-point Likert scale. A higher score indicated a higher perceived quality of the app. Cronbach α was 0.90 at the time of development and 0.93 in this study.

The user usability evaluation was measured using the uMARS tool after permission was obtained from the original developers and translator [21,23]. The uMARS comprises 20 items for engagement (five items), functionality (four items), aesthetics (three items), information (four items), and app subjective quality (four items), and each item is rated on a 5-point Likert scale. A higher score indicated a higher perceived quality of the app. Cronbach α was 0.90 at the time of development and 0.82 in this study.

In addition, the participants were asked the following open-ended questions about their experiences with the CS app.

- 1) Tell me about the problems you experienced while using the CS app (experts and users)
- 2) What do you think are the pros and cons of the CS app? (Experts and users)
- 3) Which aspect would the CS app be most helpful for among nursing students? (Experts)
- 4) Do you think the CS app is useful for learning? Why or why not? (Users)
- 5) What do you think needs to be corrected or supplemented in the CS app? (Experts and users)

Ethical considerations

Approval was first received from the institutional review board (Approval no.2007/001-013) at the university with which the authors were affiliated, and then the data collection for user evaluation began. The author who conducted the data collection is a doctoral student who does not have direct authority over the students who participated in the data collection. Students who voluntarily expressed willingness to participate in the study after reading the recruitment announcement were provided the consent form containing the study purpose, procedure, anticipated effects, potential risks, data management, and researchers' contact information. They also signed a written consent form. As a token of gratitude, the participants were given a coffee voucher worth 20,000 KRW. The participants were informed that they had the freedom to withdraw from the study at any time without being disadvantaged. Furthermore, they were informed that the collected data would only be used for research purposes, would be anonymously processed during analysis, and would be stored in a locked cabinet with restricted access until disposal after study completion.

Results

The development and usability evaluation results of the CS app for nursing student education are discussed in this section.

Description and installation of developed items

Analysis

We reviewed cancer survival management guidelines using the keywords "cancer survival" and "guidelines" to check cancer survival management items. In addition to searching foreign literature such as PubMed, EMBASE, and CINAHL, Korean data were reviewed from DBpia, RISS, and the National Cancer Information Center (Appendix 2, 3).

Based on a manual for cancer survivorship, NCCN (National Comprehensive Cancer Network) clinical practice guidelines, the Cancer Experience Health Care Guide, and a literature review (activity, diet, health management), medication (anti-hormone therapy, drugs for chronic conditions), diet, exercise, stress management,

symptom management, and regular medical checkup were chosen as the items for the CS app. A counseling tab, where students provide counseling for cancer survivors, was added to level 3 (see Figure 2).

Design

Students could download the CS app using a file provided by researchers. Figure 2 shows screenshots of levels 1–3 in the CS app. The

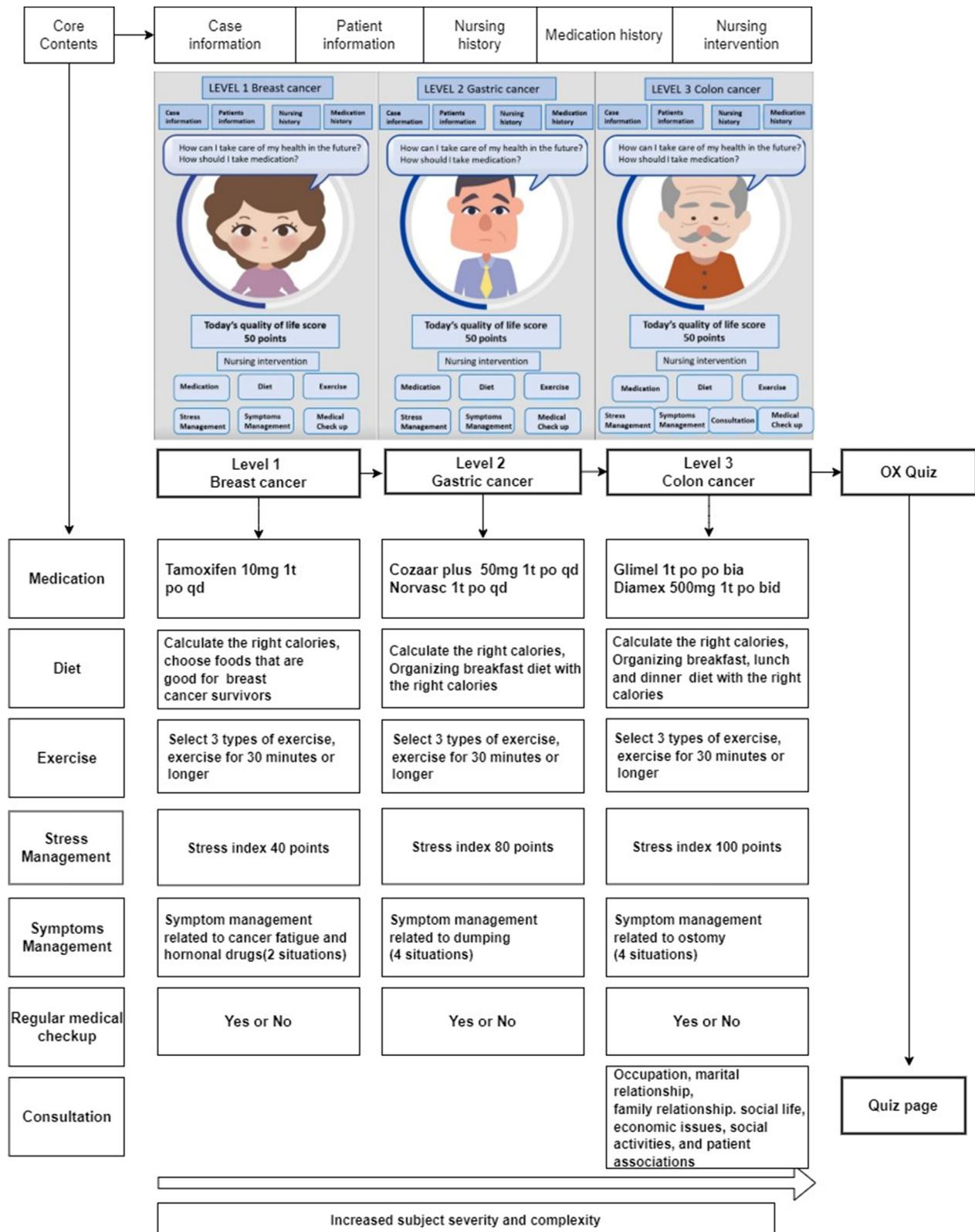


Figure 2. Main Contents and Levels of the Developed App.

patient's case, information, care history, and medication history can be accessed at the top of the screen. Nursing intervention, medication, diet, exercise, stress management, symptom management, and regular medical checkup tabs are shown at the bottom of the screen.

Development

The storyboard for developing the CS app included the login screen, initial screen (intro), main screen (main), and setting screen, and efficiency of presentation and the functionality for technical implementation were considered. To log in, users entered individual numbers in the login screen. The intro screen explained the learning goals of the CS app, whereas tabs for breast cancer, gastric cancer, colon cancer, and quizzes were shown on the main screen. The setting screen contained tabs for inquiry, educational materials, videos, FAQs (frequently asked questions), scoreboards, and sound effect settings for the CS app (Appendix 4).

The patient at level 1 is a breast cancer survivor. The objective of this level is to acquire knowledge about disease-specific medication, diet, exercise, symptom management, and health checkup. The patient at level 2 is a gastric cancer survivor. The tasks in this level include more complex, individual-specific medication administration, calculation of proper calorie intake, encouragement of the patient during exercise, a high-stress stage, and symptom management. The level 3 patient is a colorectal cancer survivor who requires more complex, situation-specific nursing interventions than level 2, such as counseling about marital relations, family, and social life.

Each level of the CS app was designed, so users could move from one level to the next after the first level is completed. The initial quality of life score of each patient is 50, and the score changes the next day based on the sum of the scores for medication, diet, exercise, stress management, symptom management, and regular medical checkup. If appropriate nursing intervention is implemented, the patient's quality of life score increases, and in the opposite case, the quality of life score decreases. Symptom management, one of the nursing interventions, was presented in a dialog format where the patient makes a complaint about his/her symptoms and the nursing student selects and provides an appropriate nursing intervention. The counseling tab in level 3 was designed in a way that the nursing student can directly write content that provides emotional support to the actual patient. As the background screen and narration of the patient change according to the patient's quality of life score, the nursing student strives to further improve the patient's situation. Appendix 4 explains how the quality of the score is calculated.

The CS app was developed for the Android operating system and will be registered on the Google Play Console. The system

requirements are Android 8.0 (Oreo) or higher, and the programming languages used were C# (Microsoft, Redmond, WA) and PHP (Zend Technologies, Cupertino, CA). Unity (Unity Technologies, San Francisco, CA) 2020.1.15 was used as a platform for development. MySQL (Oracle Corporation, Redwood City, CA) was used as the application database, and eight tables were created.

CS app implementation and usability evaluation

General characteristics of the participants to evaluate usability

Five experts participated in the evaluation of the CS app: one nursing informatics expert with PhDs, three oncology nurse specialists with master's degrees, and one app developer with more than 5 years of experience. Table 1 lists the general characteristics of the experts.

A total of 20 nursing students, 10 from the third year and 10 from the fourth year, participated in the user evaluation. Of these, 17 were female, and three were male. Four students had prior experience using an educational app (Table 1).

Survey analysis after CS app usability

The experts gave the highest rating (4.05) for functionality and the lowest (3.40) for engagement. The mean quality score given by experts was 3.66 out of 5. Nursing students gave the highest rating (4.35) for information and the lowest (3.45) for engagement. The mean quality score given by students was 3.97 out of 5 (Table 2).

Experts gave the question of whether the CS app has an achievable goal (part of the "information" subcategory) their highest rating (4.25 points). Conversely, nursing students gave the question of whether the CS app has visual information (part of the "information" subcategory) their highest rating (4.50 points). Both groups' lowest scores were given in the subjective quality subcategory: experts gave their lowest score (2.40) for how many times they thought they would use the CS app (none: two people; 3–10 times: two people; 10–50 times: one person), whereas nursing students gave their lowest score (2.65) for whether they were willing to pay to use the CS app (Table 2).

Comments from experts and nursing students

To the question, "Which aspect would the CS app be most helpful for nursing students," the expert panel answered that students could obtain information about each level and acquire an understanding of patients' situations and basic knowledge about health management of cancer survivors. Furthermore, the experts

Table 1 General Characteristics of the Experts and User Groups (N = 25).

Variable	Category	Experts (n = 5)		Nursing students (n = 20)	
		n (%) or mean ± SD		n (%) or mean ± SD	
Gender	Women	4 (80.0)		17 (85.0)	
	Men	1 (20.0)		3 (15.0)	
Major	Nursing informatics	1 (20.0)			
	Nursing oncology	3 (60.0)			
	App developers	(20.0)			
Degree of education	PhD candidate	2 (40.0)			
	Master degree	2 (40.0)			
	Bachelor degree	1 (40.0)			
Duration of career		9.60 ± 4.72			
Grade	Junior			10 (50.0)	
	Senior			10 (50.0)	
Age				22.05 ± 1.97	
Experience of using of educational apps	Yes			4 (25.0)	
	No			16 (75.0)	

Note. SD = standard deviation.

Table 2 Evaluation of the Experts and Nursing Students: Subcategory (N = 25).

Subcategory	Item	Expert (n = 5)		Nursing students (n = 20)	
		Mean ± SD		Mean ± SD	
Engagement	1. Entertainment	3.20 ± 0.84	3.40 ± 0.85	3.35 ± 0.88	3.45 ± 0.59
	2. Interest	3.40 ± 1.14		3.75 ± 0.91	
	3. Customization	3.40 ± 1.14		2.95 ± 0.60	
	4. Interactivity	3.00 ± 1.22		3.10 ± 1.22	
	5. Target group	4.00 ± 0.70		4.10 ± 0.79	
Functionality	6. Performance	4.20 ± 0.84	4.05 ± 1.16	4.10 ± 1.02	4.08 ± 0.63
	7. Ease of use	4.00 ± 1.73		3.90 ± 1.02	
	8. Navigation	3.80 ± 1.79		3.85 ± 0.88	
	9. Gestural design	4.20 ± 0.84		4.45 ± 0.69	
Aesthetics	10. Layout	3.60 ± 1.14	3.53 ± 1.17	3.85 ± 0.75	4.00 ± 0.51
	11. Graphics	3.40 ± 1.14		4.00 ± 0.79	
	12. Visual appeal	3.60 ± 1.34		4.15 ± 0.59	
Information	13. Accuracy of app description	4.00 ± 0.71	3.64 ± 1.02	-	4.35 ± 0.38
	14. Goals	4.25 ± 2.07		-	
	15. Quality of information	3.75 ± 1.87		4.45 ± 0.60	
	16. Quantity of information	3.25 ± 1.52		4.15 ± 0.88	
	17. Visual information	4.00 ± 0.71		4.50 ± 0.61	
	18. Credibility	3.80 ± 1.10		4.30 ± 0.47	
	19. Evidence base	2.50 ± 1.41		-	
	20. Would you recommend the app to people who might benefit from it?	3.66 ± 0.90		3.97 ± 0.41	
App subjective quality	21. How many times do you think you would use this app in the next 12 months if it was relevant to you? ^a	3.40 ± 1.14	3.10 ± 0.72	3.30 ± 0.80	3.13 ± 0.73
	22. Would you pay for this app? ^b	2.40 ± 1.34		2.85 ± 0.81	
	23. What is yours overall star rating of the app?	3.00 ± 0.00		2.65 ± 1.46	
		3.60 ± 0.89		3.70 ± 0.66	

Note. SD = standard deviation.

^a Five-point Likert scale was used (1 = none, 2 = 1–2 times, 3 = 3–10 times, 4 = 10–50 times, 5 = >50 times).

^b Item 22 were 5-point scale from 1 (definitely not) to 5 (definitely yes).

believed that the CS app would help students approach patients more easily.

To the question, “Do you think the CS app is useful for learning,” students affirmed that they were able to learn about cancer survivorship care. They also said that the symptom management tab was particularly easy to use and memorable because it allowed them to talk to the patient in the case. Moreover, the students mentioned that the CS app would be helpful for them to be prepared for clinical practicum courses and that it would help them develop an interest in nursing care and health management for cancer survivors. Regarding areas where the CS app needed revision, they said there was not enough space for students and instructors to interact and that it would be beneficial to have more timely feedback to allow them to check the intervention score and the patient's quality of life score immediately after the intervention (Table 3).

Total app usage time by expert and nursing students

After surveying the usage time to determine the utilization of and interest in the CS app, it was found that five experts spent an average of 8.92 minutes and nursing students 7.18 minutes on the CS app. The most recent nursing intervention of the day was reflected in the patient's quality of life score the next day. Only the latest quality of life score was reflected, and the number of daily logins was not checked (Appendix 5).

Discussion

This study was aimed to develop a CS app for nursing students and evaluate it by experts and users (nursing students) for its usability. The CS app allowed the students to experience nursing interventions for cancer patients in mobile setting. In particular, the symptom management feature in the CS app was designed to enable a virtual conversation between the students and the

patients for them to learn how to interact with the patients. In addition, by differentiating patients' conditions in three levels, the CS app was designed to enable the students to learn the complexity of various patients cases step by step.

Through the CS app, students were given the opportunity to perform nursing interventions on patients in a virtual setting, which is often difficult in clinical training due to patient safety concerns. In contrast to other chronic illness care smartphone apps for nursing students, we developed a scoring system in which a patient's condition changed according to the user's performance in the CS app [13]. In this study, the change in the patient's quality of life intrinsically motivated the students to modify their inputs (nursing interventions). Furthermore, the results of nursing interventions conducted by the students were expressed as the quality of life in a comprehensive way.

Considering that MARS scores for an online educational app providing COVID-19 information ranged from 2.4–4.8 [24], the CS app developed in this study can be regarded as having a good quality rating overall, as its MARS scores surpassed 3.0 [25]. The expert ratings for each domain ranged from 3.40 to 4.05, with the highest rating for functionality and lowest rating for engagement. The user (nursing students) ratings for each domain ranged from 3.45 to 4.35, with the highest rating for information and lowest for engagement. The aforementioned COVID-19 educational app was also given a good rating for functionality and a low rating for engagement. It was speculated that the low rating for engagement could be due to the lack of eye-catching colors, graphics, and entertainment [24]. The low rating for engagement in the CS app may also be attributable to the absence of a channel for communication between the administrator and nursing student, apart from the researchers' contact information being missing. In a previous study, the expert usability evaluation for an emotional education mobile app for middle school students was 4.00 points, whereas the user evaluation was 3.96 points. The expert evaluation was higher than that in the present study, but the user evaluation was similar [26].

Table 3 Comments From the Experts and Nursing Students (N = 25).

Category		CS app's Advantages
Expert	Information	1. Helpful for gaining knowledge about each disease
		2. Enables students to engage in experiential thinking by determining the need for a specific intervention for a particular disease and performing the intervention
		3. Provides information about each level
		4. Provides an opportunity to gain an understanding of the patient's situation
		5. Will make it easier for students to approach patients
Nursing student	Correction	6. Priority intervention by disease is required
	Education	7. Add more game elements to arouse interest
Nursing student	Education	1. Can experience an educational method for health management of cancer survivors
		2. The conversation-style design of the symptom management tab makes learning easy and memorable
		3. Can comprehensively learn about the appropriate nursing interventions for patients in various cases
		4. The quizzes were extremely helpful in retaining the learned contents, and taking the quizzes repeatedly allowed for repetitive learning
		5. Was able to learn more clearly about the things that nurses should pay close attention to and provide care for, compared with other types of learning
	Information	6. Provides credible information and case-based scenarios that are effective for learning
		7. Will be helpful in preparing for clinical procedures
	Engagement Correction	8. Helped develop an interest about health management and health improvement for cancer survivors
		9. Lack of space for interaction between instructors and students
		10. The app needs quick feedback to check the intervention score and the patient's quality of life score.

Note. CS app = cancer survivorship application.

This study has several theoretical implications. We applied Knowles' adult learning theory and the three aspects of Bandura's self-efficacy theory: enactive mastery experience (use of three levels), vicarious experience of success (educational materials), and verbal persuasion (feedback provided within the CS app). In addition, we implemented three levels of cancer survivor scenarios using the 3D simulation framework to provide an opportunity for students to experience different patient cases. Also, we incorporated the gamification theory to motivate students to participate [19]. Thus, the key significance of this study is that several theoretical principles were applied to develop the CS app for nursing student [7].

The analysis of the content evaluations in this study revealed that the participants used star ratings as a means of expressing their interest. However, a previous study that examined the usefulness of reviews and star ratings for online products found that star ratings had no relation to products or subjects; rather, text reviews were highly related to product selection [27]. In another study that evaluated an app developed for hyperlipidemia management, the lowest ratings in the subjective quality category were given to the item assessing whether experts and users were willing to pay to use the app (3.00 and 2.7, respectively) [21]. Furthermore, in a study evaluating an emotional education, mobile app developed to promote the mental health of middle school students, experts, and users both gave willingness to pay for the app 3.6 points [26]. In the present study, experts and student users gave 3.0 and 2.65 points for willingness to pay, respectively.

This is a notable result because it contradicts the high star rating of 3.70 given by students. Thus, it seems that students do not want to use the app if they need to pay for it because, despite gamification, these apps still differ from normal games developed purely for entertainment. In other words, even if educational apps feature high usability and practicability, student users may not actively purchase them. To address this issue, educational apps for professional study should be developed in collaboration with schools, industries, and developers, with funding from public institutions or industry–university foundations, so that the apps can be available for students at no cost to encourage active utilization.

In this study, nursing students positively rated the CS app, mentioning that they developed an interest in nursing care and management of cancer survivors, which highlights the potential of the CS app as a useful learning medium for nursing students. In the usability evaluation, patients' quality of life scores increased for all

nursing students with the exception of one, and all students strived to increase their patients' quality of life scores.

In the past, many attempts have been made to apply gamification to educational apps. After medical students used medical knowledge software based on gamification, they participated more actively when solving problems, and their correct answer rate significantly increased in the competitive team–based and individual quizzes and retests. Furthermore, the leaderboard was identified as the game-playing element that motivated users to participate [28]. In the present study, we intended to motivate participation by creating a “scoreboard” tab. However, in the CS app, the notification for competitions was not implemented. Subsequent studies should apply notifications for competitions or current performance to further motivate participation.

Finally, in the study of developing a virtual hypertension and diabetes management app for nursing student education [13], researchers could not reflect changes in the patient's blood sugar or sodium level in the app as precisely as the intervention of nursing students gave due to technical barriers. However, in this study, an algorithm to increase or decrease the quality of life score based on the nursing intervention performed by the student was developed. Thus, the changes in the patient's state stimulated the students' caregiving instinct. Using advances in information communication technology and establishing a technological foundation to develop an array of patient cases that are not commonly encountered during clinical training would be beneficial for nursing education.

This study contributes to the nursing academia at large in several ways. First, to our knowledge, this is the first study to develop an app for nursing students to learn about the promotion of cancer survivors' health. This is relevant in today's world where the number of cancer survivors is increasing; thus, nursing students must learn about the amount and quality of cancer survivorship care. Second, the students participated in this study became interested in and understood the importance of the care for cancer survivors. Third, through the CS app, knowledge of cancer symptom management and conversation skills with cancer patients was cultivated before clinical practice in advance what they should learn in clinical practice. Fourth, details of nursing care for cancer survivors in terms of their medication, diet, exercise, stress management, symptom management, and regular medical checkup to improve the quality of life were implemented through the CS app. Fifth, the intrinsic motivation of students was promoted by developing an algorithm in

which each patient's quality of life score increased and decreased according to the nursing care they provided.

However, this study also has a number of limitations. First, it did not implement a system of competition to increase participation in the app, nor did it implement a user interface that allowed interaction between the administrator and nursing students and among nursing students. Second, convenience samples were used for usability evaluation, and only the Android platform was used in consideration of the cost in the development process. Third, we attempted to create a question-and-answer tab to enable interactions between the administrator and the students and among the students after the usability evaluation but could not proceed with the update due to cost restrictions and lack of data storage. Thus, establishing a question-and-answer feature in the early design stage is important in future studies. Finally, the effect evaluation after CS app development has not yet been conducted; thus, further research is needed.

Conclusion

The CS app is expected to be an effective and user-friendly educational tool to increase the knowledge and self-efficacy of nursing students in learning cancer survivorship care. Nursing students stated that they were able to comprehensively learn about cancer survivor care and that the conversational feature in the symptom management tab allowed for easy and memorable learning. In particular, incorporating common patient symptoms through conversational interaction that enabled students to learn

about them consistently was a valuable element of learning for nursing students preparing for clinical practicum.

A key component of the CS app, developed based on gamification, was feedback, and it was the most mentioned feature among users. The CS app was modified by reflecting quick feedback, which appeared after the usability evaluation by the CS app users. We confirmed that proper feedback is an essential motivator and component of the instructor–user interaction. Developing additional apps containing more patient cases that enable interaction with nursing students and patients would contribute to the establishment of mobile apps as a complementary learning tool to clinical practicum. Subsequent studies should also implement and evaluate the CS app developed in this study.

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Conflict of interest

The authors declare no conflict of interest.

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Appendix 1 Calculation Data Structure.

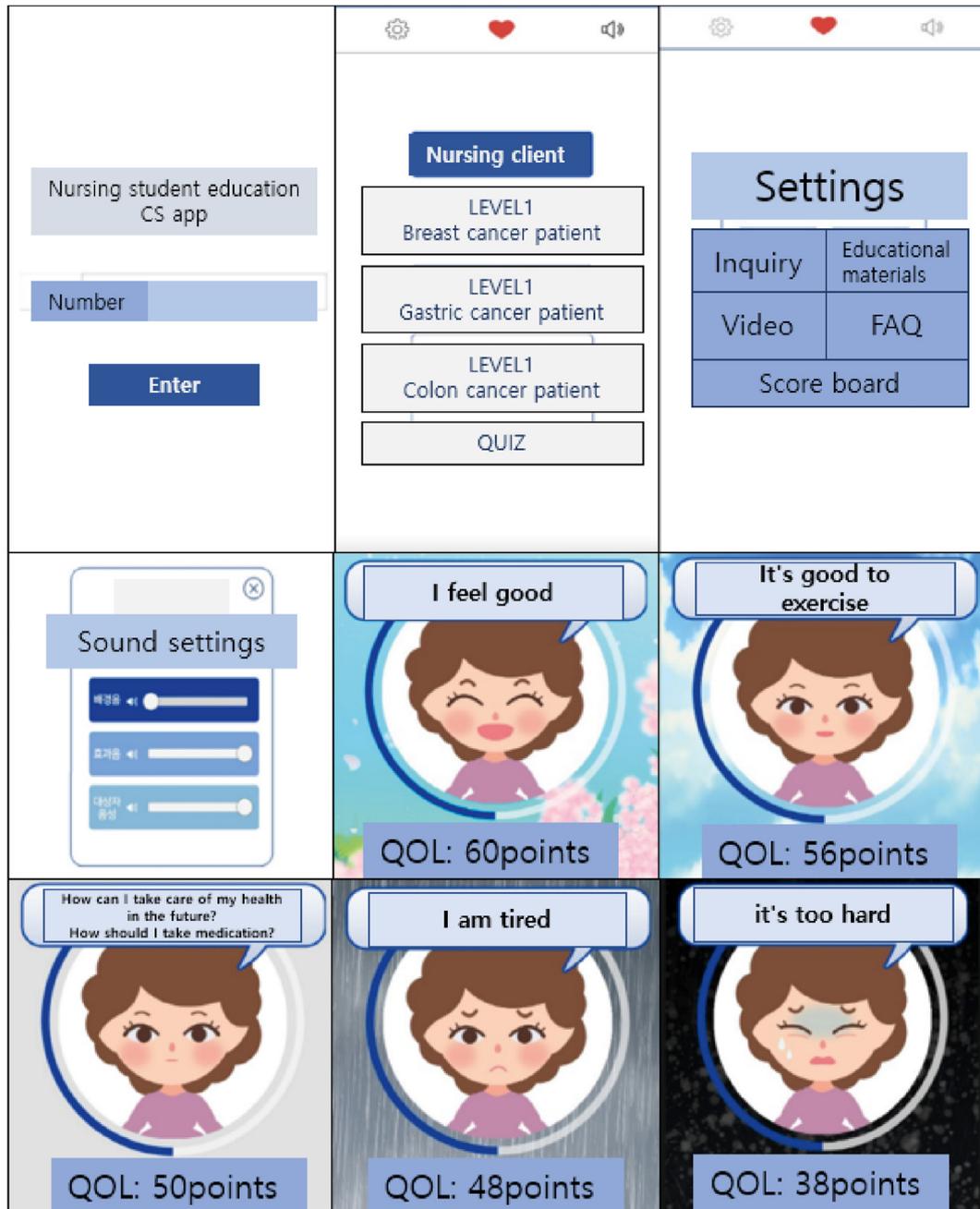
Quality of life score	Medication (20) + diet (20) + exercise (20) + stress management (20) symptom management (20) + regular medical checkup (20) = 120 points
0–120 points	<ol style="list-style-type: none"> 1. 110–120: Patient's quality of life score increased by 10 points 2. 90–109: Patient's quality of life score increased by 8 points 3. 70–79: Patient's quality of life score increased by 6 points 4. 50–69: Patient's quality of life score decreased by 2 points. 5. Fewer than 50: Patient's quality of life score decreased by 4 points

Appendix 2 Cancer Patient Guideline and Websites.

No	Reference/website	Title	Journal
1	Arends J, Bachmann P, Baracos V, Barthelemy N, Bertz H, Bozzetti F, et al (2017)	ESPEN guidelines on nutrition in cancer patients	Clin Nutr, 36(1), 11–48.
2	Birken SA, Ellis SD, Walker JS, DiMartino LD, Check DK, Gerstel AA, & Mayer DK. (2015)	Guidelines for the use of survivorship care plans: a systematic quality appraisal using the AGREE II instrument	Implement Sci, 10, 63.
3	Coletta AM, Marquez G, Thomas P, Thoman W, Bevers T, Brewster AM, et al (2019)	Clinical factors associated with adherence to aerobic and resistance physical activity guidelines among cancer prevention patients and survivors	PLoS One, 14(8) e0220814.
4	Denlinger CS, Sanft T, Baker KS, Baxi S, Broderick G, Demark-Wahnefried W, et al (2017)	Survivorship, Version 2.2017, NCCN Clinical Practice Guidelines in Oncology	J Natl Compr Canc Netw, 15(9), 1140–1163.
5	Okubo R, Wada S, Shimizu Y, Tsuji K, Hanai A, Imai K, et al (2019)	Expectations of and recommendations for a cancer survivorship guideline in Japan: a literature review of guidelines for cancer survivorship	Jpn J Clin Oncol, 49(9), 812–822.
6	Yun YH, et al (2013)	Manual for cancer survivorship	Koonja.co.kr
7	www.cancer.go.kr	National Cancer Information Center Cancer Experience Health Care Guide Cancer Patient Life Guide (life management, diet, symptom management)	
8	https://www.macmillan.org.uk	Macmillan Cancer Support	
9	https://www.nccn.org (National Comprehensive Cancer Network)	NCCN Clinical practice guidelines in oncology (NCCN Guidelines) Survivorship Version 1. 2020-March 17.2020	
10	https://www.cancercares.org	Cancer care	
11	https://www.cancer.gov	National Cancer Institute (NCI)	
12	https://www.canceradvocacy.org	National Coalition for Cancer Survivorship (NCCS)	
13	https://www.cancer.org	American Cancer Society	
14	https://www.acsm.org	American College of Sports Medicine	
15	https://www.cancernetwork.com	The Cancer Information Network	
16	https://preventcancer.aicr.org	American Institute for Cancer Research	
17	https://www.asco.org	American Society of Clinical Oncology	

Appendix 3 Literature Review of Cancer Patient Health Management.

No	Author	Title	Content	Journal
1	Park JH, Shin DW (2012)	Cancer Survivor 1 Million Era, Cancer Survivor Health Management	Prevention and screening for secondary cancer, chronic disease management and vaccinations, health habit management (smoking, obesity, nutrition, physical activity), psychosocial problem management	Research Institute for Healthcare Policy Korean Medical Association, 10(4), 66-72.
2	Lee JE, Shin DW, Cho BL (2014)	The current status of cancer survivorship care and a consideration of appropriate care model in Korea	Secondary cancer prevention and screening, management of accompanying diseases, lifestyle management, psychosocial problems	Korean Journal of Clinical Oncology, 10(2), 58-62.
3	Song CE (2018)	Integrative review of guidelines related symptom management and physical activity for developing of self-care management program for cancer survivors	Symptom management: fatigue, sleep disturbance, pain, depression, and anxiety Physical activity management: exercise (flexibility, strength, aerobic exercise recommended)	Journal of the Korean Contents Association, 18(4), 586-600.
4	Lee Y (2013)	Cancer Survivor's Health Management	Prevention and screening for secondary cancer, chronic disease management (hypertension, diabetes, hyperlipidemia, osteoporosis, anemia), diet, exercise, proper weight management	Korean Society for Health Promotion and Disease Prevention. Paper presented at 2013 spring conference. Seoul.
5	Park JH, Bae SH (2017)	Effects of psychoeducational intervention for cancer survivors: a systematic review and meta analysis	Among 41 papers, counseling and behavioral therapy were significant for psychological education intervention	Journal of Korean Academy of Nursing, 47(2), 143-163.
6	Viscuse PV, Price K, Millstine D, Bhagra A, Bauer B, Ruddy KJ (2017)	Integrative medicine in cancer	Role in the management of physical and emotional issues: physical activity, diet, dietary supplement, mind-body modalities, acupuncture, massage therapy	Curr Opin Oncol, 29(4), 235-242.
7	Sisler J, Chaput G, Sussman J, Ozokwelu E (2016)	Follow-up after treatment for breast cancer: practical guide to survivorship care for family physicians	Four main tasks: Survivorship care 1) surveillance (annual mammography) 2) management of long-term effects (pain, fatigue, lymphedema, distress, cardiac and bone health) 3) health promotion (physical activity) 4) care coordination	Can Fam Physician, 62 (10), 805-811.
8	De Lorenzo F, Apostolidis K, Florindi F, Makaroff LE (2018)	Improving European policy to support cancer survivors	Key priorities for action 1) timing and content of follow-up, rehabilitation 2) raising awareness of both short-term and long-term treatment-related effects 3) health maintenance 4) information regarding legal protections 5) psychological support.	Journal of Cancer Policy, 15, 72-75.



Appendix 4. Screen Capture in the CS App and Background Changes According to Quality of Life.

Appendix 5 CS App Total Usage Time by Experts and Nursing Students (N = 25).

Category	Experts (n = 5)	Nursing students (n = 20)
	Mean ± SD	Mean ± SD
Usage time (minutes)	8.92 ± 3.11	7.18 ± 3.17

Note. SD = standard deviation.

References

1. WHO. International agency for research on cancer. World Health Organization; 2018 [internet]. [cited 2020 Feb 15]. Available from: <https://www.who.int/cancer/PRGlobocanFinal.pdf>
2. Miller KD, Nogueira L, Mariotto AB, Rowland JH, Yabroff KR, Alfano CM, et al. Cancer treatment and survivorship statistics. *Ca - Cancer J Clin.* 2019;2019(69): 363–85. <https://doi.org/10.3322/caac.21565>
3. Park JH, Shin DW. Cancer survivor 1 million era, cancer survivor health management. *J Kor Med Assoc.* 2012;10(4):66–72. Korean.
4. Shin DW, Sung SW, Lee JK. Management of cancer survivors in Korea. *J Kor Med Assoc.* 2015;58(3):216–26. <https://doi.org/10.5124/jkma.2015.58.3.216>. Korean.
5. Luengo-Fernandez R, Leal J, Gray A, Sullivan R. Economic burden of cancer across the European Union: a population-based cost analysis. *Lancet Oncol.* 2013;14(12):1165–74. [https://doi.org/10.1016/S1470-2045\(13\)70442-X](https://doi.org/10.1016/S1470-2045(13)70442-X)
6. Jang KI, Kim SH. Educational needs in the development of a simulation based program on cancer patient nursing. *Kor J Health Commun.* 2015;10(1):1–8. <https://doi.org/10.15715/kjhc.com.2015.10.1.1>. Korean.
7. Bajpai S, Semwal M, Bajpai R, Car J, Ho AHY. Health professions' digital education: review of learning theories in randomized controlled trials by the digital health education collaboration. *J Med Internet Res.* 2019;21(3):e12912. <https://doi.org/10.2196/12912>
8. Kim JH, Park H. Effects of smartphone-based mobile learning in nursing education: a systematic review and meta-analysis. *Asian Nurs Res.* 2019;13(1):20–9. <https://doi.org/10.03.248/j.anr.2019.01.005>
9. Kyaw BM, Posadzki P, Paddock S, Car J, Campbell J, Tudor Car L. Effectiveness of digital education on communication skills among medical students: systematic

- review and meta-analysis by the digital health education collaboration. *J Med Internet Res.* 2019;21(8):e12967. <https://doi.org/10.2196/12967>
10. Kim MS. Development and effectiveness of smartphone application for the medication confirmation of high-alert medications. *Kor J Adult Nurs.* 2014;26(3):253–65. <https://doi.org/10.7475/kjan.2014.26.3.253>. Korean.
 11. Pereira FG, Silva DV, Sousa LM, Frota NM. Building a digital application for teaching vital signs. *Rev Gaucha Enferm.* 2016;37(2). <https://doi.org/10.1590/1983-1447.2016.02.59015>
 12. Bayram SB, Caliskan N. Effect of a game-based virtual reality phone application on tracheostomy care education for nursing students: a randomized controlled trial. *Nurse Educ Today.* 2019;79:25–31. <https://doi.org/10.1016/j.nedt.2019.05.010>
 13. Kang J, Suh EE. Development and evaluation of "chronic illness care smartphone apps" on nursing students' knowledge, self-efficacy, and learning experience. *Comput Inform Nurs.* 2018;36(11):550–9. <https://doi.org/10.1097/CIN.0000000000000447>
 14. Knowles MS, Holton EF, Swanson RA. In: *The Adult Learner. The definitive classic in adult education and human resource development.* 6th rev. ed. USA: Elsevier; 2005. p. 148–64.
 15. Bandura A. Self-efficacy: toward a unifying theory of behavioral change. *Psychol Rev.* 1977;84(2):191–215. <https://doi.org/10.1037/0033-295X.84.2.191>
 16. Suh EE. Development of a conceptual framework for nursing simulation education utilizing human patient simulators and standardized patients. *J Kor Acad Soc Nurs Educ.* 2012;18(2):206–19. <https://doi.org/10.5977/jkasne.2012.18.2.206>. Korean.
 17. Cancer survivor health care guide [internet]. Seoul: National Cancer Information Center; 2020 [cited 2020 Feb 15]. Available from: https://www.cancer.go.kr/docview/preview.do?attach_seq=8132
 18. Floryan M, Chow PI, Schueller SM, Ritterband LM. The model of gamification principles for digital health interventions: evaluation of validity and potential utility. *J Med Internet Res.* 2020;22(6):e16506–e16506. <https://doi.org/10.2196/16506>.
 19. Molenda M. In search of the elusive ADDIE model. *Perform Improv.* 2003;42(5):34–7. <https://doi.org/10.1002/pfi.4930420508>
 20. Floryan MR, Ritterband LM, Chow PI. Principles of gamification for internet interventions. *Transl Behav Med.* 2019;9(6):1131–8. <https://doi.org/10.1093/tbm/ibz041>
 21. Lee JY. *Development and evaluation of hyperlipidemia management mobile application based on transtheoretical model.* Korean: Seoul: Seoul National University; 2017.
 22. Stoyanov SR, Hides L, Kavanagh DJ, Zelenko O, Tjondronegoro D, Mani M. Mobile app rating scale: a new tool for assessing the quality of health mobile apps. *JMIR Mhealth Uhealth.* 2015;3(1):e27–e27. <https://doi.org/10.2196/mhealth.3422>.
 23. Stoyanov SR, Hides L, Kavanagh DJ, Wilson H. Development and validation of the user version of the mobile application rating scale (uMARS). *JMIR Mhealth Uhealth.* 2016;4(2):e72. <https://doi.org/10.2196/mhealth.5849>
 24. Davalbhakta S, Advani S, Kumar S, Agarwal V, Bhoyar S, Fedirko E, et al. A systematic review of the smartphone applications available for coronavirus disease 2019 (COVID19) and their assessment using the mobile app rating scale (MARS). *medRxiv.* 2020. <https://doi.org/10.1101/2020.07.02.20144964>
 25. Masterson RM, Maurer MS, Reading M, Hiraldo G, Hickey KT, Iribarren S. Review and analysis of existing mobile phone apps to support heart failure symptom monitoring and self-care management using the mobile application rating scale (MARS). *JMIR Mhealth Uhealth.* 2016;4(2):e74. <https://doi.org/10.2196/mhealth.5882>
 26. Lee JY. *Development and evaluation of an emotional education mobile app to promote mental health of middle school students.* Seoul: Seoul National University; 2017. Korean.
 27. Pelsmacker PD, Dens N, Kolomiiets A. The impact of text valence, star rating and rated usefulness in online reviews. *Int J Advert.* 2018;37(3):340–59. <https://doi.org/10.1080/02650487.2018.1424792>
 28. Nevin CR, Westfall AO, Rodriguez JM, et al. Gamification as a tool for enhancing graduate medical education. *Postgrad Med.* 2014;90(1070):685–93. <https://doi.org/10.1136/postgradmedj-2013-132486>