# Application and Analysis of a Mobile E-Book System Based on Project-Based Learning in Community Health Nursing Practice Courses

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**ABSTRACT**

Nursing practice courses are the most formative part of nursing education. Through practice, nursing students apply, validate, and clarify theories taught in class. Recently, research on the application of mobile devices in nursing practice courses has advanced rapidly. An e-book system that integrates text, audio, and images can improve a learner's attention, interest, and creativity. Few studies have explored e-book use in education in regional health centers, and studies that have approached this topic have focused only on the data search and retrieval aspects. To address this gap, the current study introduced an e-book system that integrated project-based learning and authentic learning into a community health nursing practice course. Analysis results of a 3-week experiment indicated that the diverse functions, multimedia features, and convenience of the e-book system not only increased learning interest and motivation but also improved learning effectiveness. However, the cognitive load imposed on nursing students using the e-book system also increased, because they were required to create and edit teaching materials for a new health care education method.

**Keywords**

Community health nursing, Nursing student, E-book, Project-based learning, Authentic learning

## Introduction

Both nursing theory and practice are essential to the nursing profession. Nursing students' capabilities after professional training depended on the effectiveness of nursing education curricula. Thus, an effective curriculum must be developed to train students before they become professional nurses (DeBack & Mentkowski, 1986; Tzeng & Ketefian, 2003). Nursing practice courses are regarded as the capstone of nursing education (Gothler, 1985). Nursing students apply, verify, and clarify theories learned in class through practical experience in the nursing field, thus reducing the potential that they will commit early-career errors when they begin formal practice (Rauen, 1974).

With the emergence of information technology, learning schemes have become more diverse. The prevalence of portable devices has led to new directions in the development of learning models (Christensen & Knezek, 2017; Crompton, Burke, & Gregory, 2017; Hsieh & Tsai, 2017; Karimi, 2016; Kim, Lee, & Rha, 2017). In recent years, applications of portable devices in nursing and practice courses have developed rapidly. Through use of these devices, labor and errors are reduced, and nursing students increase their professional knowledge and skills (Forehand, Miller, & Carter, 2017; Mackay, Anderson, & Harding, 2017; Wu, 2014a). Among these devices, e-books are favorable because they enable integration of text, voice, video, and other media to facilitate the development of social relations among learners and enhance their interest in the learning process. A high-interactivity e-book system can also achieve the effects of edutainment (Sorathia & Servidio, 2012). When used with appropriate teaching strategies, guidance, and planning, e-books serve as a sound tool with which learners can achieve their learning objectives (Muira & Hawes, 2013; Smith et al., 2013; Wu, 2014b). Melrose, Park, and Perry (2013) discovered that with the systematic guidance and real-time assistance of e-books, nurses and other health professionals could implement creative teaching procedures. These new teaching strategies may improve nursing students' comprehension of course material and advance their practical proficiency. Wu (2014b) developed a multifeature e-book annotation system that nursing students used to analyze and discuss cases among their peers. The study revealed that the introduction of e-books increased learning effectiveness among the nursing students. Nursing students can quickly collect and integrate information from e-books, avoiding the inconveniences of traditional paper-based learning materials. Learning motivation and cooperation among nursing students may also be enhanced through e-book use, which may stimulate the students' problem-solving and critical thinking abilities. Furthermore, Gueval, Tarnow, and Kumm (2015) introduced a concept-based model into public health courses and incorporated e-books into the traditional curriculum. They reported that most nursing students were satisfied with the immediacy and portability of the e-books. The instant search and review functions of the e-books also led to improvements in the students' hands-on skills and comprehension, in turn increasing their confidence and motivation.

Nursing courses increasingly emphasize critical thinking, clinical judgment, and problem-solving abilities (Girot, 2000). Teaching strategies affect learners' message selection, acquisition, and construction, shaping their behavior and thinking in the process (Weinstein & Mayer, 1986). Authentic learning approaches typically focus on complex "real-world" problems and solutions and involve role-playing exercises, problem-based activities, case studies, and participation in virtual practice communities (Lombardi, 2007). These learning environments are inherently multidisciplinary and imitate real-world situations. Authentic learning combines multiple disciplines, perspectives, methods, and communities (Downes, 2007). Students immersed in authentic learning activities can develop the types of "portable skills" that newcomers to any discipline may struggle to acquire on their own (Reeves, Herrington, & Oliver, 2002).

Project-based learning (PBL) was proposed by American educator William Heard Kilpatrick in 1918. PBL has been systematically implemented in medical education to enhance medical school students' development of critical thinking and problem-solving abilities (Barrows, 1996). Numerous experts have modified the PBL model, which has also been used in nonmedical disciplines (Barrows, 1996; Hou, 2010). PBL involves presenting real-world problems to help students obtain knowledge and skills (Barrows, 1983). This approach can be applied to many disciplines to connect concepts and theories with real-world problems (Barrows & Tamlyn, 1980). Learners develop their metacognitive and critical thinking abilities by solving problems in teams through the collection, analysis, and discussion of information (Krajcik, Blumenfeld, Marx, & Soloway, 1994; Fleming, 2000). In nursing practice courses, group interactions combined with a multifunctional e-book system can increase students' interest in the learning process, and multimedia presentations can be used to diversify the teaching material of nursing practice courses (Wang, Tan, & Song, 2007; Wu & Chen, 2018). Teaching approaches based on edutainment may enhance students' learning motivation and active participation (Makarius, 2017; Svane, Aderklou, Fritzdorf, & Hamilton-Jones, 2001).

Most studies on the use of e-books in the medical field have focused on the use of e-books in the operations of large medical institutions and in the conveyance of related concepts (Athilingam, Osorio, Kaplan, Oliver, O'Neachtain, & Rogal, 2016; Farrell, 2016; Jamu, Lowi-Jones, & Mitchell, 2016; Zhao, Freeman, & Li, 2016). E-book use in practical nursing education in regional health institutions, such as district public health centers, has rarely been examined. In addition, with regard to their use in the medical field, e-books have been discussed mostly for their data search and retrieval functions, particularly search and retrieval of disease information, drug information, patient information, and medical guidance (Dee & Stanley, 2015; Ritchie, 2017; Saha, Saha, & Neogy, 2018; Williams & Dittmer, 2009). E-books' potential uses for integration of teaching theory and practice is seldom mentioned in the literature. To address the gap between theory and practice, traditional teaching methods in nursing practice should be combined with diverse and authentic learning strategies to increase the real-world experiences of nursing students. Edutainment may be used to achieve this purpose. Accordingly, this study introduced an e-book learning system suitable for community health nursing courses. The proposed portable system may be used to diversify learning content and practice activities for nursing practice courses and it offers instantaneous application and support features.

Bradram and Bossen (2003) discovered that when nursing students used e-books, instances in which the devices failed to provide complete information hindered the students' work and learning processes. Dunphy, Finlay, Lemaire, MacNairn, and Wallace (2011) determined that device malfunction increased users' frustration in their work processes. Disturbances in accessing information increases mental load, strains working memory, and interferes with long-term memory (Vogel-Walcutt et al., 2011). When the cognitive load required for a task exceeds a learner's working memory capacity, learning performance is impaired (Young et al., 2014). To determine whether the use of an e-book system adds pressure to nursing practice and whether associated innovations in teaching strategies overburden nursing students during the learning process, this study used a subjective cognitive load scale to assess relevant performance and cognitive load metrics.

In this study, various knowledge areas and skills were integrated in PBL activities to enhance students' learning motivation and facilitate cooperation and metacognitive development. Under this strategy, learners can acquire knowledge and skills by solving problems and simultaneously cultivate high-level cognitive abilities (Blumenfeld et al., 1991; Solomon, 2003). This study also explored the effect of the proposed e-book system, which integrates PBL and authentic learning, on the learning effectiveness, learning motivation, and cognitive load of nursing students in a community health nursing practice course. Under the strategy implemented in the study, students were encouraged to think critically to address complicated nursing problems, be responsible for their own behavior, and maintain professional and humanitarian attitudes (Watson & Foster, 2003).

# E-book system integrating PBL and authentic learning in a traditional community health nursing practice course

The nursing students were tasked with combining both academic and practical skills in a real-world environment after one semester of a community health nursing course. Each nursing student was required to participate in a 3-week practical course concerning community health nursing practices, the content of which included community hygiene. Practical experience of professional nursing can incite nursing students' interest in the trends of community health nursing. Practical experience also offers an opportunity for students to apply and deepen their understanding of professional information. In the present study, the proposed e-book system was used in both individual health education and community health education sessions. Before the health education sessions, the experimental group of nursing students was required to collate and prepare their materials into interactive e-books. The e-book system enabled nursing students to efficiently create content-rich multimedia interactive teaching materials, and involved lower costs, less time, and fewer privacy issues than those associated with traditional paper methods. Moreover, materials from the Internet were used in the e-books, improving the convenience of data collection and the range of available data. The rich and dynamic content not only drew clients' attention, but also deepened their impressions of the information, thereby improving the overall administration of health care services. The e-books thus served as edutainment for both the nursing students who developed them and the clients who were their target audience. In the context of this study, "clients" refers to people who received the individual or community health education. The interface of the e-book system developed in this study is represented in Figure 1.



*Figure 1.* Interface of the e-book system

In a teaching strategy that combines PBL with authentic learning, students are required to solve complex, realistic problems. The goal of this strategy is to motivate students to become curious, positive thinkers and autodidacts. The steps of the integrated teaching method applied in the present study are outlined as follows.

## Preparation

Nursing teacher introduced the content, objectives, and plan of the practice program, as well as the purpose and methods of community health nursing. After dividing nursing students into groups, a head nurse of a regional health institution assigned the groups topics regarding individual and community health education. Within their groups, the students were to discuss search methods, labor division, and schedules for the design of the e-book that would serve as the basis for individual and community health education.

## Implementation

The nursing students used the e-book system to create health education materials based on personal knowledge and information accessed from the Internet. The software in which students assembled the e-book system was similar to Microsoft PowerPoint; simple drag and drop functions could be used to assemble content. The e-book system also offered numerous predesigned interactive functions, such as drag-and-match, scratch-off, multi-choice, multimedia play, and picture rotation. Each group used relevant auxiliary functions in the e-book system to create a multimedia presentation and annotate critical parts of the presentation that required further explanation to clients. Students used the Internet to access information related to various health education topics.

Through the collection and analysis of network data as well as communication and discussion within their groups, the nursing students cultivated the abilities to solve problems and synthesize knowledge. Each subgroup in the experimental group collected, organized, and arranged the contents of their e-book according to their assigned topic. The final e-books appeared similar to real books and included a page-turning function and interactive health education content in multimedia presentations. The digitized collation of health education content improved data storage, transmission, management, and use; these improvements also enhanced interpersonal interactions. The nursing teacher assisted students in conducting the relevant activities and guided them in presenting the content. The teacher also observed and assessed student performance.

### Presentation

In the implementation phase of this study, students designed and presented individual and community health education materials using vivid interactive multimedia content. The dynamic presentations not only attracted the attention of clients, but also deepened their comprehension of the information, improving the health care service at the basic level. Moreover, the multimedia interactions helped to increase the clients' interest in health education, strengthened the relationship between clients and nursing students, and boosted students' confidence in their nursing skills and oral communication abilities. The nursing teacher evaluated the students' abilities to synthesize knowledge and express themselves orally, and helped them develop skills in problem-solving, communication, and management.

### Evaluation

The first goal of PBL evaluation is to assess learning effectiveness. The second goal is the evaluation of the learning process by assessing the problem-solving and interpersonal interactions of nursing students (Shepherd & Cosgriff, 1998). In addition, multidirectional evaluation methods can be used for self-assessment through feedback provided by others (Krajcik, Czerniak, & Berger, 1999). This study used self-reported evaluations from students (25%), a nurse from the internship institution (25%), and the nursing teacher (50%) to assess learning effectiveness.

### Reflection

The nursing students reflected on the process of individual and community health education and the corresponding evaluation. Based on their experiences, students considered potential new uses for the system. The nursing teacher assisted the students in improving their methods to obtain better results and increase their understanding.

## Research design

### Participants

This study enrolled students from two classes at Fourth Nursing School and distributed them randomly into either an experimental group or a control group. Each group comprised 32 students. According to the requirements of the school, the students were further divided into heterogeneous subgroups to complete practical nursing courses. Each subgroup comprised 8–10 students, and groups were led by the same nursing teacher. Nursing students in the experimental group used the e-book system and implemented the teaching strategy of combined PBL and authentic learning. Nursing students in the control group implemented the same teaching strategy, but they used the traditional paper-presentation method. Both groups were required to carry out individual and community health education. To incentivize the nursing students to perform well during the experiment, of the course results were graded.

### Experimental procedures

Students participated in the community health nursing practice course in regional public health centers 8 hours a day for 3 weeks. On the first day of the course, the nursing teacher explained the role of public health nurses and the procedure, methods of evaluation, and precautions of practice activities. The nursing teacher separated the

students into groups according to teaching strategy. Time was allotted for students in the experimental group to familiarize themselves with the operation of the e-book system. During the first week, all nursing students were required to attend classes in the regional public health center to learn about the basic functions of grassroots health care and to prepare individual health education materials for home visits the following week. Students in the experimental group were required to create interactive e-books explaining the health education materials (which included information on diabetes, hypertension, chronic kidney disease, and stroke), and students in the control group created paper presentations. During the second week, students were assigned clients for home visits. Students in the experimental group used the e-books to explain basic health information and promote health education to the clients during the home visits, whereas nursing students in the control group used traditional paper-based presentations. The nursing teacher evaluated the performance of students after the home visits. Students reflected on the evaluations they received from the teacher in their preparations of material for community health education sessions (involving topics such as maternal and child health, sexual health, accident injury prevention, chronic disease prevention and treatment, cancer prevention, and elderly care) to be held in the third week. During the third week, each group taught and promoted health education in their assigned community. The experimental group used the multimedia e-book and interactive methods to teach lead community health education, whereas the control group used traditional methods. Figure 2 presents photos taken in the individual and community health sessions.



*Figure 2.* Individual and community health education sessions

The nursing teacher evaluated students' performances in the community health education process. In addition to the assessment from the nursing teacher, the nurse who oversaw the practice course in the regional public health center provided an evaluation score. Before the end of the practice course, the nursing students were required to evaluate their own performance during the practice activities, as well as to rate their learning motivation and cognitive load. Figure 3 presents a flowchart of the experimental procedure.
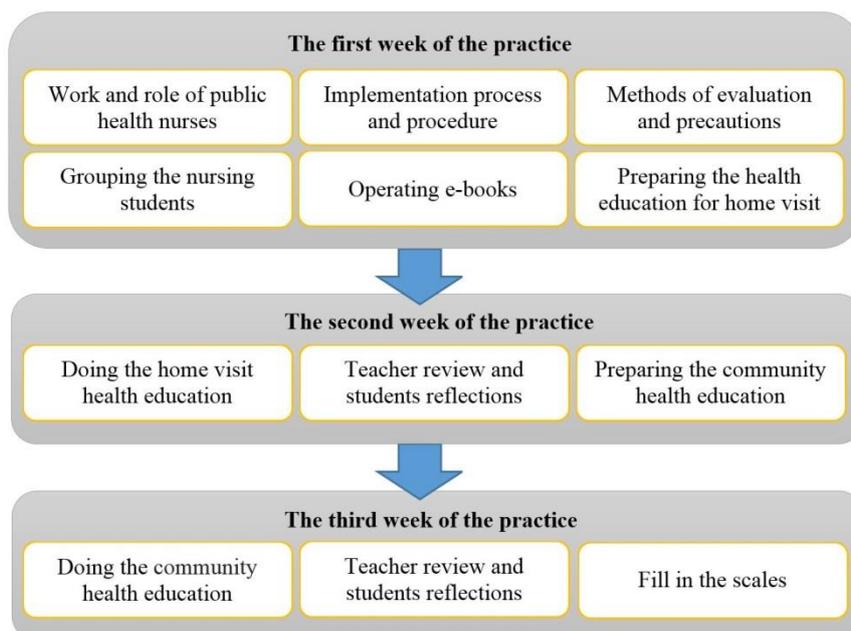


*Figure 3.* Experimental procedure

**Assessment tools**

*Learning effectiveness*

This study used three evaluations to determine whether the teaching strategy of the e-book system based on PBL and authentic learning improved learning effectiveness. The nurse from the internship institution who oversaw the practice course, the nursing teacher, and the students evaluated the community health nursing practice process according to seven dimensions. The criteria of these seven dimensions were based on the evaluation of learning effectiveness formulated by the school, and the three evaluation methods were required by the school. The evaluation methods and criteria used in this study have been used in the school for numerous years. This study followed the school's specifications to familiarize scorers with the evaluation criteria to enhance evaluation accuracy. The seven dimensions are presented in Table 1. Use of multiple assessment sources improved the quality of the evaluation of the learning effectiveness.

*Table 1.* The seven dimensions of learning effectiveness

| Performance |
|---|

**I. Basic biological medicine and general care skills**
- I understand what constitutes a healthy community environment and I ensure each client's safety.
- I can recognize the causes, symptoms, and risk factors of a client's illness.
- I can describe the purpose for a client's medication as well as how the medication functions and what precautions related to the medication the client should observe.
- I can recognize when a client's health status is abnormal (such as abnormal values of three prominent symptoms).
- I can provide appropriate nursing instructions.
- I can describe the purposes and methods of various community health care clinics.
- I can accurately perform various community nursing skills.
- I can accurately perform the steps of a home visit and complete nursing records.
- I exhibit excellent performance in my educational hygiene internship.
- I accurately complete internship assignments on factory hygiene.
- I can precisely write instructional plans and accomplish group health education tasks.

**II. Care**
- In the nursing process, I apply care skills such as listening and sympathetic engagement.
- I protect each client's rights and privacy and actively care about their case.
- I comprehend and follow ethical rules for nursing.
- I can participate in ethics-related discussions regarding clinical issues.

**III. Ethics**
- Before performing care procedures, I explain the purpose and process to the client.
- I respect each client's self-esteem and value.
- I protect each client's personal and illness-related privacy.
- When executing nursing activities, I can provide the client with fair care rights.
- When encountering an ethical challenge, I analyze the problem according to various dimensions of ethics.

**IV. Communication and cooperation**
- I can establish a therapeutic interpersonal relationship with a client and the client's relatives using communication skills.
- I can actively discuss the care procedure for a client's illness with the internship instructor or a clinical teacher.
- I understand the work model of a health care team.
- I can determine appropriate care service based on a client's situation and can properly administer care.
- I can accomplish a task through mutual assistance, cooperation, communication, and negotiation with a team.

**V. Fulfillment of duties**
- I am on time for my professional commitments and do not ask for leaves of absence.
- I dress appropriately and maintain a professional attitude.
- I exhibit a diligent, proactive, and serious learning attitude and I seek out learning opportunities.
- I can manage a community hygiene clinic.
- I learn actively and I am collaborative. When I discover errors, I report them accurately.
- I identify with the role and function of a nurse.

**VI. Critical and creative thinking**
- I can systematically assess a client's health situation (family and community).
- I can determine the priority of a client's health problems according their needs (community).
- I can establish and execute personalized care according to the health problems of a client (community).
- I practice effective evaluation according to nursing objectives and measures.
- I use a creative approach to complete community health evaluation reports.
- I use creative thinking to complete group health education activities.

**VII. Lifelong learning**
- I can proactively provide a client and the client's relatives with appropriate health education.
- In the psychiatric nursing internship, I proactively collect, read, and use data through multiple channels.
- I demonstrate concern about mental illness issues in society and particular mental disorder cases.
- I determine which aspects of my performance do not meet professional standards, and I adjust the behaviors to further my personal growth.

*Learning motivation*

The aim of the e-book method was to incite the interest of nursing students, maintain their attention, and stimulate their curiosity and motivation to enhance self-learning efficiency. The effect of the multimedia interactive e-book system on learning motivation was assessed using a modified version of Keller's (1999) attention, relevance, confidence, and satisfaction (ARCS) learning motivation scale, for which 24 items were rated on a 5-point Likert scale.

*Cognitive load*

An additional evaluation was conducted to determine whether the introduction of the e-book system engendered additional pressure or burden in the nursing practice process. Students in both groups completed a subjective self-evaluation using a modified version of the cognitive load scale proposed by Kalyuga (2000) and Cerpa et al. (1996), comprising four items rated on a 5-point Likert scale (Table 2). The scale measured two subjective dimensions: mental load and mental effort (Sweller, 1989; Sweller, 1998).

*Table 2*. Items of the cognitive load scale

| Mental load | Mental effort |
|---|---|
| The contents of the tasks were complicated. | I have made an intellectual effort when completing the contents of the tasks. |
| The tasks were challenging. | I have given my best to solve the tasks. |

## Results

**Analysis of learning effectiveness**

To evaluate learning effectiveness, the independent sample t-test was applied to the scores from the three evaluation types completed based on the practice course results. The effectiveness of integrating PBL and authentic learning through the e-book system into the community health nursing practice course was explored through descriptive statistical analyses.

*Table 3*. Statistical results of the learning effectiveness analysis

| Achievement | N | Group | Mean | SD | t | p | d |
|---|---|---|---|---|---|---|---|
| Self-evaluation | 32 | Control group | 86.84 | 1.886 | -4.990 | .000* | 1.2486 |
|  |  | Experimental group | 89.28 | 2.020 |  |  |  |
| Internship institution evaluation | 32 | Control group | 84.13 | 1.431 | -4.704 | .000* | 1.1717 |
|  |  | Experimental group | 85.78 | 1.385 |  |  |  |
| Nursing teacher's evaluation | 32 | Control group | 85.34 | 1.473 | -5.723 | .000* | 1.4315 |
|  |  | Experimental group | 87.56 | 1.625 |  |  |  |
| Total score of practice course | 32 | Control group | 85.41 | 1.459 | -5.795 | .000* | 1.4532 |
|  |  | Experimental group | 87.55 | 1.486 |  |  |  |

*Note.* $^*p < .05$.
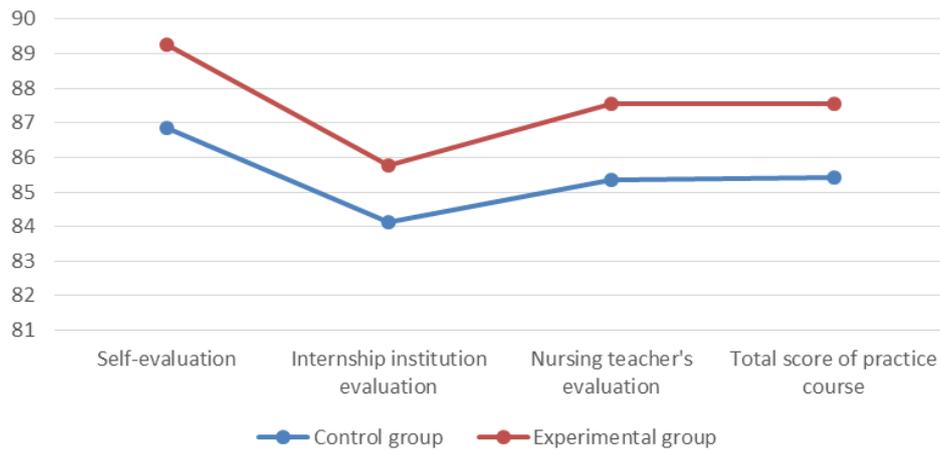
*Figure 4*. Average of the three evaluations and total score

As illustrated in Table 3, all *p* values were less than .05, indicating significant differences between the experimental group and the control group for each of the three evaluation types, as well as for overall score. The average scores from the three evaluations were greater for the experimental group than for the control group. Among the three evaluation types, the evaluation from the internship institution exhibited the lowest scores, and the highest scores were derived from the students' self-evaluations. The scores closest to the overall average scores were those from the nursing teacher (Figure 4).

**Analysis of learning motivation**

Learning motivation analysis was conducted by applying the independent sample *t*-test to the scores of the ARCS scale indicated by the two groups. The reliability of the scale was examined using Cronbach's α. Based on the ARCS scale scores from the students, the effect of the practice strategies on the four dimensions of learning motivation were determined. The results derived from the reliability analysis of each dimension are presented in Table 4. All values were greater than 0.90, revealing that the learning motivation scale applied in this study exhibited high consistency and reliability.

*Table 4*. ARCS reliability analysis

| Dimensions | Cronbach's α |
|---|---|
| Attention | 0.963 |
| Relevance | 0.969 |
| Confidence | 0.915 |
| Satisfaction | 0.960 |

The results obtained from the *t*-test analysis of the learning motivation scale are presented in Table 5. The value of each item in the four dimensions was less than .05, revealing significant differences between the two groups with regard to learning motivation. A more detailed observation of the average value of each item revealed that for the "relevance" dimension, the difference between the two groups was relatively small, and the "confidence" dimension was associated with the next smallest difference, followed by the difference for the "satisfaction" dimension, and finally, that for the "attention" dimension. These results indicated that the multimedia content and interactivity of the e-book system held students' attention during the activities and that the teaching strategy of integrating PBL and authentic learning guided the nursing students to achieve the practice objectives. Increased motivation can increase learners' participation and provide learners with a sense of satisfaction, thereby enhancing self-learning efficiency.

*Table 5*. Statistical analysis results for ARCS motivation scale scores

| Items | Mean | | SD | | *p* | *d* |
|---|---|---|---|---|---|---|
| | C | E | C | E | | |
| A_1 | 2.78 | 3.69 | .706 | .535 | .000* | 1.4528 |
| A_2 | 2.59 | 3.81 | .665 | .397 | .000* | 2.2277 |
| A_3 | 2.63 | 3.97 | .707 | .400 | .000* | 2.3329 |
| A_4 | 2.63 | 3.97 | .660 | .246 | .000* | 2.6905 |
| A_5 | 2.72 | 3.91 | .523 | .390 | .000* | 2.5796 |
| A_6 | 2.56 | 3.97 | .619 | .309 | .000* | 2.8822 |

| | | | | | | |
|-----|------|------|------|------|-------|--------|
| R_1 | 3.63 | 4.53 | .492 | .507 | .000* | 1.8016 |
| R_2 | 3.50 | 4.44 | .508 | .504 | .000* | 1.8577 |
| R_3 | 3.50 | 4.47 | .508 | .507 | .000* | 1.9113 |
| R_4 | 3.53 | 4.47 | .507 | .507 | .000* | 1.854 |
| R_5 | 3.59 | 4.50 | .499 | .508 | .000* | 1.8073 |
| R_6 | 3.53 | 4.44 | .507 | .504 | .000* | 1.8002 |
| C_1 | 2.66 | 4.31 | .602 | .471 | .000* | 3.0528 |
| C_2 | 2.84 | 4.25 | .723 | .440 | .000* | 2.356 |
| C_3 | 3.34 | 4.09 | .545 | .296 | .000* | 3.5833 |
| C_4 | 3.09 | 4.13 | .588 | .336 | .000* | 4.3773 |
| C_5 | 3.25 | 4.22 | .672 | .420 | .000* | 1.7311 |
| C_6 | 3.31 | 4.25 | .644 | .440 | .000* | 1.7044 |
| S_1 | 2.13 | 4.09 | .421 | .296 | .000* | 5.386 |
| S_2 | 2.13 | 4.09 | .421 | .296 | .000* | 5.386 |
| S_3 | 2.19 | 4.09 | .471 | .296 | .000* | 4.8302 |
| S_4 | 3.09 | 4.19 | .588 | .397 | .000* | 2.1927 |
| S_5 | 3.25 | 4.25 | .672 | .440 | .000* | 1.7607 |
| S_6 | 3.31 | 4.28 | .644 | .457 | .000* | 1.7372 |

*Note.* $^*p < .05$.

### Analysis of cognitive load

When a job is assigned to a learner's cognitive system, it generates cognitive load (Paas & Van Merriënboer, 1993). If the learning process considerably exceeds a learner's working memory capacity, the learner's understanding and problem-solving abilities are negatively affected (Sweller, 1989; Sweller, 1998). To understand the cognitive loads that the nursing students experienced during the practice activities, the cognitive load scores provided by the students were analyzed (Table 6).

*Table 6.* Statistical analysis results for cognitive load

| Mental | N | Group | Mean | SD | t | p | d |
|--------|----|--------------------|------|-----|--------|--------|--------|
| Mental load | 32 | Control group | 3.37 | .55 | -3.325 | .0005* | 0.8392 |
| | | Experimental group | 3.84 | .57 | | | |
| | 32 | Control group | 3.34 | .60 | -3.733 | .000* | 0.9354 |
| | | Experimental group | 3.93 | .66 | | | |
| Mental efforts | 32 | Control group | 3.31 | .59 | -3.643 | .0005* | 0.9137 |
| | | Experimental group | 3.84 | .57 | | | |
| | 32 | Control group | 3.46 | .56 | -3.418 | .0005* | 0.8746 |
| | | Experimental group | 4.00 | .67 | | | |

*Note.* $^*p < .05$.

Statistical analysis (Table 6) revealed that the *p* values for mental load and mental effort were both less than .05, indicating that the cognitive load and mental effort of the experimental group were greater than those of the control group. Therefore, nursing students using the new e-book method for health education spent more energy and mental resources during the practice activities. In other words, the nursing students that used the e-book system to edit content for individual and community health education experienced higher cognitive loads from this task than the control groups students did from using the traditional method.

## Discussion

Practice courses in nursing schools help learners structure abstract concepts, internalize nursing ethics, and apply nursing skills proficiently in real-world situations (Christy, 1980). Nursing practice courses combine theory with practice to facilitate nursing students' professional development (Clark, Owen, & Tholcken, 2004).

Wireless networks and portable devices have become more advanced and prevalent and have been introduced into nursing practice courses (Huffstutler, Wyatt, & Wright, 2002). Portable devices save labor, reduce errors, and provide instantaneous access to information (Miller et al., 2005). Moreover, the real-time feedback and core knowledge support provided by such devices can contribute to students' mastery and application of skills (White, Allen, Goodwin, Breckinridge, Dowell, & Garvy, 2005; Wu, 2014a). This study applied an interactive

multimedia e-book system under a teaching strategy of PBL combined with authentic learning in a community health nursing practice course. The rich presentation mechanisms and auxiliary functions of the e-book system enhanced students' abilities to achieve the practice curriculum objectives. Students were more interested in home visits and the community health education process was more efficient when the experimental method was used.

The results of the learning effectiveness evaluation indicated that the three assessment scores and the overall practice score of the experimental group were higher than those of the control group. Thus, the multifunctional e-book system improved the effectiveness of health education in the context of systematic PBL. Moreover, according to the teacher's observations, students progressed in self-planning, group cooperation, and practice processes, and they expanded the scope of the health education materials. Among the scores from the three evaluation types, the self-evaluation scores were always the highest, which was consistent with the findings of previous studies (Bouzidi & Jaillet, 2009; Cho, Schunn, & Wilson, 2006; Knowles, 2005). Studies have indicated that evaluation by various third parties is relatively objective, whereas self-evaluation is usually not trustworthy because of personal bias (Bouzidi & Jaillet, 2009; Jonathon, 1986; Novicevic, Buckley, Harvey, & Fung, 2008; Phillips, 2016). Therefore, to assess learning effectiveness, educational institutions should reference a teacher's or an unaffiliated party's evaluation. This study used evaluation scores from the practice institution and the nursing teacher as the basis for the overall score of the practice activities. The practice institution scores were the lowest. This evaluation may have been stricter than others because representatives of the practice institution interacted directly with clients. The nursing teacher's evaluation may be considered the most objective, because the teacher was not connected to clients and could evaluate students objectively.

Learning motivation analysis results indicated significant differences between the perspectives of the students in the two groups. Analysis of the data and the teacher's observations revealed that nursing students who prepared e-books for individual and community health education were required to use more attention during the practice process than nursing students in the control group. Nursing students in the experimental group required extra time, effort, and resources to refine illustrations and interact with clients. Thus, nursing students in the experimental group scored higher for both mental load and mental effort than those in the control group. These results corresponded with findings in previous studies. Paas (1992) believed that scales for measuring cognitive load and can be used reflect the cognitive cost and to determine the content required for successful learning performance. In addition, Marcus, Cooper, and Sweller (1996) argued that prior knowledge, content organization, and content characteristics in the learning process affect cognitive load. Gerjets and Scheiter (2003) determined that teaching objectives and processing strategies were mediating factors of cognitive load, and that activity planning affected the cognitive load and processing strategies during the learning process. In the present study, nursing students in the control group used traditional paper-based methods to conduct health education sessions and were obliged to carry heavy papers and related materials, in contrast with the portable multimedia presentation and real-time interactive activities of the e-book. The e-book system not only attracted the attention of health education clients but also improved the interactions among nursing students and clients, promoting familiarity and thereby enhancing the effectiveness of the health education service. PBL as a guiding strategy for out-of-classroom teaching may have encouraged the nursing students to increase their initiative, strengthen their problem-solving abilities, and explore solutions through peer cooperation. Furthermore, the majority of nursing students in the experimental group indicated that their listeners appeared excited and interested in the multimedia presentation of the health education content, and thus the nursing students were more willing to participate in promoting health education. The nursing students who used the e-book system felt more professional and confident in the overall practice process, and scored higher than the control group, on average, on every dimension of the ARCS scale.

## Conclusion and future work

The introduction of a portable e-book system into community health nursing practice courses can help to reduce the costs, time, and privacy concerns associated with traditional paper methods. Moreover, the Internet can be used in the proposed method to conveniently access and collect a range of information. In the present study, the rich and dynamic content of the e-books not only drew clients' attention, but also deepened their comprehension of the health education materials, thereby improving health care services at the grassroots level.

The analysis results indicated that nursing students in the experimental group (for which the e-book system was integrated with the combined teaching strategy of PBL and authentic learning) collaborated with each other during the learning process, despite increased cognitive load. They worked diligently, carefully reflected upon their task, and designed their presentations to facilitate positive interactions in individual and community health education sessions. Positive feedback regarding their work also brought them a sense of self-satisfaction. Self-

satisfaction increases learning motivation (Keller, 1999; Small & Gluck, 1994; Lee, 2000). Learning motivation, in turn, increases competence, self-efficacy, positive emotions, expectations, and value, leading to higher performance and learning effectiveness (Cameron & Pierce, 1994; Elliott, & Dweck, 1988; Moos, 2014; Duffy & Azevedo, 2015).

The limitations in this study were that most students in the nursing school were women, and the e-book system was only tested in the community health nursing practice course. Additionally, this study only analyzed learning effectiveness, learning motivation, and cognitive load. In the future, use of the system may be extended to students and teachers of other relevant nursing courses to increase the convenience of their learning environments. More in-depth studies can be conducted on application of the proposed system in specific cases and by specific nursing teachers. The results of this study may serve as a reference for scholars and professionals in relevant fields in their efforts to develop more convenient and effective learning environments.

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