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Effects of mental process integrated nursing training using mobile device on students' cognitive load, learning attitudes, acceptance, and achievements

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ABSTRACT

Clinical nursing training is important to nursing educators and student nurses in nursing education since safe and competent care depends on good clinical problem solving skills. Therefore, developing better cognitive problem-solving strategies or tools are essential for clinical nursing practices. Moreover, learning diagnosis is also a critical determinant in the acquisition, processing, and application of clinical skills in nursing practices. Bearing this in mind, this study aims to develop a mobile interactive learning and diagnosis (MILD) system to support problem-based learning (PBL) in a clinical nursing course based on the testing-based approach. Using mobile devices as a learning tool to integrate both real-world and digital-world resources for students and adopting PBL as a learning strategy to facilitate the development of the clinical problem solving skills. To show the effectiveness of the proposed approach, an experiment was conducted in a foundations of nursing course at a nursing college in Taiwan. The experimental results show that the proposed approach is helpful to students in improving learning performance and reducing cognitive loads. Moreover, it was also found that most students showed positive perceptions toward the usage of the proposed system.

1. Introduction

Clinical nursing training is essential to student nurses in nursing education since they will stand the first line to face and educate patients in hospitals after becoming a nurse. Clinical training not only facilitates students to integrate the knowledge and skills for patient cares, but also provides students the opportunity to internalize the role of the nurse as caregiver (Wolley & Jarvis, 2007). Therefore, it is very important to ensure that students receive quality clinical practice that enhances their learning performances and problem-solving abilities in nursing (Kuen, 1997).

In nursing practice, it is important that nurses are able to solve clinical problems since safe and competent care depends on good clinical problem solving skills. To achieve this, many scholars have emphasized the need for developing better cognitive problem-solving strategies or tools in clinical nursing practice (Benner, 1984; Harbison, 1991a, 1991b; Hurst, Dean, & Trickey, 1991; Taylor, 2000). Moreover, learning diagnosis is also a critical determinant in the acquisition, processing, and application of clinical skills in nursing practice (Carpenito-Moyet, 2006).

With regard to the learning tools, although several researches have developed computer-assisted learning environments or web-based learning environments to simulate problem-solving tasks and scenarios as close to the real-world situation as possible, this kind of simulation inevitably lacks the contextual complexity of the clinical environment (Gerdprasert, Pruksacheva, Panijpan, & Ruenwongsa, 2010; Jeffries, 2005; Jou & Liu, 2012; Jou & Wang, 2013a; Moule, 2006; Moule, Ward, & Lockyer, 2010). In addition, researchers have also indicated that it is important to learn in an authentic environment as well as in a virtual world (Wu, Hwang, Su, & Huang, 2012). Therefore, despite the rapid adoption of information and communication technologies (ICTs) in nursing education, an appropriate technology-based learning approach is still lack for integrating real and virtual clinical environments with PBL.

To date, with the advances of mobile technologies, mobile learning has recently revolutionized and democratized the delivery and accessibility of education (Jou & Wang, 2013b). Using mobile devices as a learning tool for nursing education can facilitate instructors and students to establish a learning environment with both real-world and digital-world resources (Hwang, Wu, & Ke, 2011). Moreover,

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in order to adopt diverse learning strategies to support clinical learning, mobile devices are also suitable for nursing activities.

Therefore, this study aims to develop a mobile interactive learning and diagnosis (MILD) system to support PBL in a clinical nursing course based on the testing-based approach (Lin, Lin, & Huang, 2011). Using mobile devices with the proposed system, students can learn nursing skills and record clinical data associated with PBL procedure, thereby helping students increase their learning performance in a clinical nursing course. Moreover, the proposed system can further assessment students' learning results to provide appropriate diagnoses for facilitating students' discussions and reflections. To evaluate the effectiveness of the proposed approach, the following research questions are investigated.

(1) Do the students who learn clinical skills with the PBL mobile learning approach show better learning achievements than those who learn clinical skills with the conventional PBL approach?
(2) Do the students who learn clinical skills with the PBL mobile learning approach show better learning attitude than those who learn clinical skills with the conventional PBL approach?
(3) Does the PBL mobile learning approach decrease the students' cognitive load in comparison with the conventional PBL approach?
(4) What are the students' perceptions of the MILD system in terms of perceived usefulness and perceived ease of use?

2. Literature review

2.1. Problem-based learning

With regard to the strategies, problem-based learning (PBL) is an appropriate cooperative learning model that can facilitate students to learn with a learning scaffold for solving a given problem (Suebnukarn & Haddawy, 2006). Instructors can support students to investigate questions, and students can share their study results with others after collecting and analyzing information. This can enhance students' learning motivation, facilitate deep learning, and increase interaction opportunities when engaging in a problem-solving process (Baghaei, Mitrovic, & Irwin, 2007).

PBL is a well-known constructivism learning strategy (Kuhlthau, 1997; Tseng, Chiang, & Hsu, 2008). To date, several variants of PBL have been adopted in different educational contexts (Chu, Lu, & Sathiakumar, 2008; Costa, Honkala, & Lehtovuori, 2007; Mitchell, Canavan, & Smith, 2010). Moreover, notably, PBL has been widely adopted as an alternative to traditional didactic medical literature over past decades. However, in nursing education few investigations have been reported of using PBL in clinical education.

In PBL procedure, the most common approach involves student-centered small groups that conduct collaborative problem-focused learning activities. Amabile (1988) proposed a five-stage PBL procedure that involves: (1) task presentation; (2) preparation; (3) idea generation; (4) idea validation; and (5) outcome assessment. West (1990) proposed a four-stage cyclical model for PBL procedure that involves: (1) recognition, (2) initiation, (3) implementation, and (4) stabilization. Based on above concepts and methods, Chen (2013) synthesized a "cognition–action–reflection" (i.e. knowing, doing, and thinking) mental process to propose a three-stage PBL procedure: (1) identifying the problem and situation; (2) designing the method and solving problem; and (3) reflecting on the process and result.

Based on the literatures of nursing education, a well clinical nursing practice depends on the application of cognition, action, and reflection (Kuiper & Pesut, 2004; National League for Nursing, 1992; United Kingdom Central Council for Nursing Midwifery and Health Visiting, 1999, Walker & Redman, 1999). Therefore, ass mentioned above, this study adopts Chen's PBL approach to engage students in cognizing, solving, and reflecting clinical nursing problems for enhancing the clinical practices since this approach can fit and support the needs of the clinical nursing practice. Fig. 1 shows the PBL procedure with mental process and the corresponding instructions and learning activities supplied by the instructor to students for solving a problem.

In addition, as the advanced mobile technology, using mobile devices as a learning tool for PBL can facilitate instructors and students to establish a learning environment with both real-world and digital-world resources (Hung et al., 2012). Moreover, in nurse education, the integration of PBL and mobile technology can assist students in learning process in a more organized, conceptualized, interactive, and promoted manner (Tan, Lin, & Lai, 2014). Therefore, in this study, combining the aforementioned properties of mobile technology with PBL offer a great opportunity in the application of innovative instruction in nursing education.

2.2. Testing-based diagnostic approach

With regard to the learning diagnosis, several studies have developed various approaches to assess students' knowledge level (Cheng, Huang, Chen, & Lin, 2005; Cheng, Lin, & Huang, 2009; Huang, Lin, & Cheng, 2009). Nevertheless, most of the approaches only assign a score or grade to teachers and students with regard to the whole assessment result, and thus both of them are unable to immediately and clearly realize what gaps or weaknesses may exist in the latter's knowledge (Gerber, Grund, & Grote, 2008; Lin et al., 2011). Moreover, it is also difficult for teachers to manually provide full-personalized diagnostic supports to each student.

Testing-based diagnostic approach was proposed by Lin et al. (2011) to assist teachers and students in discovering latter's learning problems based on students' testing information. This approach developed a knowledge diagnosis model to measure and infer students' understanding level with regard to every concept involved in an assessment. To apply the approach in a course, educators have to use two indicators, X and Z, to set two relationships between concepts and test items in advance through associated tables. Based on the settings, this model can measure the importance of each concept in the assessment by using the following function.

$$\mathrm{IRP}(C_i) = \frac{\sum_{m=1}^{n}\sum_{j=1}^{k} Z_{im}X_{mj}}{\sum_{i=1}^{n}\sum_{m=1}^{n}\sum_{j=1}^{k} Z_{im}X_{mj}}$$

where $\mathrm{IRP}(C_i)$ represents the importance ratio of concept C_i in the assessment that ranged from 0 to 1. X_{mj} represents the degree of relevance between mth concept and jth test item that ranged from 0 to 1. Z_{im} represents the relationship between ith and mth concepts that also ranged from 0 to 1.

After students took the assessment, this model would use another indicator, R, to represent the relationship between the students' answers and test items through a binary coding scheme, and further use the following function to infer the students' understanding level with regard to each concept in the assessment.

$$\mathrm{USS}(S_l, C_i) = \frac{\sum_{m=1}^{n}\sum_{j=1}^{k} R_{lj}Z_{im}X_{mj}}{\sum_{m=1}^{n}\sum_{j=1}^{k} Z_{im}X_{mj}}$$

where $\mathrm{USS}(S_l, C_i)$ represents the understanding level of lth student on ith concept that ranged from 0 to 1. R_{lj} indicates the answer of lth student on jth test item that valued 0 or 1.

To achieve the aim of this study, the testing-based diagnostic approach was applied to analyze students' learning problems

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