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Nursing Task Ontology Based Learning System Re-design for Enabling Adaptive On-Demand Learning Environment

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Abstract: Regarding planning, implementation, and evaluation of nursing activities that nursing staff practice, nurses must judge and practice knowledge and skills they should apply after proper situation assessments. The reason is that no two situations are identical in individual patients' real circumstances, even though guiding principles exist. Problem-solving processes in nursing include the following activities: Definitely grasping a subject's needs by classifying them into health problems, and psychological and social problems; planning and implementing a solution; and evaluating the results. This study provides scenes with reality (example contexts) based on nursing processes in practice. We aim at providing opportunities for learners to construct knowledge and skills in their respective contexts, along with imaging of nursing practices. For learners who wish to work as nursing staff in the future but who might have few opportunities to be involved in actual nursing processes, providing scenes that can provide simulated experiences at an early stage is expected to have some positive impacts on them: promotion of a detailed self-image of the future, motivation for learning, improvement of enthusiasm for learning, design of study and career planning, qualitative improvement of learning, and so on. In this paper, we firstly describe the characteristics of the learning task in nursing domain, secondly we show an overview of our system and an evaluation result and lastly we describe the further extension of our system towards enabling adaptive on-demand learning environment.

Key-Words: Nursing task ontology, Evaluation of the system, Multi-media learning materials, Imaging

1 Introduction

Regarding planning, implementation, and evaluation of nursing activities that nursing staff practice, nurses must judge and practice knowledge and skills they should apply after proper situation assessments. The reason is that no two situations are identical in individual patients' real circumstances, even though guiding principles exist. Nursing activities that should be provided are not necessarily identical, even for patients with similar medical conditions (diagnoses). Nursing activities should be determined considering various implicit elements that do not emerge as symptoms on the surface, such as emotional, mental and social conditions, age, physical strength, preference, medical history, and so on. This requires high abilities for situation assessment and judgment. Cultivating them through daily experiences, experts support medical nursing scenes based on solid nursing abilities that are established through considerable experience.

Therefore, in nursing education or learning before going out in the medical scene practical nursing abilities cannot be obtained merely through mastery of knowledge and nursing skills. In daily learning opportunities, implementation of various simulated problem-solving scenes is required to induce students to put acquired knowledge to practical use in individual nursing practice situations and to thereby solve problems. In contrast, constructing knowledge and skills through trial and error in actual clinical practice might cause suffering to patients, unlike learning with normal coursework. Therefore, educators need to provide opportunities for learners to put knowledge into practice and to exercise skills according to their developmental stages by properly setting up pseudo practices or clinical practices.

Problem-solving processes in nursing include the following activities: Definitely grasping a subject's needs by classifying them into health problems, and psychological and social problems; planning and

implementing a solution; and evaluating the results. The processes are commonly called "nursing processes". In greater detail, it consists of the following six: 1. Comprehensive understanding of a subject by information gathering; 2. Assessment and extraction of nursing problems; 3. Preparation of a nursing plan; 4. Nursing practices; 5. Evaluation of practices; and 6. Modification of the nursing plan. They are implemented spirally in order corresponding to form 1–6.

This study provides scenes with reality (example contexts) based on nursing processes in practice. We aim at providing opportunities for learners to construct knowledge and skills in their respective contexts, along with imaging of nursing practices. For learners who wish to work as nursing staff in the future but who might have few opportunities to be involved in actual nursing processes, providing scenes that can provide simulated experiences at an early stage is expected to have some positive impacts on them: promotion of a detailed self-image of the future, motivation for learning, improvement of enthusiasm for learning, design of study and career planning, qualitative improvement of learning, and so on.

This study particularly develops learning material frameworks for promoting imaging of nursing scenes, self-imaging as a nursing practitioner, and self-imaging as a learner, as in the following [2].

1) Imaging of nursing scenes: Breaking down a patient's condition and nursing practice scenes.

2) Self-imaging as a nursing practitioner: Breaking down the present situation and self in the future as a nursing practitioner.

3) Self-imaging as a learner: Objectively grasping oneself as a learner based on self-imaging as a nursing practitioner.

In this paper, we show an overview of our system and an evaluation result and describe the further extension of our system towards enabling adaptive on-demand learning environment.

2. Overview of the Pilot System for Problem-Solving Based Learning in Nursing Domain

We have developed an e-learning framework as shown Fig. 1 and gotten meaningful results for using in the situation of classes and self-learning in their home. Our research aims at embedding the adaptive on-demand retrieval function of learning materials to make the system more useful for the learner in clinical training. In this section, we describe the overview and effectiveness of our pilot framework by referring the evaluation results.

We emphasize to realize the learning framework that can enhance the learner to imagine the nursing scenes and oneself as a nursing practitioner and a learner.

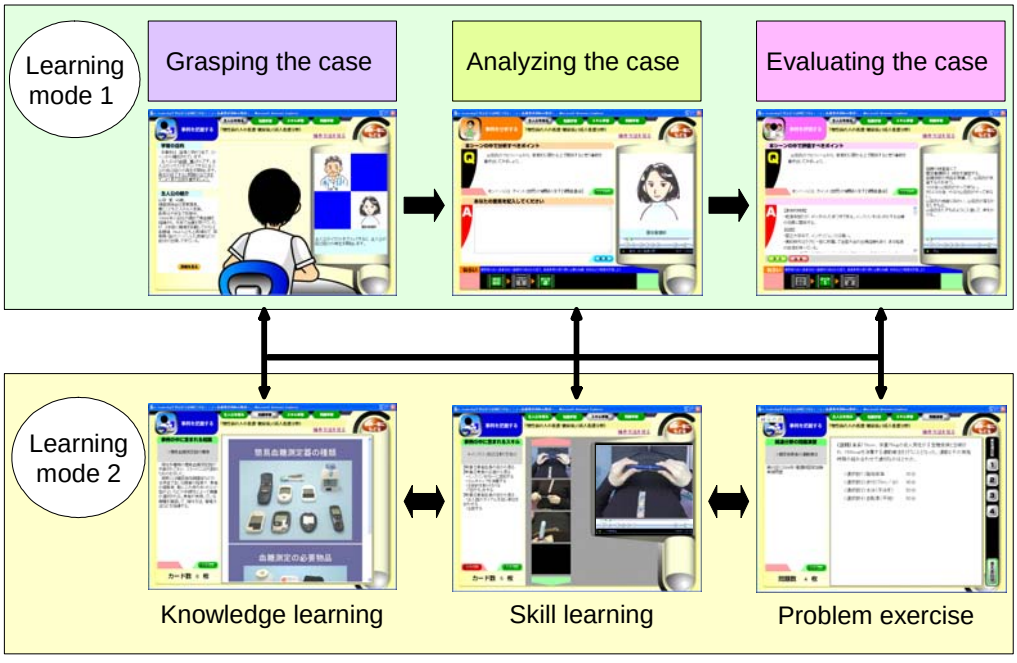

Figure 1: Summary of a learning material framework developed in this study.

Table 1: Self-evaluation results of learning objective achievement

	Total	Experimental Group	Control Group
Learning Objective 1	3.72	3.61	3.82
Learning Objective 2	3.71	3.64	3.79
Learning Objective 3	3.77	3.79	3.74
Total Average	3.72	3.78	3.85

Table 2: Self-evaluation results of imaging the patient

	Total	Experimental Group	Control Group
Imaging the Patient	3.75	3.92	3.58
Imaging the Patient's Situation	3.67	3.84	3.50

Thereby, we adopted the problem-based learning style to grow up the ability of breaking down a patient's condition and nursing practice scenes, breaking down the present situation and self in the future as a nursing practitioner and objectively grasping oneself as a learner based on self-imaging as a nursing practitioner.

Figure 1 shows a summary of a learning material framework developed in this study.

This learning material framework has accumulated examples according to nursing subjects. Therefore, learners can start learning by selecting an example and a learning mode. As learning modes, the following two are provided: The first mode is a problem-solving learning mode, which enables conductance of problem-solving type learning according to nursing processes by case.

We recorded voice data in the form of a patient talking about a medical condition during interaction with a nurse (a nurse interviewed the patient to obtain necessary information for practicing nursing activities). Furthermore, we created lively narration by employing a professional narrator to present real conditions. We contrived that students could imagine case contents only through voice.

Lively interactions between a patient and a nurse are shown to learners in each phase that is necessary for proper planning and implementation of a nursing plan: The phase of grasping a subject's condition, the phase of analyzing nursing practice scenes, and the phase of evaluating analysis results. Simultaneously, noteworthy points for problem-solving and teachers' (experts') suggested answers are presented appropriately so that learners can practice problem-solving learning by referring to them.

The second mode is a related learning mode. It enables the study of knowledge (e.g., anatomical physiology of human body and pathological physiology of diseases, developmental processes of human, and the medical welfare system) and nursing skills (e.g., methods of self-blood glucose measurement and method for insulin self-injection, method of complete bed bath for postoperative patients, and assessment of infants' developmental condition) that are necessary for problem-solving in each case, by repeatedly watching figures and illustrations, photographs, and so on.

In general, even learned "known" knowledge is not always "constructed as the manageable condition" in a scene to apply. Therefore, we anticipate that providing a system that enables appropriate reference and study of required knowledge and nursing skills in each problem-solving scene by the problem-solving learning mode contributes to acquiring contexts (meta-knowledge) that put them into practice.

We carried out self-administrated questionnaires about learning material evaluation in classes using the case of the person who have a gastrectomy operation. We set three main learning objectives as follows: 1) Learners can examine the supporting methods for the patient with other group members, 2) They can continue to practice the examined supporting methods until to master them and 3) They can clarify the subjects by evaluating the performed supporting methods.

We obtained answers from 63 students in the second grade and 68 students in the third grade. Summarized results especially about promoting effects of imaging are shown as Table 1 and Table 2 (five stage evaluation).

Table 1 represents the self-evaluation results of learning objective achievement. Average marks of experimental group and control group are 3.78 and 3.85, respectively. This doesn't indicate bad results as following discussion.

Table 2 represents the results of imaging the patient. Average marks of experimental group are higher than the ones of control group. Average mark of imaging of

the patient and her situation indicates significant difference that the mark of experimental group is higher than the one of control group.

It is notable that learners using our learning framework can imagine the patient and her situation better than the ones with ordinary learning style whereas the self-evaluation results of learning objective achievement is lower. It suggests the framework can make the learner be aware of oneself as a nursing practitioner and as a learner and make his/her evaluation criteria get stricter by imaging the real situation. In other words, it can prompt the learner's meta-cognition [1][4]. Prompting meta-cognition is quite important to make the learning activities effective especially in problem-solving oriented learning [5][6][7][8].

More detailed evaluation results from the other viewpoints are described in [2].

3 Towards Building Adaptive On-Demand Learning Environment Based on Nursing Task Ontology

The educational objectives in clinical training are to re-construct the knowledge and skills to the useful knowledge by displaying them in the actual problem-solving contexts as well as to improve the learners' ability of planning, implementing and evaluating through their experiences. It is required for supporting the learner adequately in the clinical training that adaptive on-demand learning environment which can follow the learner who tries to nurse the real individual patient. In this study, we aim to re-construct our e-learning framework and embed the adaptive on-demand retrieval function of learning materials. Learner can get the knowledge required for performing adequate nursing activities for the patient facing her and can imagine the nursing situation and oneself as a nursing practitioner with fidelity before performing because it can show the adequate learning materials according to the situation.

In this section, we show an overview of the new

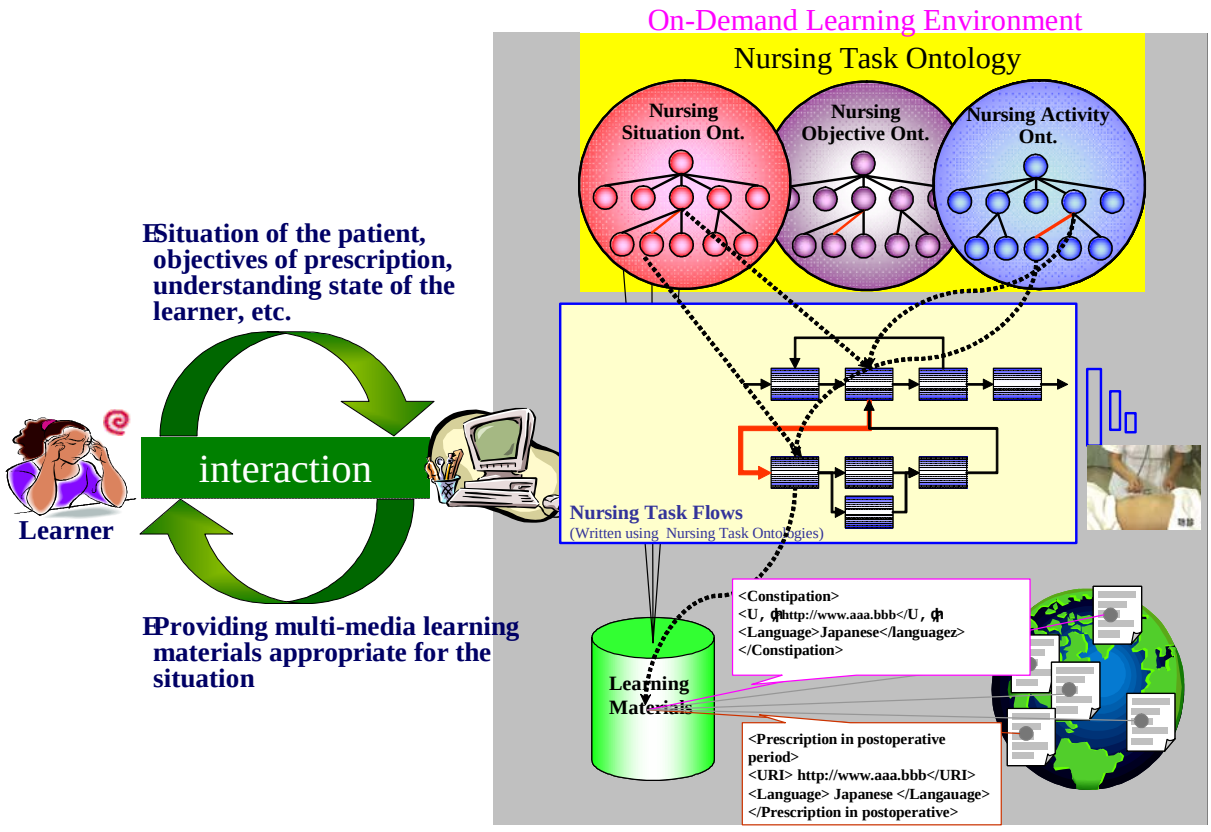

Figure 2: Overview of the adaptive on-demand learning environment

framework and embedded functions.

As described above, nursing activities that should be provided are not necessarily identical, even for patients with similar medical conditions (diagnoses). Thereby, it is quite important to consider various implicit elements that do not emerge as symptoms on the surface for determining the adequate nursing activities.

Consider the situation in planning and implementing the series of nursing activities for the patient who complains constipation. Basic nursing activity for the patient is to massage her abdominal region along the flow of bowels. But on the other hand, when postoperative patient who has a wound in her abdominal region claims same thing, the nursing activities are totally different. In this situation, the nurse has to give painkiller, change the posture of the patient to half-sitting position, fix the bally belt and massage the abdominal region for the direction of the wound.

Figure 2 represents our new framework of the learning system. The learner is located left side and the system is right side. The system can show the learning materials to achieve the nursing objectives according to the information of patient's symptoms, nursing objectives and so on input by the learner.

For instance, when the learner inputs the information that the patient's symptom is constipation and the nursing objective is to ease the symptom in learning mode 1 (problem-solving learning mode), then the system shows learning materials of massage methods. On the other hand, when the learner inputs the information that the "postoperative" patient claims same symptom, then the system shows different learning materials based on the series of nursing activities; ones of posture change methods, bally belt fix methods, massage methods and so on.

The key to realize this function is nursing task ontology [3]. It systemizes concepts appeared in the nursing task in a machine understandable manner. It consists of three kinds of ontologies, that is, nursing situation ontology, nursing objective ontology and nursing activity ontology.

Nursing situation ontology systemizes the concepts related to the environment in which nursing activities are preformed and that characterizes the situations of a patient. For example, operating room, private room, shared room, preoperative, postoperative, diabetes and so on are organized.

Nursing activity ontology does the concepts related to the nursing activity that are performed by a nurse. For example, medical examinations by interview, examination by touch, endodermic injection, hypodermic injection and so on and their respective effects are defined.

Nursing objective ontology does the concepts related to nursing objectives. For example, relieve the pain, make the patient relax by removing the mental uneasiness and so on are organized.

Nursing objective ontology plays a role of combining the nursing situation ontology and nursing activity ontology, thereby the system can understand the rational relations among the situations around the patient, nursing objectives and adequate nursing activities.

Nursing task flows are modeled and the appropriate tags are attached to learning materials based on these ontologies. Consequently, the system can show the adequate learning materials based on the understanding of the nursing task flow (nursing contexts) through the interaction with the learner.

4 Concluding Remarks

In this paper, we showed an evaluation result of our framework and overview of our new framework. Now, we focus on building the framework that can capture the situation around the patients for the practical use in clinical training. Thus we assume the learners who use the system have fundamental knowledge. But we need to clarify the concepts needed for capturing the learners' understanding states when we try to make the system useful for the novice learners. We want to build such sophisticated functions by building instruction task ontologies and integration mechanism of nursing task ontologies and instruction task ontologies as a future work.

We have been re-constructing existing learning materials as a first step, however, we can adopt the framework for the WWW resources since the framework is quite general one.

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