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Supporting the creation of sequence of events in nursing education

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***Abstract*—**The goal of this research was to develop a Sequence of Events Creation Support System for nursing students. We first conducted a student attitude survey on Sequence of Events to identify points that the students felt were difficult. The three main problem areas were 1) thinking about correlations, 2) drawing diagrams, and 3) collecting references. We therefore designed the system that would help students overcome these difficulties. The system, which makes use of Microsoft Excel VBA, enables students to easily draw, review, and revise Sequence of Events. We examined Sequence of Events created using the Sequence of Events Creation Support System and created by hand to determine the differences in the content of the Sequence of Events created and in the creation process. Experimental results demonstrated the effectiveness of the system. Next, we conducted lectures and exercises using the system in two 1st year courses at a nursing college and we conducted a questionnaire survey to evaluate the effectiveness of the system. Based on the results of this evaluation, we confirmed that the opinions obtained were for the most part positive.

***Keywords*—**Nursing education, Learning support system, Sequence of events, Instructional design, Educational evaluation

I. Introduction

THE drawing of a diagram like a concept map [1] or mind maps [2], it is called a Sequence of Events in the area of nursing science, is one of the integral activities in the nursing education [3][4]. In the context of nursing education, Sugisaki stated that the learning effects from having students create Sequence of Events are useful in understanding patients and in the nursing process as a whole, and pointed out various advantages to this learning approach, including its potential to foster critical thinking skills in the students [5]. It has also been pointed out, however, that creating these diagrams is time-consuming, and that the diagram creation process itself places a burden on the students. This indicates that the creation of Sequence of Events is an advanced, complicated, and arduous activity for learners.

In terms of educational support, previous researches have focused on drawing strategies [6][7] and evaluation standards [8][9] related to drawing Sequence of Events in nursing education. These could be seen as an approach to supporting students' activities by clarifying the standards for creating and evaluating Sequence of Events.

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In the current research, we have adopted another approach of supporting the creation of Sequence of Events by reducing the physical burden on the students that results from actually drawing the diagram. For example, in most nursing education scenarios, the students generally create the Sequence of Events by hand, without using a computer. Furthermore, it is not enough to complete the Sequence of Events once; it is generally necessary to redraw the diagram several times, based on corrections by the instructor. The goal of this research was to develop a Sequence of Events Creation Support System to reduce the burden on the students resulting from drawing and redrawing the diagrams, and to evaluate the effectiveness of this system by introducing it into nursing classes.

II. Nursing Student Attitude Survey on Sequence of Events

We first conducted a student attitude survey on Sequence of Events in nursing education. The purpose of this survey was to clarify how students feel about Sequence of Events and to grasp their difficulties in doing so.

A. Participants

A total of 51 third-year students from Aichi Kiwami College of Nursing participated.

B. Method

The participants responded to questions in a paper survey. Question 1: Is drawing a Sequence of Events helpful (useful)? Question 2: Is drawing a Sequence of Events onerous (difficult)? The questions were composed of two parts. In the first part, participants evaluated whether drawing Sequence of Events is "useful" and "difficult" according to five stages: I think so, I rather think so, I can't say either way, I don't really think so, and I don't think so. In the second part, they explained the reasons for their responses in the five stage evaluation.

C. Usefulness of Sequence of Events

The average value for the five stage evaluation was 3.73 (I think so (5 participants), I rather think so (29), I can't say either way (15), I don't really think so (2), and I don't think so (0)). Thus nearly 70% of the students felt that a Sequence of Events is useful.

In the free response part, participants gave a total of 55 reasons why they felt the Sequence of Events is a good thing. We used the KJ method to divide the free responses into four categories. (The figures in parentheses indicate the number of

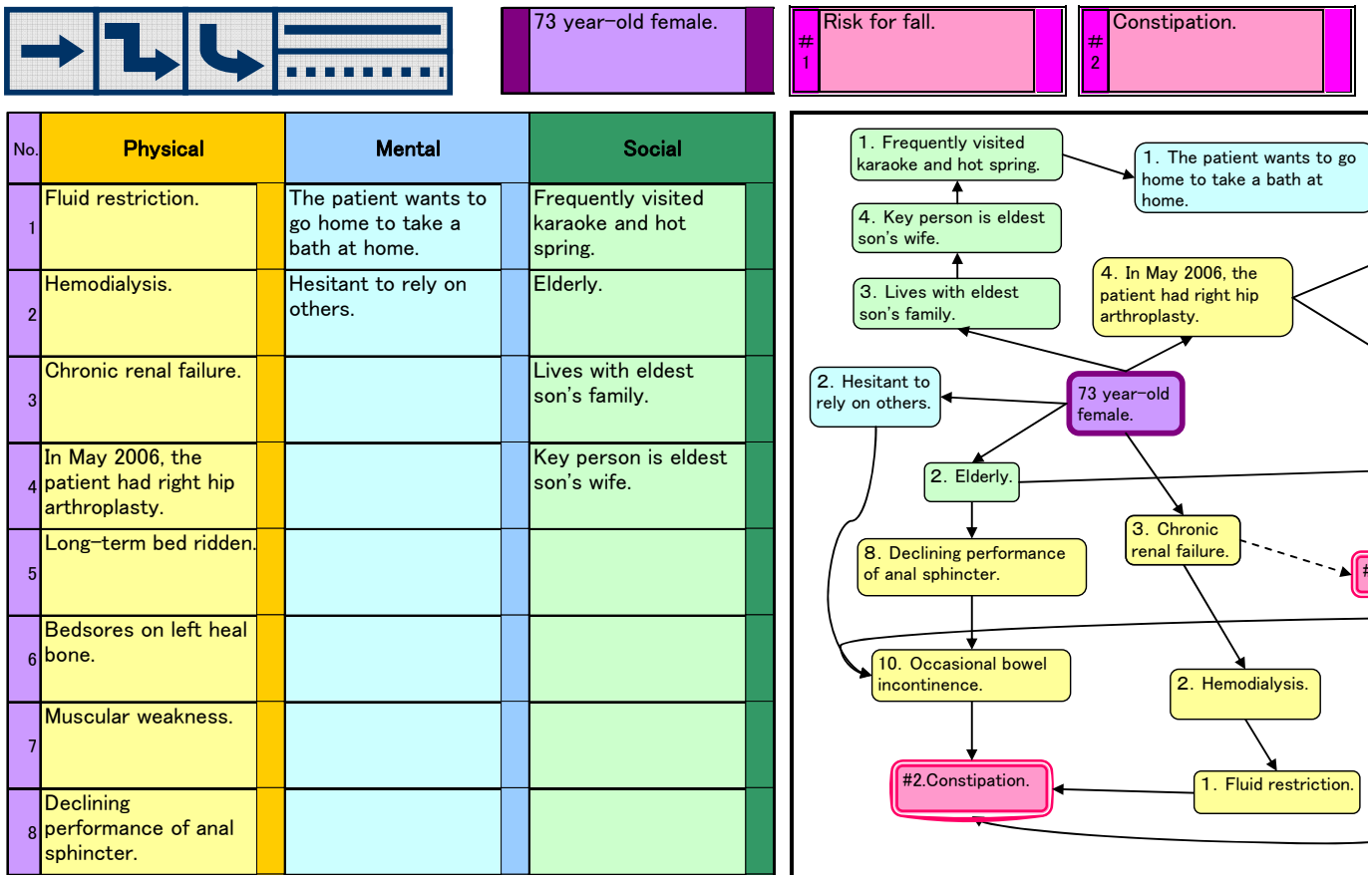

Fig.1 The Sequence of Events Creation Support System.

participants.)

- Understanding correlations (17)
- Grasping the patient's total situation (15)
- Identifying patient problems and pathology (13)
- Arranging information (10)

D. Difficulty of Sequence of Events

The average value for the five stage evaluation was 3.82 (I think so (12 participants), I rather think so (23), I can't say either way (11), I don't really think so (4), and I don't think so (1)). Thus nearly 70% of the students felt that a Sequence of Events is difficult to draw.

In the free response part, participants gave a total of 63 reasons why they felt the Sequence of Events is difficult to draw. The free responses were divided into six categories according to the KJ method.

- Understanding correlations (17)
- Arranging and revising diagrams (13)
- Time-consuming (10)
- Examining reference materials (8)
- Establishing the work flow (6)
- Understanding patient pathology and conditions (5)

E. Discussion

According to the survey, many students are well-aware of how useful it is to draw Sequence of Events. On the other hand, they also feel that it is a very difficult and complex task. Sugisaki points out that the usefulness of Sequence of Events depends on three factors: enhancing nursing capability, understanding the patient's background, and expanding the ability to think [3]. Our survey also shows that students recognize the usefulness of Sequence of Events, especially in arranging relevant patient information and in gaining a deeper understanding of related problems and the patient's total condition.

The survey results also indicate that many students feel that drawing Sequence of Events is difficult. Specifically, students have trouble with examining correlations, arranging correlations into a diagram, making revisions, and searching for appropriate reference materials. Because of these difficulties, students do not have enough time to draw Sequence of Events.

Based on the responses from this survey, we set about to design a student support system. Our aim was to develop a system that supports three specific activities: 1) thinking about correlations, 2) drawing Sequence of Events, and 3) collecting reference materials.

III. Development of the Sequence of Events Creation Support System

Based on the results of the attitude survey, we designed a Sequence of Events Creation Support System for nursing students. This section provides an overview of the system.

The system (Fig. 1), which is based on Microsoft Excel VBA, was developed for the purpose of alleviating the difficulty of

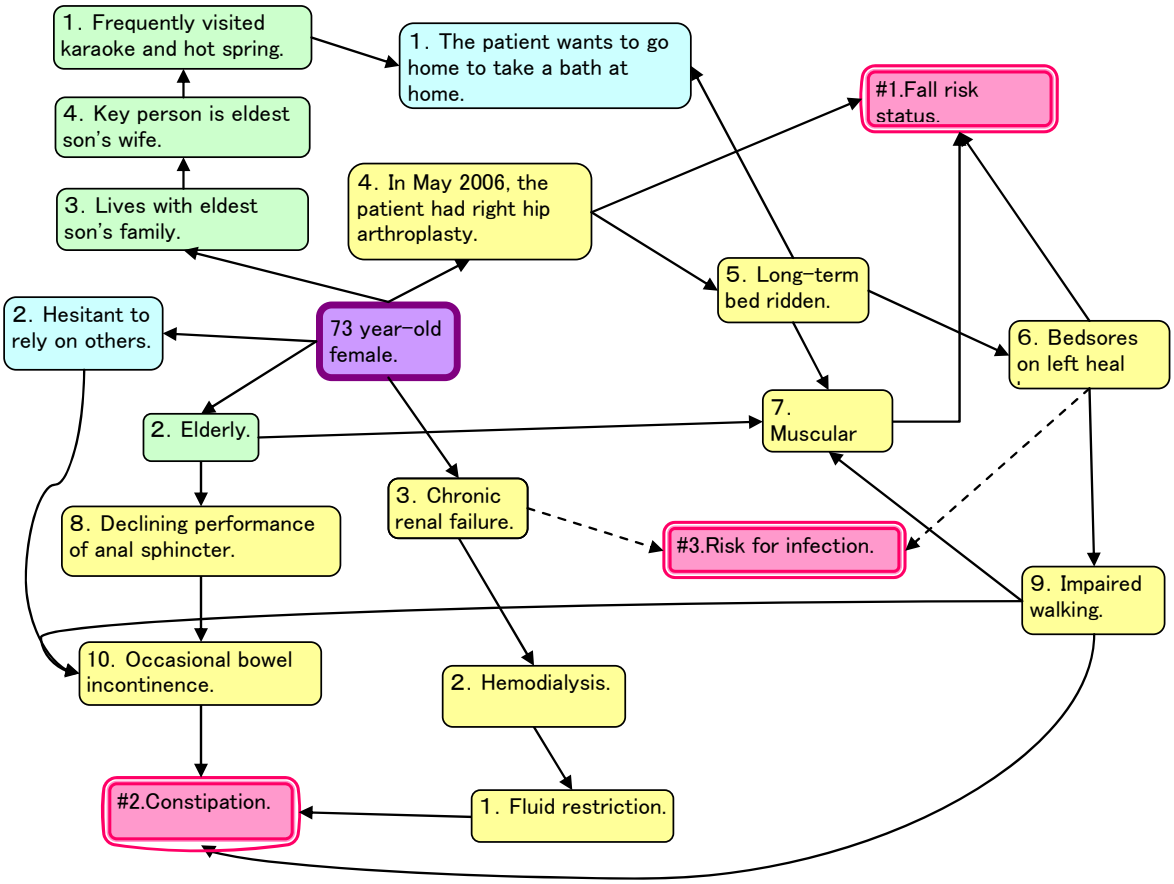

Fig.2 The sample of sequence of events created with the Sequence of Events Creation Support System.

drawing Sequence of Events. Using the system involves the following steps.

A. *Preparing Information List*

The first step is to prepare an information list. The student fills in basic information about the patient, covering several categories (e.g. physical, mental, and social characteristics). It is also possible to enter other nursing-related matters at this time.

B. *Arranging Nodes*

There is a node creation button beside each item list column that when pressed records the content of the respective item and creates a node. The student can arrange nodes freely. By pressing the line type button, it is possible to switch the node line between solid and dotted.

C. *Connecting Links*

Pressing the link creation button creates an arrow connection between two nodes. There are three types of links: straight line, curved line, and hooked line. Similar to a node, by pressing the line type button, it is possible to switch the link line between solid and dotted.

Fig. 2 shows a sample of Sequence of Events created with the Sequence of Events Creation Support System.

IV. Evaluation of the Sequence of Events Creation Support System

We will examine Sequence of Events created using the Sequence of Events Creation Support System and created by hand, to determine the differences in the content of the Sequence of Events created and in the creation process.

A. *Participants*

The participants were eight nurses who had graduated from a nursing college less than two years before.

B. *Method*

The experiment was a within-subjects design with one factor and two levels. Each of the participants created Sequence of Events both using the Sequence of Events Creation Support System (System conditions) and drawing by hand (Hand drawing conditions). The order of execution was counterbalanced.

The task was to summarize the following information for cerebral infarction patients in Sequence of Events, based on forms that contained the information in question: Patient's name, name of diagnosis, medical history, history of the present illness, physical observations when first taking charge of the patient, current status, lifestyle before hospitalization, and status of everyday life (Fig.3). In this experiment, we created two similar tasks assuming two cerebral infarction patients who

Name: Ms. K
Age: 76
Gender: Female

Name of diagnosis: Cerebral infarction
Medical history: Uterus and ovaries removed due to uterine cancer at age 48
History of the present illness: In August 2009, in the afternoon, while drinking tea and chatting with a friend at home, she suddenly complained of feeling ill, and fell over to her left. She tried to get up, but she could not, as she found it difficult to move her left hand. Ms. K was taken to a hospital by ambulance, and a head CT scan was administered. The results confirmed an infarction in a branch of the middle cerebral artery, and the patient was admitted to the hospital. Drug treatment and rehabilitation was initiated, and after three weeks, the paralysis of the left side of the body had been substantially alleviated. The patient was transferred to this hospital for rehabilitation.

Physical observations when first taking charge of the patient
Height: 153cm
Weight: 50kg
Blood pressure: 130/78mmHg
Pulse: 76 bpm (no rhythm irregularities)
Respiration: 22/min. (Regular breathing; no lung noise heard on examination)
Body temperature: 36.2°C
Sensory organs: Mild presbyopia. Uses reading glasses when reading newspapers or books. Hard of hearing.

Current status
- Before changing hospitals, fell on two occasions while walking to the bathroom. During everyday life, she could move using a cane, but tends to be shaky. She has been advised to call a nurse when she wants to go to the bathroom, but she often goes by herself.
- As a result of rehabilitation including walking with a cane, her lower body muscles have gradually recovered. She has some difficulty lifting her left lower arm, and she is sometimes unstable when she walks.
- She has a strong desire to do things on her own. She says, “I have to go home quickly and take care of my flowers. I want to be discharged soon.”
- Her daughter comes to visit every two or three days, to help take care of her (e.g., to do the laundry). The patient is considerate of her daughter’s position, saying “I feel badly because she’s very busy, and I’m inconveniencing her.”

Lifestyle before hospitalization
- Lives alone. Lives on pension and savings.
- Did shopping, housework, and other errands on her own.
- Husband died 13 years ago. Has two children; son (56) lives far away with his wife and child. Daughter (50) lives nearby, but finds it difficult to get away from home because she must take care of her mother-in-law, and her granddaughter, who was born last year.
- Before her husband became ill, they often went on trips together. Since his death, she has spent time growing flowers and vegetables in her garden.
- She gets along well with her neighbors, and enjoys drinking tea and chatting with her friends. She has a quiet character, however, and finds it difficult to actively speak to others.

Fig.3 Experimental task.

were close in age but different genders.

The students used the system to first create a list summarizing information related to the patients. Next, the students create nodes by pressing the node creation button located next to the list, and position the node on the drawing area. Then, they create links between any two nodes by pressing the link creation button. The nodes and links created can be moved freely.

In the experiment, the participants were first given an explanation of how to use the system, and were given a practice task. After that, they were instructed to do Task 1 using either System or Hand drawing conditions. Then, they were instructed to do Task 2 using the other conditions. In the case of the Hand drawing conditions, the participants created Sequence of Events using forms on which the System Screen was printed. At this time, the participants we free to use the lists in any way they wished.

Table.1 Experimental Results.

Condition	Participants	The number of items entered in the lists	The number of information nodes	The number of prediction nodes	The number of link	The number of times nodes and links were changed	The number of times nodes and links were moved
Hand drawing	A	15	12	5	21	13	5
	B	24	19	2	23	6	5
	C	27	24	9	40	9	8
	D	11	11	9	20	4	6
	E	22	19	13	35	7	4
	F	18	17	3	26	8	10
	G	7	7	5	14	5	5
	H	15	15	3	22	6	3
Average		17.4	15.5	6.1	25.1	7.3	5.8
System	A	-	19	4	31	12	3
	B	-	24	4	31	7	2
	C	-	24	14	53	9	1
	D	-	9	14	24	3	1
	E	-	20	6	29	7	2
	F	-	23	5	34	6	3
	G	-	16	7	23	5	1
	H	-	19	7	33	10	1
Average		-	19.3	7.6	32.3	7.4	1.8

C. Results

The results of an analysis of the differences between the two conditions in the Sequence of Events created and the creation process brought to light the following characteristics (Table.1). In this experiment, we used the Wilcoxon signed-rank test to test the results.

1) Number of nodes

We categorized the nodes created into information nodes (recording information listed on the task form) and prediction nodes (recording predictions not listed on the task form), and compared these two categories. The results showed that there were more information nodes for the Hand drawing conditions ($p<.05$). There was no significant difference in the number of prediction nodes (n.s.).

2) Number of links

When we compared the number of links created, we confirmed that there were more links for the Hand drawing conditions ($p<.05$), although there was no significant difference in the number of links for each node (n.s.).

3) Number of nodes and links revised

We compared the number of times nodes and links were revised during the diagram creation process. Based on the results, we confirmed that more nodes and links were moved under the System conditions ($p<.05$). Meanwhile, there was no significant difference in the number of times nodes and links were changed (n.s.).

D. Discussion

Based on the results of this experiment, we confirmed that Sequence of Events created under System conditions had fewer information nodes than those created under Hand drawing conditions.

Regarding this point, when we observed the subjects' creation process, we confirmed that many subjects created nodes while selecting information from the information entered in the list. (Note: There was no significant difference in the number of nodes for Hand drawing conditions vs. the number of items entered in the lists for System conditions.) This suggests that when the subjects were using the System, they selected information in accordance with the level of importance.

In the creation process, nodes and links were repositioned more often under the System conditions. This was predicted as an advantage of using the system, and indicates that using system alleviates the burden on the students resulting from revising the Diagrams by hand. These results demonstrate the effectiveness of the Sequence of Events Creation Support System.

V. Introducing the System into Classes

A. Class Design

In this research, we conducted lectures and exercises using the Sequence of Events Creation Support System in two 1st

Table.2 Effectiveness of the Sequence of Events Creation Support System.

Question		Strongly agree 4	3	2	Strongly disagree 1	Average
Time to create the diagrams	It doesn't take time.	17	32	17	2	2.9
Drawing the diagrams	It is possible to draw diagrams easily.	26	31	7	4	3.2
	It is possible to draw diagrams neatly.	34	26	6	2	3.4
	It is possible to draw diagrams in detail.	23	23	18	4	3.0
Redrawing the diagrams	It is easy to erase nodes or links.	15	40	11	2	3.0
	It is easy to revise diagrams.	35	25	5	3	3.4
	It is easy to rearrange nodes or links.	35	22	10	1	3.3
Thinking of the associations	It is useful to classify information by kinds of color or line.	33	27	8	0	3.4
	It is easy to organize information.	30	27	11	0	3.3
	It is easy to think of associations.	27	33	6	2	3.3

year courses at a nursing college: "Information Literacy," and "Basic Nursing Skills."

When creating Sequence of Events, specialized knowledge of nursing is required to think about the associations. In addition, the students need to have skills in the operation of Microsoft Excel in order to use this system. In this research, we therefore designed the classes to provide incremental support in the acquisition of these skills.

Specifically, in Information Literacy, we used two class periods (each period lasting 90 minutes) to first provide an introduction, by (1) explaining basic knowledge regarding Sequence of Events, and (2) providing a basic explanation of how the system is used. Then, having selected themes that do not require much specialized knowledge of nursing, we had the students (3) create Sequence of Events based on data from interviews among the students, and (4) create Sequence of Events for two themes based on the life story of Florence Nightingale.

Next, in Basic Nursing Skills, we used eight class periods in the unit "Nursing skills for a variety of circumstances," and had the students create Sequence of Events related to case studies on paper (pathologies and symptoms accompanying cerebral infarctions; physical changes resulting from aging; and effects of these symptoms on daily lifestyles). For these themes, we distributed basic items related to pathologies to the students in the form of templates to provide support in the acquisition of specialized knowledge related to nursing. The students completed the Sequence of Events by adding information to the templates.

B. System Evaluation Method

After the end of the classes, we conducted a questionnaire survey to evaluate the effectiveness of the Sequence of Events Creation Support System. The survey comprised three questions: (1) Do you want to use this system? (2) Effectiveness of the system, and (3) Problems with the system.

Out of 71 first-year nursing college students who took both of the courses described in section 3.1, 68 (those who responded to the survey) were included as subjects for the analysis.

C. Do you want to use this system?

The students used a four-point scale to respond to the question "When creating Sequence of Events, would you rather use this system or draw the diagrams by hand?"

Out of 68 respondents, 32 answered "4" (47.1%) and 25 answered "3" (36.8%). A total of 11 students answered that they would prefer to draw the diagrams by hand (five answered "2" (7.4%), and six answered "1" (8.8%)). We thus confirmed that more than 80% of the students surveyed responded positively to the use of this system.

D. Effectiveness of the system

In order to evaluate the effectiveness of the system, we created ten items related to factors recognized in the previous survey as "difficult" in the creation of Sequence of Events: "Time to create the diagrams (1item)," "Drawing the diagrams (3 items)," "Redrawing the diagrams (3 items)," and "Thinking of the associations (3 items)"(Table2). The students responded to each item using a four-point scale where 4 means "Strongly agree" and 1 means "Strongly disagree."

The average score for all items other than "It doesn't take time." was three or more. This suggests that the use of this system alleviates, to some degree, the various difficulties accompanying the creation of Sequence of Events.

E. System Usability

We evaluated the usability of the system using SUS (System Usability Scale)[10]. Table 3 shows the usability of the Sequence of Events Creation Support System. The SUS consists of 10 questions, each of which is responded to on a scale of 1 to 5 (and where half of these are "reverse" items (No. 2, 4, 6, 8, 10), to be scored as "5" = 1, "4" =2, and so on).

The average score of 6 items (No. 1, 3, 5, 6, 7, 8) was three or more. However, the average score of other 4 items (No. 2, 4, 9, 10) was less than three. This result suggests the necessity of the improvement of the system usability.

Table.3 Usability of the Sequence of Events Creation Support System.

Question	Strongly agree 5	4	3	2	Strongly disagree 1	Score
1. I think that I would like to use this system frequently.	9	26	26	5	2	3.5
2. I found the system unnecessarily complex.	10	18	24	12	4	2.7
3. I thought the system was easy to use.	5	19	28	15	1	3.2
4. I think that I would need the support of a technical person to be able to use this system.	9	25	24	9	1	2.5
5. I found the various functions in this system were well integrated.	10	29	25	2	2	3.6
6. I thought there was too much inconsistency in this system.	2	5	43	15	3	3.2
7. I would imagine that most people would learn to use this system very quickly.	9	3	25	3	1	3.6
8. I found the system very cumbersome to use.	2	6	40	14	6	3.2
9. I felt very confident using the system.	2	5	37	19	5	2.7
10. I needed to learn a lot of things before I could get going with this system.	6	20	31	9	2	2.7

F. Problems with the system

The students' responses were divided into three categories: Input, Display, and Links.

Regarding "Input," the students pointed out difficulties related to Kanji conversion and keyboard input, which are not so much problems with the system itself as they are with the system implementation method (e.g., confirming information processing skills).

There were few problems regarding "Displays," but those that the students pointed out referred to the types and colors of nodes and links, the scope of the drawing, and the size of the nodes and text.

Regarding "Links," 13 of the students (about 19% of the total) pointed out the difficulty of drawing links.

VI. General Discussion

A. Effectiveness of the system

The responses obtained from the students in the survey indicated that using the system to create Sequence of Events alleviated the burden of drawing and redrawing the diagrams. The main reason given for this result was that compared to creating Sequence of Events by hand, the system made it easier to input text and to position, move, and delete nodes.

We also received a positive response with regard to "Thinking of the associations," which is the main purpose of creating Sequence of Events. Based on our observations, it appears that two elements of the system's operations – (1) inputting information into the item list and (2) Sorting items into color-coded categories – help the students to think about associations.

In typical nursing education scenarios, the students are not often required to create item lists or sort items into color-coded categories when creating Sequence of Events. With this system, the students begin by inputting information and inferences drawn from that information. We can assume that this information acts as the first step in the students' awareness of associations. Positioning this information on the diagram with an awareness of categories can also be thought to promote a further awareness of associations throughout the diagram as a whole.

B. Approaches to introducing the system into classes

When introducing the Sequence of Events Creation Support System into classes, in this research, we provided the students with incremental support across two courses.

Creating Sequence of Events requires specialized knowledge of nursing, and understanding associations is a complicated and advanced activity for students. First year students in particular, most of whom have never studied nursing before, still do not have sufficient specialized knowledge of factors such as pathologies and the structure and functions of the human body, so understanding associations from a nursing perspective places an extremely heavy burden on these students.

For this reason, in the initial "Information Literacy" course, we selected themes that did not require much specialized knowledge of nursing, in order to provide training in "Representing information in a diagram." Later, in the "Basic Nursing Skills" course, we worked on "Thinking about associations" based on a nursing perspective.

Regarding the Sequence of Events created in Basic Nursing

Skills, we first had the instructors create a template containing basic information and associations, and distributed these templates to the students. This was the first time for many of these students to attempt to systematically grasp information from a nursing perspective, and we believe that presenting information on pathologies and related associations in a partially completed format helped to promote the students' understanding.

VII. Conclusion

In this research, we developed a system for supporting the creation of Sequence of Events, and evaluated the effectiveness of the system by introducing it into nursing education classes. Based on the results of this evaluation, we confirmed that the opinions obtained were for the most part positive, but that a number of issues still remain.

The area that is most in need of improvement is the function for creating links. In this evaluation, the respondents pointed out problems related to Input, Display, and Links, but there were a particularly large number of responses regarding problems in the creation of links. In order to create diagrams in which associations are easy to see and easy to understand, it is necessary to make careful adjustments to ensure that the link paths do not overlap, but in the classes, we could see many students spending inordinate amounts of time making these adjustments. In the future, we would like to make further improvements to the system so that we can provide students with more effective support in the creation of links as well.

References

[1] J. D. Novak, Concept Mapping: A Useful Tool for Science Education, Journal of Research in Science Teaching, Vol.27, No.10, pp937-949, 1990.

[2] T. Buzan and B. Buzan, The Mind Map Book: How to Use Radiant Thinking to Maximize Your Brain's Untapped Potential. London: BBC Books, 1993.

[3] C. Akinsanya and M. Williams, Concept Mapping for Meaningful Learning, Nurse Education Today, Vol.13, No.1, pp.41-46, 2004.

[4] L. Hsu and S. Hsieh, Concept Maps as Assessment Tool in a Nursing Course. Journal of Professional Nursing, Vol.21, No.3, pp.141-149, 2005.

[5] H. Sugisaki and I. Ogawa, Learning Effects of Use of Sequence of Events in Adult Nursing Practicum (Acute Period), Bulletin of Nara Medical University School of Nursing, Vol.2, pp.1-6, 2006.

[6] A. All and R. Havens, Cognitive/Concept Mapping: A Teaching Strategy in Nursing, Journal of Advanced Nursing, Vol.25, No.6, pp.1210-1219, 1997.

[7] P. M. Schuster, Concept Mapping: A Critical Thinking Approach to Care Planning. Philadelphia: F.A.Davis, 2002.

[8] A. R. Castellino and P.M. Schuster, Evaluation of Outcomes in Nursing Students Using Clinical Concept Map Care Plan, Nurse Educator, Vol.27, No.4, pp.149-150, 2002.

[9] Y. Toyoshima, F. Itou, Y. Hagi, Y. Nishibori, T. Kazaoka, S. Kishita, and S. Itou, Evaluation of Student Learning about the Nursing Process Using Written Simulation in Adult Nursing Course (Part 3): Analysis of Student Self-evaluation in Learning with Sequence of Events, Bulletin of Department of Nursing Seirei Christopher College, Vol. 13, pp81-90, 2005.

[10] J. Brooke, SUS: A "Quick and Dirty" Usability Scale, in *Usability Evaluation in Industry*, P. W. Jordan, B. Thomas, B. A. Weerdmeester, and A. L. McClelland, Eds. London: Taylor and Francis, 1996.