IIAI Open Conference Publication Series
IIAI Letters on Informatics and Interdisciplinary Research
Vol.006, LIIR437
DOI: https://doi.org/10.52731/liir.v006.437

Development and Evaluation of a Digital Concept Mapping System for Nursing Process Learning Support
－ An Assessment Based on Nursing Students' User Experience －

Sakiko Sumai [*], Norio Ishii [†],
Yuri Suzuki [‡], Hiroaki Sawano [§]

Abstract

This study aimed to develop and evaluate the utility of a digital concept mapping system (AKa Tool) designed to support learning in the nursing process. The system was tested by 215 nursing university students during nursing process lectures, and a questionnaire survey was conducted regarding their user experience and the system's utility. An analysis of the responses from 69 students (response rate: 32.1%) revealed that 41.8% evaluated the system's usability positively, whereas 36.4% evaluated it negatively. Computer skills and system user experience were found to be significantly associated, as well as system usability and its application during the lectures ($p<0.01$). Free-text responses regarding the desired improvements were categorized into seven groups: [Printing Issues], [Copy Function], [UI/Display], [Operability], [Shapes and Arrows], [System Stability and Performance], and [Other]. The results suggest that the system exhibits a degree of utility in nursing process learning, although further improvements are needed to enhance its usability.

Keywords: digital concept mapping, nursing process, nursing informatics, usability evaluation.

1. Introduction

The role of nurses is to accurately assess patients' conditions and provide care that improves, maintains, and promotes patient health. To accomplish this, nurses must develop the ability to understand and implement each phase of the nursing process (assessment, nursing diagnosis, planning, implementation, and evaluation) in order to deliver individualized evidence-based practice. This enables high-quality nursing care that is tailored to each patient's needs ［1］.

Concept maps are widely used in nursing process education to organize patient information and identify problems related to nursing provision. Concept maps are schematic diagrams that visually represent relationships between a patient's basic information (age, disease name, etc.), medical conditions and causes, treatment and the patient's lifestyle, family and social background, and psychological conditions. Traditionally, these have been created manually.

[*] Shubun University, Aichi, Japan
[†] Ichinomiya Kenshin College, Aichi, Japan
[‡] Chubu University, Aichi, Japan
[§] Aichi Institute of Technology , Aichi, Japan

However, this can lead to decreased visibility as complexity and line intersections increase with the amount of information. Additionally, modifications and updates require considerable effort, potentially compromising their primary function as tools for organizing thoughts. In recent years, digital tools have been developed to support concept map creation in nursing education. Notably, CmapTools ［2］(Cañas & Novak, 2005) is a widely used free concept mapping software in education that has also been utilized in nursing education［3］(Mammen, 2016). CmapTools, developed at the Institute for Human and Machine Cognition (IHMC) at the University of Florida, provides features for collaborative concept map creation and knowledge sharing. However, existing tools are designed for general purposes and have limited functionality specifically tailored to the characteristics of the nursing process and the learning needs of nursing students.

To address these challenges, our research group has developed a digital concept mapping system (Associate Kango Tool: hereinafter referred to as AKa Tool) (Akutsu et al., 2016) ［4］and has continued to make improvements. In this study, the utility of this digital concept mapping system was examined by testing nursing students during nursing process lectures and surveying their user experience and utilization patterns.

2 Research Objectives

This study aimed to develop a digital system for creating concept maps in the nursing process and evaluate their user experience and utility by nursing students. Specifically, we sought to verify the effectiveness of the digital concept mapping system in terms of efficient information organization and modification, improved visibility, and clarification of thought processes.

3 Research Methods

3.1 Target

In total, 215 university nursing students participated in the testing of the digital concept mapping system (hereafter referred to as the AKa Tool) during lectures.

3.2 Method

(1) System overview

Concept map creation tool: AKa Tool[4].

AKa Tool is realized by a web application that does not depend on the OS. The system development environment is HTML5, JavaScript, jQuery Ver. 1.11.1, and system improvements have been continued from 2014 to the present day. The main functions include (1)input and editing of patient information using text boxes, (2)free placement of information by drag and drop, (3)visualization of relationships between information with arrows and lines, (4) place adjustment function to minimize line overlap and intersection,(5)data saving and sharing, and (6) printing function.

Furthermore, to fundamentally address the challenges of traditional hand-drawn concept maps (Figure 1), AKa Tool (Figure 2) features an innovative design that makes adding,

modifying, and deleting patient information on web pages extremely easy, significantly reducing visibility degradation and information reading difficulties caused by line intersections that frequently occur in hand-drawn maps. It also enables the creation of large-scale and complex concept maps that would be physically constrained and difficult to produce by hand, functioning as a next-generation educational tool that effectively supports the visualization of logical thinking and systematic information organization in the nursing process.

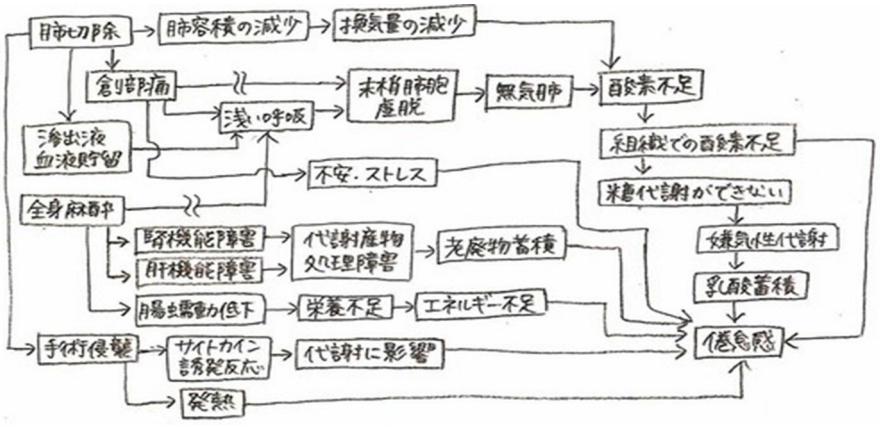

Figure 1: Hand-drawn concept map

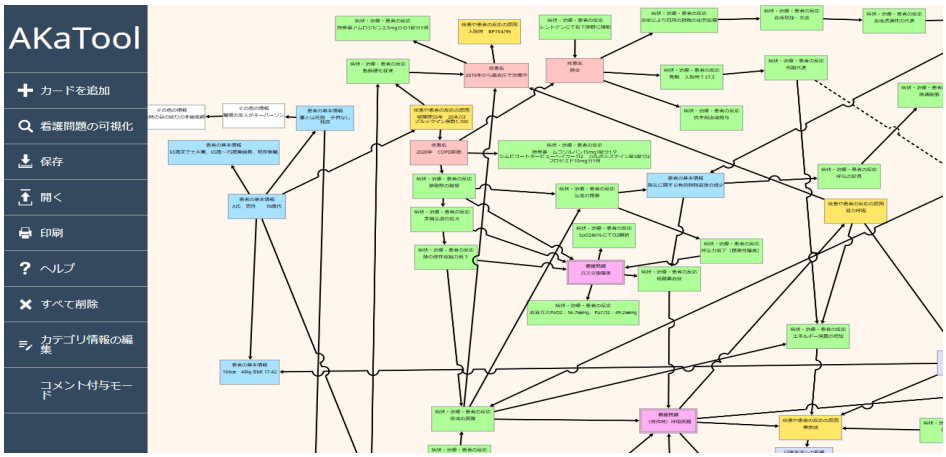

Figure 2: Digital concept mapping system

(2) Data collection methods

(i) After allowing students to practice sufficiently until they could use the system adequately without a manual, participants were asked to rate Aka Tool's "usability" on a 5-point scale (1: difficult to use - 5: easy to use) and "utilization status" on a 4-point scale (1: did not utilize at all - 4: utilized very much).

(ii) For the self-assessment of digital literacy, participants were asked to evaluate their “computer skills” (multiple responses allowed) and “level of confidence” (5-point scale).

Free-text responses were solicited regarding potential improvements.

(3) Analysis method

The survey results were tabulated, and free-text responses to the AKa Tool were qualitatively analyzed and categorized. The relationship between computer skills and AKa Tool usage was analyzed using a Chi-squared test. Statistical analyses were performed using SPSS Statistics (version 250; IBM) at a significance level of 5%.

4 Ethical Considerations

This study was approved by the Research Ethics Committee of Shubun University (approval number: 2023SR003). The participants were provided with written and verbal explanations of the study's purpose and methods, voluntary participation, anonymity, and no impact on their academic evaluation; all participants provided informed consent.

5 Results

Responses were received from 69 of the 215 students (response rate: 32.1%) included in the analysis.

(1) Differences in user experience by computer skill level

Regarding computer skills, over 90% of participants indicated they could "input text in Word or Excel." Conversely, less than 10% reported skills in "attaching files to emails or using CC/BCC functions," and less than 50% reported using "online meeting systems." Regarding confidence in computer skills, the most common response was "average" (40.6%), followed by "somewhat unconfident" (34.8%).

(2) Evaluation of AKa Tool usability (Figure 3)

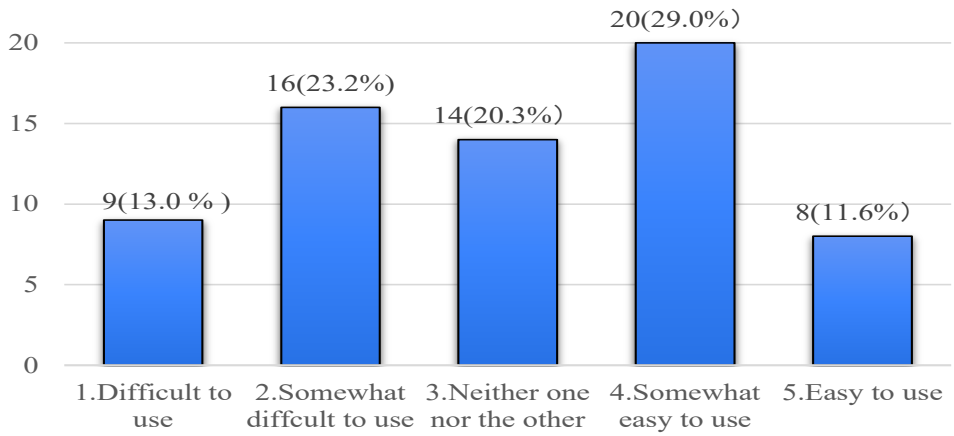

Figure 3: AKa Tool Usability

"easy to use" group (responses of "4" or "5") comprised 28 students (41.8%), indicating slightly more positive evaluations.

(3) Relationship between computer skills and AKa Tool usability

Cross-tabulation of computer skills and AKa Tool usability (Table 1) showed that seven students who rated their computer skills as "average" evaluated AKa Tool as "somewhat easy to use." Additionally, among students who rated their computer skills as "somewhat unconfident," six evaluated AKa Tool as "somewhat difficult to use" and six as "somewhat easy to use."

Table 1: Computer Skills and AKa Tool Usability (n=69)

		1.Difficult to use	2.Somewhat difficult to use	3. Neither	4.Somewhat easy to use	5.Easy to use	Total
Computer Skills	1.Not confident at all	0	3	1	3	0	7
	2.Somewhat unconfident	4	6	4	6	3	23
	3.Average	5	5	9	7	2	28
	4.Somewhat confident	0	2	0	4	1	7
	5.Very confident	0	0	0	0	2	2
	Total	9	16	14	20	8	67

(4) Relationship between AKa Tool usability and utilization during clinical practice

Table 2 shows the results of the Chi-square tests examining the relationship between the usability and utilization of the AKa Tool during the clinical practicum. Students who evaluated AKa Tool as "somewhat easy to use" had the highest rate of "utilized" during practicum, while those who evaluated it as "somewhat difficult to use" had a high rate of "did not utilize at all" ($p<0.01$).

Table 2: AKa Tool Usability and Utilization During Clinical Practicum (n=69)

		1. Did not utilize at all	2.Somewhat did not utilize	3.Utilized	4.Very utilized	Total	P value
Usability	1. Difficult to use	4(0.8)	5(2.1)	0(-2.3)	0(-0.8)	9	<0.00
	2.Somewhat difficult to use	8(1.7)	6(1.1)	2(-2.1)	0(-1.2)	16	<0.00
	3.Neither	6(0.9)	3(-0.5)	5(0.1)	0(-1.1)	14	<0.00
	4.Somewhat easy to use	4(-1.5)	3(-1.4)	12(2.9)	1(-0.2)	20	<0.00
	5.Easy to use	0(-2.1)	1(-1.0)	4(1.0)	3(4.0)	8	<0.00
	Total	22	18	23	4	67	

( ) indicates adjusted residuals, p<0.01

The chi-square test results indicated a statistically significant relationship between the two variables ($p<0.01$). Residual analysis revealed that students who evaluated Aka Tool as "easy to use" had a significantly higher proportion of "utilized very much" responses than expected (adjusted residual=4.0, $p<0.01$), and students who evaluated it as "somewhat easy to use" had a significantly higher proportion of "utilized" responses than expected (adjusted residual=2.9, $p<0.01$). Conversely, students who evaluated it as "difficult to use" had a significantly higher proportion of "somewhat did not utilize" responses than expected (adjusted residual=2.1, $p<0.01$).

3) Improvement requests

Free-text responses regarding improvement requests yielded 38 codes. Qualitative analysis and classification based on similarity resulted in seven categories: [Printing Issues] (11 codes), [Copy Function] (five codes), [UI/Display] (seven codes), [Operability] (five codes), [Shapes and Arrows] (six codes), [System Stability and Performance] (two codes), and [Other] (two codes).

Major improvement requests included “misalignment of shapes when printing,” “difficulty with copy function,” “addition of right-angle arrow function,” and “improvement of screen zoom operations.”

6 Discussion

(1) Utility of the digital concept mapping system

The results of this study revealed that 41.8% of students evaluated AKa Tool’s usability positively, while 36.4% evaluated it negatively. These findings suggest that the digital concept mapping system may offer certain conveniences compared with traditional hand-drawing methods. However, there was also significant room for improvement.

A particularly noteworthy point is the significant relationship observed between system usability and utilization during the lectures. In addition it can be said that the more students perceive the system as easy to use, the higher their actual utilization tends to be. This demonstrates that usability directly affects actual usage frequency, underscoring the importance of system improvements [6].

(2) Relationship between computer skills and system user experience

Analysis of the relationship between computer skills and system user experience showed that students who self-evaluated their computer skills as “average” or higher tended to find the system easier to use. This indicates that digital literacy influences system acceptance [7]. However, examples of students with low confidence in computer skills who nevertheless evaluated the system as “somewhat easy to use” suggest that intuitive and easily learnable interface design may overcome differences in digital literacy.

(3) Implications for system improvement

Improvement requests from free-text responses were categorized into seven groups: [Printing Issues], [Copy Function], [UI/Display], [Operability], [Shapes and Arrows], [System Stability and Performance], and [Other]. The requests related to printing functionality were the

most numerous, indicating that maintaining the layout during printing is critical for practical applications. Additionally, features such as right-angle arrows and flexible placement are required to improve visibility.

These improvement requests represent important elements to consider in the design of digital tools for nursing education and indicate directions for system enhancements to more effectively support nursing students' learning processes.

7 Conclusion

This study developed and evaluated a digital concept mapping system, AKa Tool, whose objective was to support nursing learning. The result of surveys completed by nursing students indicated that the system exhibited a degree of utility in the nursing process. However, the findings also highlight the need for further improvements to enhance system usability. In particular, there is a need to improve printing functionality, enhance operability, and increase the flexibility of visual representations. Moving forward, we aim to refine the system based on these findings and contribute to developing effective digital learning support tools for nursing education.

This work was supported by JSPS KAKENHI Grant Number JP21K10590.

Reference

[1] V. Henderson (Translated by M. Yumaki, K. Kodama): The Basic Principles of Nursing, Latest Edition, Japan, Japanese Nursing Association Publishing, 2016.

[2] Cañas, A. J., & Novak, J. D：CmapTools: A Knowledge Modeling and Sharing Environ-ment. Concept Maps: Theory, Methodology, Technology. Proceedings of the First Interna-tional Conference on Concept Mapping. Pamplona, Spain: Universidad Pública de Navarra.

[3] Mammen, J. R. Computer-Assisted Concept Mapping: Visual Aids for Knowledge Con-struction. Journal of Nursing Education, 55(7), 403-406, 2016.

[4] M. Akatsu, H.Sawano, Y. Suzuki et al：A Proposal and Evaluation of AKa Tool (Associate Kango Tool):An Association Chart Production Tool for Nursing Education, Japanese Society for Information and Systems in Education Vol. 33, No. 1, pp. 31–42,2016.

[5] S. Sumai, N. Ishii, H. Sawano, Y. Suzuki, R. Miyazaki: ICT-Based Nursing Education and Clinical Practice How-to BOOK, Kinpodo, 2022.

[6] I. Suishu, M. Ono, H. Kimura et al.: Nursing Students Response to the New Electronic Record System for Their Learning Practice in the Hospital, Medical Information Science 20 (3), 243–248, 2000.

[7] R. Fu: Survey on Digital Literacy and Information Literacy of First-Year University Students, Kaichi International University Bulletin vol. 21, 169–182, 2022.