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Nursing Informatics Competency among Nurses at a Teaching Hospital in Malaysia

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ABSTRACT

Nursing informatics merges nursing science with information and analytical sciences to identify, describe, manage, and disseminate nursing data, information, knowledge, and wisdom. Identifying nurses' informatics competency will help improve information technology utilisation in clinical practice. The aim of this study was to assess basic competency in nursing informatics and related factors influencing nurses working in a university teaching hospital. Thus, a cross-sectional study was conducted. A stratified random sampling of the total population of 1,136 nurses with sample size of 316 nurses participated in this study. The data was collected using a self-reported questionnaire utilising the Nursing Informatics Competency Assessment Tool (NICAT) reaching targeted sample by convenient approach. The results of this study showed that 85% ($n = 269$) nurses were competent in nursing informatics competency. There was a significant relationship between basic nursing informatics competency and sociodemographic of age ($t = 4.194$, $p = 0.000$), gender ($t = -2.558$, $p = 0.011$), educational level ($F [2,313] = 5.094$, $p = 0.007$) and working discipline ($F [6,309] = 8.309$, $p = 0.000$). There was also a significant relationship between basic nursing informatics competency and working experience ($\rho = -0.231$, $n = 316$, $p = 0.000$). However, the study is based on self-reporting and does not measure the actual performance of nursing informatics competency. Overall, the findings indicated the need for improvement in nursing informatics by exposure or awareness for potential age group and particular clinical setting for training and educational of nursing informatics.

Keywords: *Nursing informatics competency, Computer literacy, Informatics competency, Informatics skills, Nurses*

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INTRODUCTION

Nurses are used to overcoming obstacles, incorporating new technologies into their practice to improve their performance. Technology is a unique tool for helping nurses face new issues and learn how to use its resources. It can help them remodel their approach to patient care in a variety of ways. Hospital Information System (HIS) and telemedicine have been developed to enhance efficiency, decrease medical error, increase cost effectiveness and improve patient care. In the Malaysian Plan (1996–2000), it was stated that there would be 33

paperless public hospitals in Malaysia (1). Following that, Universiti Kebangsaan Malaysia Medical Centre (UKMMC) is the first government hospital in Malaysia or Asia to develop its own Total Hospital Information System (THIS). Caring Hospital Enterprise System (C-HETs), a new information technology system is developed at UKMMC (2).

Nursing informatics is the application of information and technology to all aspects of nursing practice in order to improve patient outcomes and increase patient safety (3). It is characterised as integrating fundamental computer skills, information literacy, and information management, which are crucial and essential elements of the current nursing practice (4). A skill set known as computer literacy includes the psychomotor abilities required to use computer tools and understanding of underlying hardware and software functionality. The ability of a nurse to identify the need for information and to appropriately locate, assess, and use that information for patient care is known as informatics literacy. The ability to use data to support clinical decisions, recording and ensuring data integrity, upholding confidentiality, and using information security are all parts of the skill set known as information management (5).

Therefore, in several countries, there has been a great emphasis on ensuring that nursing practitioners have the skills necessary to utilise technology effectively and productively in their practise settings to benefit both patients and healthcare providers. Several studies have found that most nurses believe they lack basic computer skills and informatics competency. A study by Garde et al. (6) on the Australian nurses presented that 11% were novice, 17% were advanced beginner, 35% were competent and 33% were proficient, when asked about their level of competency in their primary health informatics role. On the other hand, Siti Zuhaida et al. (7) studied registered nurses' knowledge and attitudes towards electronic nursing process documentation in teaching hospitals. Although 50.8% of respondents had a low knowledge level, 89.4% had a positive attitude towards electronic documentation. The previous studies also indicated nurses over 50 years old and those who graduated before 1984 had lower computer test scores. Computer skills had the lowest mean score among informatics subscales (8). Nurses working in critical care units have much higher nursing informatics competency than other units because of the criticality of working in critical care settings. Critical patients need high-tech equipment and constant monitoring. In these units, patient safety and outcomes are more important (9). Another study also demonstrated that diploma and degree nurses have different nursing informatics competency (10).

However, previous research was limited to Iranian, Korean, Taiwanese and Egyptian nurses (11–13). It may not reflect the competencies of basic nursing informatics of nurses in Malaysia. There are few studies on assessing basic nursing informatics competencies among nurses in Malaysia, and even fewer studies on the factors influencing nurses' informatics competency which have been published. This has put a unique challenge in addressing the nursing informatics competency among nurses in Malaysia. In the digital age, nurses must be capable of using data, information, and technologies to enhance nursing care (14). To be more precise, the importance of gaining and exhibiting informatics competency makes it easier for nurses to put their specific knowledge into practice. To make the best decisions, nurses need to know how to obtain, store and apply the appropriate information at the appropriate moment. Additionally, nurses are the ones who communicate with patients the most and use technology the most. Technology used ought to foster a positive mindset and increase nurse output. In order to transform the culture of healthcare and improve the quality of care, nurses must be involved from the beginning in the design of systems. Thus, the aim of this study is to assess the basic competency in nursing informatics among nurses in one of the leading teaching hospitals in Kuala Lumpur, Malaysia and the significant factors associated with nurses' informatics competency. The findings will aid in determining which

areas of informatics require more attention in the development of improved educational programmes. Identifying the factors associated with informatics competency will also serve as a springboard for developing appropriate strategies to prepare and support nurses for informatics practice.

METHODOLOGY

Study Design

A cross-sectional study was conducted among registered nurses in a teaching hospital located in the centre of Peninsular Malaysia—Hospital Tuanku Canselor Muhriz (HCTM) in Cheras, Kuala Lumpur. The target population was from different working disciplines including medical, surgery, orthopaedic, intensive care unit (ICU), psychiatry, obstetrics and gynaecology (O&G), and operation theatre. A self-reported questionnaire Nursing Informatics Competency Assessment Tool (NICAT) was used to collect data for this study. The period of recruitment was within three weeks in May 2022.

Sample Size Estimation

Sample size is determined by adopting the Krejcie and Morgan (1970) formula using the total number of interested population. The study sample size was estimated to be 287. However, 10% attrition rate was included in the sample size to reduce missing data and potential error rate or bias. As a result, the minimum estimated sample size was 316 respondents. This study divided nurses into three categories based on their discipline and subdivided into working discipline. A stratified random sampling method was used to ensure equal representation from each group. Proportional sampling was used to ensure accuracy. Nonprobability convenient sampling was used for each nurse's sample due to the COVID-19 standard of procedure.

Eligibility and Recruitment

The respondents comprised of registered nurses, head nurse and nurse manager working in HCTM. The nurses with working experience one year and above were included whereas nurses on confinement leave, study leave, long medical leave and COVID-19 quarantine were excluded from the study. Eligible nurses were approached by each discipline ward manager to distribute the questionnaire. The distributed questionnaire was attached with the information detailing the consent, research procedure and justifications of the study.

Study Instrument

This study used self-reported questionnaires, NICAT with permission from Jouparinejad et al. and Rahman (9, 15). NICAT evaluates nursing informatics focused education and training programmes. This tool can evaluate nurses during new hire, orientation, education, and clinical informatics system implementation (9). NICAT measures nursing informatics competency in three dimensions using 30 items, including computer literacy, informatics literacy, and informatics management skills. The questionnaire has two parts. Part I is sociodemographic data and Part II is the Malay and English version of NICAT.

Part I collects sociodemographic and professional information about registered nurses in 10 items, namely age, gender, race, job position, working department, level of education, and related factors such as nursing experience (in years), HIS time (in hours per day), shift work, and HIS or computer skills training. Part II includes (A) assessing computer literacy skills with 10 questions that demonstrate psychomotor abilities for using computer tools and basic hardware and software functionality—all are necessary for effective bedside nursing. Part II (B) assesses nurses' ability to recognise, retrieve, evaluate, and use information for patient care with 13 questions. Part II (C) contains seven questions about information management skills that evaluates nurses' ability to use data to support clinical decision-making, documentation, data integrity, confidentiality and security.

The questionnaire uses a self-rated 5-point Likert scale; not competent = 1, somewhat competent = 2, competent = 3, very competent = 4, and expert = 5. The minimum score for Part II (A) is 10, while the maximum score is 50. Part II (B) scores ranging from 13 to 65, while Part II (C) has a minimum score of 7 and maximum score of 35. The total nursing competency scores are categorised as novice (≤ 30), advanced beginner (31–59), competent (60–89), proficient (90–119) and expert (120–150).

The data collection began after obtaining approval from the HCTM Research Ethics Committee and permission from the Head of Nursing Department. Due to the COVID-19 pandemic, the researcher was unable to visit the selected department due to infection risks. However, a responsible nurse manager was appointed to assist in administering questionnaire booklets. A briefing session was conducted, and weekly updates were made to ensure a smooth process of data collection. Eligible participants were informed about the study, and their participation was voluntary.

Reliability

Utilising back-to-back translation techniques, the NICAT questionnaire was translated from English to Malay for the current study circumstances. Both versions (English and Malay) were then content validated by nursing informatics expertise lecturer of the Nursing Department with over five years of experience and the head of department of the Information Technology Centre HCTM. The instruments' reliability was examined among registered nurses to ensure their comprehension and time spent. In the pilot study, a total of 32 respondents from non-clinical disciplines were recruited to complete the questionnaire reliability test and the results were excluded from the main study. Cronbach's alpha for the nursing informatics questionnaire was 0.960. The Cronbach's alpha for Part II (A) was 0.935, 0.888 for Part II (B), and 0.955 for Part II (C). The nurses demonstrated comprehension and took roughly 10 to 15 minutes to complete the entire questionnaire. The results showed that this instrument was valid and reliable for assessing fundamental nursing informatics competencies among registered nurses at HCTM.

Statistical Analysis

Data were analysed using IBM SPSS version 25. The sociodemographic characteristics of the subjects were summarised using descriptive statistics. Mean and standard deviation (SD) were used to represent numerical data, and frequency was used to represent categorical data (in percentage). Independent *t*-test was used to compare means for variable age, gender, race and attended user or HIS training. The one-way ANOVA test was used to investigate the difference between groups variables such as level of education, job position and working discipline. The working experience and time spent on HIS variable were tested using

Spearman's rank-order correlation and Mann-Whitney U test for working hours variable. *P*-value of less than 0.05 was considered as statistically significant.

RESULTS

Demographic Characteristic

The mean age for the respondents was 38.04 years (SD = 6.14) where 292 (92.4%) were female. There were 313 (99.1%) from Malay ethnicity, 270 (85.4%) were registered nurses, 248 (78.5%) were diploma in nursing holders and only 6 (1.9%) of the studied sample had a master's degree in nursing. Most nurses working shift hours were 260 (82.3%). The respondents mean for working experience was 14.92 years (SD = 6.521) where 164 (51.8%) were more than 16 years of working experience. Half of the respondents reported that they spent more than five hours in HIS which was 160 (50.6%) and average mean time spent in HIS was 4.748 hours (SD = 3.2292). It was likely that 171 (54.1%) respondents claimed that they had not attended user or HIS training before. Respondents participated in this study were from seven different working disciplines and the response rate was 100%. The demographic characteristic is detailed in Table 1.

Table 1: Sociodemographic characteristic of respondents

Variables	Frequency (n)	Percentage	Mean	SD
Age			38.04	6.14
< 40 years old	178	56.3		
> 40 years old	138	43.7		
Gender				
Female	292	92.4		
Male	24	7.6		
Race				
Indian	1	0.3		
Malay	313	99.1		
Others	2	0.6		
Level of education				
Diploma	248	78.5		
Degree	62	19.6		
Master	6	1.9		
Job position				
Registered nurse	270	85.4		
Head nurse	35	11.1		
Nurse manager	11	3.5		
Working experience			14.92	6.521
1 to 10 years	82	26.0		
11 to 20 years	166	52.6		
21 to 30 years	68	21.5		
Working place				
Surgery	52	16.5		
ICU	41	13.0		

(Continued on next page)

Table 1: (Continued)

Variables	Frequency (n)	Percentage	Mean	SD
Medical	64	20.3		
O&G	63	19.9		
Operation theatre	58	18.4		
Orthopaedic	23	7.3		
Psychiatric	15	4.7		
Working hours				
Office hour	56	17.7		
Shift	260	82.3		
Time spent on HIS attend training			4.748	3.2292
No	171	54.1		
Yes	145	45.9		

Nursing Informatics Competencies

As shown in Table 2, 85% of the nurses (n = 269) rated their overall informatics competency as competent (> 60 marks). The mean score for total NICAT score was 87.8 marks (SD = 26.524). A total of 10 questions were asked to evaluate the computer literacy skills. The mean score for computer literacy was 28.93 marks (SD = 9.313) following informatics literacy skills with 13 questions which reported mean score of 38.36 marks (SD = 11.757) and 7 questions for information management skills whereby the mean was 20.4 (SD = 7.488). Nurses were better in computer and informatics literacy but the overall overview of NICAT score among the nurses was satisfactory. About 118 (37.3%) reported that they were proficient, 112 (35.4%) competent and only 39 (12.3%) were expert. However, 47 (14.9%) nurses reported that they were advanced beginners in nursing informatics.

Table 2: Nursing informatics competency of respondents

Nursing informatics competency	Frequency (n)	Percentage	Mean	SD
Total NICAT score			87.80	26.524
Computer literacy skills			28.93	9.313
Informatics literacy skills			38.36	11.757
Information management skills			20.40	7.488
Skill acquisition				
Novice	0	0		
Advance beginner	47	14.9		
Competent	112	35.4		
Proficient	118	37.3		
Expert	39	12.3		

Relationship between Sociodemographic and NICAT Score

Regarding the relationship between NICAT mean scores and sociodemographic characteristics as shown in Table 3, the results showed a significant relationship in respondents of age group > 40 years old ($t = 4.194$, $p = 0.000$). However, the relationship between age (in years) and total NICAT score was also investigated using Spearman's rank-order correlation coefficient. There was a strong, negative correlation between the two variables, ($r = -0.944$, $n = 316$, $p = 0.000$), with aged nurses associated with lower levels NICAT scores. As shown in Table 3, there was a significant difference in mean score of total

NICAT score between female and male nurses ($t = -2.558, p = 0.011$) with magnitude of the differences in means was -14.28 . Besides that, the one-way ANOVA revealed that level of education of the respondents had a statistically significant difference between diploma and master holders where NICAT score for the two levels of education was $F(2,313) = 5.094, p = 0.007$. Despite reaching statistical significance, the actual difference in mean scores between the groups was quite small. The effect size, calculated using eta-squared, was 0.03 . Post-hoc comparisons using the Tukey HSD test indicated that the mean score for group nurses with diploma ($M = 86.71, SD = 26.17$) was significantly different from group nurses with master ($M = 121, SD = 26.55$). Nurses with degree ($M = 88.94, SD = 26.18$) did not differ significantly from either diploma or master nurses. In addition, the Spearman's rank-order correlation showed there was a correlation between the nurses' working experience with NICAT score ($\rho = -0.231, n = 316, p = 0.000$) and longer years of working experience associated with lower level of NICAT score as shown in Table 3.

Table 3: Relationship between sociodemographic characteristic and NICAT score

Variables	Total NICAT Score				
	Frequency (n)	Mean	SD	Test	p-value
Working experience				-0.231 (ρ value)	0.000^{*a}
Age				4.194 (t -value)	0.000^{*b}
Gender				-2.558 ($n = 316$)	0.011^{*b}
Female	292	86.7	26.60		
Male	24	101.0	22.80		
Race				-0.667 ($n = 316$)	0.505^b
Malay	313	87.71	26.60		
Others	3	98.0	18.20		
Job position				2.531 (F -value)	0.081^c
Registered nurse	270	86.99	26.35		
Head nurse	35	88.63	27.37		
Nurse manager	11	105.18	24.23		
Level of education				5.094	0.007^{*c}
Diploma	248	86.71	26.17		
Degree	62	88.94	26.18		
Master	6	121.0	26.55		
Post-hoc analysis					
Diploma					
Degree					0.822
Master					0.005^*
Degree					
Diploma					0.822
Master					0.120
Master					
Diploma					0.005^*
Degree					0.120

Note: ^aSpearman's rank-order correlation coefficient; ^bIndependent t -test; ^cOne-way ANOVA; *Significant value at $p < 0.05$

The results also revealed that there was a statistically significant difference in level of NICAT score for the working discipline among the nurses with $F(6,309) = 8.309, p = 0.000$ as illustrated in Table 4. The actual difference in mean scores among the working discipline group was moderate with effect size 0.14 . Post-hoc analysis showed that nurses working

in operation theatre (M = 68.88, SD = 23.08) scored the lowest mean compared to nurses working in surgery (M = 94.52, SD = 22.73), medical (M = 92.77, SD = 21.46), ICU (M = 98.24, SD = 25.76), O&G (M = 85.33, SD = 29.27) and orthopaedic (M = 95.13, SD = 27.06). Per contra, there was no difference in mean score between nurses working in operation theatre and psychiatric. The data also showed there was no significant relationship among the variable of job position, working hours, attended user/HIS training and time spent in HIS with informatics competency.

Table 4: Relationship between factor influencing and NICAT score

Variables	Total NICAT Score				
	Frequency (n)	Mean	SD	Test	p-value
Time spent on HIS				0.67 (ρ value)	0.118
Attended HIS/Computer training				-1.651 (t-value)	0.100
No	171	5.54	2.06		
Yes	145	0.47	2.15		
Working place				8.309 (F-value)	0.007
Surgery	52	94.52	22.73		
ICU	41	98.24	25.76		
Medical	64	92.77	21.46		
O&G	63	85.33	29.27		
Operation theatre	58	68.88	23.08		
Orthopaedic	23	95.13	27.06		
Psychiatric	15	87.07	25.74		
Post-hoc analysis					
Surgery (Operation theatre)					0.000
ICU (Operation theatre)					0.000
Medical (Operation theatre)					0.000
O&G (Operation theatre)					0.006
Orthopaedic (Operation theatre)					0.000
Psychiatric (Operation theatre)					0.151
Working hours				6,852.0*	0.490
Office hour	56				
Shift	260				

Note: *n = 316

DISCUSSION

Nursing informatics competency has been studied worldwide, but this is a pioneer study in Malaysia related to nurses' basic competency in nursing informatics. Hypothetically, the nurses are those with the background of an outstanding knowledge and competency in nursing informatics. The competency score among the nurses in HCTM was competent with great satisfactory rate of 85% with mean NICAT score was 87.8 (SD = 26.52). Some other studies reported the nurses' nursing informatics competency at the expert and proficient

levels (11, 16). Nurses in HCTM had scored the highest competent in computer literacy skills, followed by informatic literacy skills and information management skills. Several studies in other countries indicated high score in computer literacy among their nurses (17) but this contradicted with another study which found that nurses were more competent in informatics literacy and management skills (11, 12, 18). Surprisingly, in the current study, no nurses had been reported as novice, while there were 37.3% nurses reported as proficient. This was in contrast with the previous study (17) which reported 23% of nurses were novice in nursing informatics competency. However, accurate comparisons were not possible due to different HIS used. This might be explained by the fact that most nurses had prior computer education before started working and the current curriculum of Bachelor of Nursing degree programmes includes computer sciences which helped the nurses raised their competency in nursing informatics. Most nurses have prior computer education and are proficient in nursing informatics, as evidenced by Elsayed et al. (11). It is also important to note that this study is based on self-reporting by the nurses using questionnaire and the nurses are working in the teaching hospital in the city of Kuala Lumpur. It is apparent that they may have received enough exposure to use the computer and the applications of related technology in nursing practice. However, peripheral hospitals in urban, semirural, and rural areas may lack similar exposure to computer skills, indicating that the results of the study should not be generalised.

This study showed that there was a relationship between nursing informatics competency and sociodemographic data among nurses. It was found that there was moderate inverse relationship with the age, which might be due to most of the nurses recruited in this study were from age range of 31 to 55 years old where they might have limited engagement with the hospital system or did not have enough training. It is supported by Jouparinejad et al. and Elsayed et al. (9, 11) which revealed that age and years of experience are significant factors in nursing informatics competency. The present study found that male nurses scored higher mean NICAT score compared to female nurses but only 7.6% male nurses were recruited. Nurses with Master in Nursing were found to be more competent compared to nurses with diploma. This conclusion matched with Kinnunen et al. (19), who reported that nursing informatics competency was associated with education level, and Yang et al. (18), who examined nurse managers' informatics competencies. Fehr (10) revealed a statistically significant difference between diploma and master holder nurses in nursing informatics skills. Degree and master holders were exposed to nursing informatics subjects while diploma holders learned computer basics, according to a previous study (18). Kleib and Nagle (20) discovered significant variations in total mean competency scores by education level, suggesting that scores rise with education.

The findings of the current study also revealed that nurses working in operation theatre scored the lowest nursing informatics competency score compared to other working disciplines. Nurses working in ICU scored the highest mean 98.24 (SD = 25.76) which shows that nurses in ICU are dealing with computers and technology to monitor patient conditions while nurses in the operation theatre are more on assisting surgeons in operations. This is supported by Jouparinejad et al. (9) who reported the nurses from critical care discipline scored competent in nursing informatics. Beside scoring the lowest mean, nurses in operation theatre also spend 0 hours in HIS majority. More administrative experiences were associated with a lower level of informatics competencies (18). Besides analysing the sociodemographic characteristics influences in NICAT score, this study also found that there was a relationship between factors of working experience and nursing informatics competency. It is consistent with the findings of Elsayed et al. (11), who discovered that age and years of experience are important determinants in nursing informatics expertise.

A similar negative link with nurses' working experience was found in a study by Khezri and Abdekhoda (12). Nurses with more than 10 years of experience were more likely lack nursing competence. Nurses who received only a minimal education in informatics as a part of their formal nursing training were more likely to have a low level of proficiency in the nursing informatics. There was no significant relationship among the variable of job position, working hours, time spent on HIS and attended user/HIS training with informatics competency. Previous study showed correlations between nurses with nursing informatics competency and time spent on HIS (11, 12). Nurses working on office hours equally reported on competent and proficient in nursing informatics with shift work nurses in the current study, but no significant relationship was reported in other studies as well (12, 17).

In addition, the current study reported that majority of nurses were not attended user, or HIS training and no relationship found. This result was in contrast with Hwang and Park (8) who found nursing informatics competency score varied significantly to nurses who attended computer or HIS training. Similarly in Iran, the critical nurses improved nursing informatics competency post training (9). There was no significant difference in relationship for time spent on HIS with nursing informatics competency in contrast to Khezri et al. (12) that revealed a statistically significant correlation, and Elsayed et al. (11) which found the amount of time nurses spent working with HIS has a direct and significant impact on their level of informatics competency. There was limited literature in relation to time spent and training with nursing informatics competencies studied. Based on the findings, the aged nurses with higher working experience would be the targeted group for nursing informatics educational programme. The findings of this study can be used to determine the nursing informatics competency among nurses in the teaching hospital and helpful in the future in acknowledging that each item in this NICAT has an influence on the present situation that nurses are in regarding nursing informatics. Besides that, the teaching hospital nursing department may make use of this finding in their profession to improve quality of care. In this study, the NICAT questionnaire was used as a measure of the level of nursing informatics competency among nurses working in the teaching hospital. The NICAT questionnaire has been translated into Malay language which can be utilised in the future.

Limitation and Future Research

This study has some limitations throughout. Firstly, nurses' self-reports rather than actual performance to determine their nursing informatics competency. Self-reported nurses may underestimate or overestimate their skills. Besides that, the number of nurses who took part in the study was not distributed evenly in terms of their job position and working place. Therefore, the distribution of the findings was not equal for demographic and had some outliers. This study also used convenience sampling. Consequently, results were hard to generalise due to time constraints and a high response rate. In addition, the researchers were not allowed to collect their own data during the COVID-19 pandemic restrictions. For future studies, it has been proposed that in subsequent research, a simple random sample method can be utilised, and all nurses should be included in the study. Future studies can also be planned to conduct larger study samples to achieve a proper distribution sample among different populations in order to obtain more precise data with larger effect size and reduce disproportionate response rate. Further research is also recommended in investigating nursing informatics competency in healthcare and evaluating the efficacy of various approaches and models to improve the nursing informatics competency of nurses in Malaysia and other cultures as well as different contexts.

CONCLUSION

Professional nurses must obtain and maintain a certain level of informatics competency that can serve as the cornerstone of their practise, supporting clinical decision-making, improving patient experience, and contributing to improved health outcomes. The findings of the study suggested that gender, level of education, working discipline, and working experience have a direct and significant impact on nurses' informatics competency. Furthermore, this study found that age has an indirect and significant impact on nurses' informatics competency. According to earlier research as well as the current study findings, nurses' level of informatics competence has a substantially bigger impact on overall patient outcomes and organisational effectiveness than information systems themselves. As a result, it is critical to promote informatics as a core competency of professional practice among both nursing workforce of now and the nursing workforce of tomorrow.

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ETHICAL APPROVAL

This study has been ethically approved by the Universiti Kebangsaan Malaysia Research Ethics Committee (UKMPPI/111/8/JEP-2022-113).

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