Distance Learning for Nurses: Using Learning Analytics to Build a Learning Support Program

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Abstract In the past decade, Japan’s nurses have benefitted from an increase in distance learning opportunities. However, there is little information on course completion and successful learning outcomes, making it difficult to implement appropriate measures that support distance learning, such as orientation courses and mentoring from faculties. This study applies learning analytics to distance learning logs and learner information to build a learning support program suitable for learners in the field of nursing. Our findings show that login frequency regarding a distance-learning course for nurses was related to course completion, as was login frequency to an orientation course three months after the start of the program. These results have implications for how educators monitor learning status and implement support. The findings, and their implications for instructional design and educator effectiveness, are applicable to all health professionals who receive education and training through distance learning.

Keywords: nursing, distance learning, learning log, learning support, learning analytics

1. Introduction

Further education and training for the nursing profession has become increasingly important at the global level, enabling nurses to adapt to current healthcare issues, such as more advanced and diverse medical treatment, shifts toward hyper-acute care, and at-home treatment of patients(1). In Japan, Continuous Professional Development (CPD) for nurses includes support for returning to work, training nurses to work in different regions and remote areas, and to provide care at home, with nurses also being trained to carry out specific medical activities (referred to in this paper as 'specific medical training')(2). The issue for nurses undergoing CPD is whether they are able to do this concurrently with their work. Amid a severe nurse shortage, it is difficult for many nurses to take time off from work to study. Distance learning using Information Communication Technology (ICT) has therefore been used to provide CPD to nurses since the 2000s(3). However, in order to complete courses during a set period, develop self-regulated learning skills, and otherwise succeed at distance learning, learners need ICT skills, the ability to manage their own learning, and to engage in collaborative learning(4). Another issue is that many learners drop out because they are unable to sustain their desire and intention to learn(5). According to a study on distance learning involving nurses working in remote areas, such as isolated islands or underpopulated mountain villages, many nurses do not have the opportunity to use computers other than for accessing electronic medical records, and many are not familiar with how to operate a computer or use the internet(6). The distance learning that is currently delivered to nurses is usually limited to the provision of learning materials, with learners being required simply to read the materials and watch videos. In most cases, the courses are not designed to promote collaborative learning, a participatory form of learning that fosters autonomy. The implication is that even learners who report having experience in distance learning may struggle to adapt to interactive distance learning.

A further factor influencing adaptability to distance learning is that nurses have wide-ranging academic backgrounds. Basic training in nursing is offered by vocational schools, junior colleges, and universities, with further training provided by graduate schools or certified nurse training schools(7). Differences in academic backgrounds contribute to gaps in academic depth of knowledge and ICT skills, and are likely to influence how a learner adapts to self-regulated distance learning. To help nurses, who are often time constrained, learn most efficiently and succeed going for-
ward with distance learning, supportive content must be designed for nurses with a broad range of academic backgrounds. Evaluation of acquisition of learner autonomy and learning management skills can help educators provide appropriate forms of support as learners move through a course.

Larusson and White define learning analytics as the collection, analysis, and application of data accumulated to evaluate the activities of a learning community, which suggests that learning analytics can be used to analyze the factors required for successful distance learning. That is, participation in distance learning by nurses can be evaluated by analyzing data stored in Learning Management Systems (LMS).

While issues associated with the successful implementation of distance learning for learners with varied backgrounds have been addressed in the literature, no studies to date have specifically examined the forms of support needed for successful distance learning in the nursing profession. In this study, we used learning analytics to investigate the implementation of distance learning for nurses. Okubo et al. described the need for learning supports designed to foster both the learning management and the motivation of Japanese nurses engaged in CPD. Based on the findings, we propose a learning support program based on instructional design that is suitable for nurses engaged in distance learning. The program associates the specific problems of ICT skills, the ability to self-regulate learning, and the ability to engage in collaborative learning with an orientation course specifically designed to address these needs and prepare them for success in CPD.

2. Methodology

2.1 Target Population

The target population for this study was 153 nurses enrolled in medical or educational institutions across Japan. They included trainees at Center A, which allocates 252 of 315 course hours to specific medical training via distance learning. To be eligible to study at Center A, nurses need to be enrolled at a medical or educational institution and have at least five years’ nursing experience. Courses at Center A started in October 2015, with a cohort of up to 30 nurses commencing their studies every six months. Participants undergo an orientation period of approximately one month, and those who have demonstrated proficiency during the orientation course proceed to study the program via distance learning over four months, with individual completion delayed if a learner is having difficulty (Figure 1). A previous study showed that when delivering a course via distance learning, providing an orientation course beforehand increased the success rate. In particular, the study showed that learners were not sufficiently prepared for online learning, including their lack of computer-related skills, which tended to delay their learning once the course had started. Okubo et al. described nurses’ anxiety around collaborative tasks such as engaging in online discussion and mutual evaluation, activities which contribute to success in e-learning. In this study, informed by research on nurses’ lack of preparedness for and anxiety around e-learning, coupled with the demands of the nursing profession, we considered a distance learning course to be successful if it was completed during the shortest possible learning period. Proficiency or achievement were not used as success factors, as these indicators of learning effect were outside the scope of our study and would have required establishing baseline learner levels.

2.2 Study Method/content and Analysis Method

Recent years have seen learning analytics—learning history and login frequency on Moodle—used in research on learning outcomes in distance learning for training medical professionals, as well as to identify students needing additional support. It is possible to reflect learning history and login frequency results in the
design of a learning support program for distance learning. This study was carried out on Moodle, which is the LMS used at Center A, using the Moodle feedback and report features. The Configurable Reports plugin used by Asada and Yagi (14) was used to collect log data.

Seven demographic characteristics were collected for each participating learner: age (29 or younger, 30–39, 40–49, 50 or older), gender, marital status, family status (e.g., young children, grandparents, other dependents), years of nursing experience (5–9 years, 10–14 years, 15–19 years, 20 years or more), academic background (Associate degree, Bachelor’s degree (College), Bachelor’s degree (University), Master’s/Doctor’s degree), and special qualifications (e.g., certified nurse or certified nursing specialist). Participants were also asked about their experiences and perceptions related to distance learning (e.g., whether they liked using computers or the internet, whether they had used Skype, whether they had previous e-learning experience). Success factors for distance learning by Ivankova and Stick (15) were investigated on a 4-point scale (1=poor, 4=good): online learning environment, exchange between learners, workplace support, and support of a significant other.

Data was downloaded directly from the Moodle server. Data was collected on the frequency with which participants logged into the orientation course (during orientation and returning to it during the program) for learning support, program login frequency by month, login frequency by login time, login frequency by day of the week, and frequency of making and revising a learning plan. Log-in frequency, rather than login session length, is a better measure of participants’ activity, as students often failed to log out when inactive on the LMS.

A self-regulated learning (SRL) scale for adult students in university online courses (16), with 23 items on a 7-point scale (1=strongly disagree, 7=strongly agree), was used to evaluate participants’ skills and strategies for self-regulated learning.

A chi-squared test, Fisher’s exact test, and the Mann–Whitney U test were performed on the dependent variables (including scores on the program) and program completion. Scores on the program were divided into 2 groups: more than 420, which was the mean of the scores, or below 420. A multiple regression analysis by stepwise methods compared the background factors, online learning experience, login frequency, and SRL scale to the scores in the program and course completion. Variance Inflation Factors (VIF) was used to check for multicollinearity. Predictive and complexity characteristics of the model were considered during modeling. The level of significance was set at 5%. IBM SPSS Statistics version 23.0 was used for the statistical analysis. The study was conducted between March 2016 and February 2019.

2.3 Ethical Considerations

The aim, purpose, and method of this study were explained to participants. Participants were advised that participation was voluntary, that privacy would be protected, and that they would not be disadvantaged in any way by declining to participate or withdrawing from the study. The terms were confirmed in writing as consent to participate, which was required prior to proceeding. The approval from the Jichi Medical University Clinical Research Ethics Committee (approval number: 16-091) had been received prior to commencing the study.

3. Results

Of the 153 participants, 138 (90.2%) completed the course (“completers”) and 15 (9.8%) did not complete the course (“noncompleters”) during the period over which the study was conducted (Table 1).

3.1 Characteristics

Table 1 shows the demographic data of the participants, divided into completers and non-completers. There was no significant difference between completers and non-completers for the seven demographic characteristics.

3.2 Distance Learning Experience/Success Factor and Completion

No significant difference was found between completers and non-completers for experience with and perceptions of distance learning (i.e., whether they liked using computers or internet, whether they had used Skype, whether they had previous e-learning experience), or in relation to online learning environments, exchange between learners, workplace support, or support of a partner, friend, or family member.
3.3 Login Frequency and Completion

Table 2 shows the program results (out of 435 points), the frequency with which participants logged into the orientation course (during both orientation and program courses) for learning support, program login frequency by month, login frequency by login time, login frequency by day of the week, number of learning plans, and frequency of re-planning. There was no significant difference between completers and non-completers in relation to performance on the program. A significant difference was found for orientation course login frequency during the orientation period, orientation or program login frequency during months 3–5, and login frequency from 7 am to 1 am for both orientation and program.

3.4 Predictors of Course Completion and Test Scores

A multiple regression analysis was performed to explore the various factors that impacted course completion (Table 3) and test scores (Table 4): the unstan-

*\(p<0.05\), (F) Fisher’s exact test

Table 1. Demographic Data of Participants.

|                  | Total (n=153) | Completers (n=138) | Noncompleters (n=15) | \(p\) |
|------------------|---------------|--------------------|----------------------|------|
| **Age**          |               |                    |                      |      |
| mean (y)         |               |                    |                      |      |
| Gender           |               |                    |                      |      |
| Female           | 103 (74.6)    | 13 (86.7)          | .90                  |      |
| Male             | 35 (25.4)     | 2 (13.3)           | .53 (F)              |      |
| **Marital status** |              |                    |                      |      |
| Married          | 77 (55.8)     | 8 (53.3)           | 1.00(F)              |      |
| **Family status** |              |                    |                      |      |
| Young children   | 60 (43.5)     | 8 (53.3)           | .39 (F)              |      |
| Grandparents     | 8 (5.8)       | 0 (0.0)            | 1.00(F)              |      |
| Other dependents | 97 (70.3)     | 11 (73.3)          | .73 (F)              |      |
| **Work experience** |            |                    |                      |      |
| mean (y)         | 16.7          | 15.7               | .27                  |      |
| **Special Qualifications (certified nurse or certified nursing specialist)** | | | | |
| yes              | 57 (41.3)     | 3 (20.0)           | .10 (F)              |      |
| **Academic background** | | | | |
| Associate degree | 84 (60.9)     | 6 (40.0)           |                     |      |
| Bachelor’s degree | 15 (10.9)   | 2 (13.3)           |                     |      |
| (College)        |               |                    | .43                  |      |
| Bachelor’s degree | 30 (21.7)   | 5 (33.3)           |                     |      |
| (University)     |               |                    |                     |      |
| Master’s/Doctor’s degree | 9 (6.5) | 2 (13.3)           |                     |      |

Table 2. Results of Exam and Login Frequency to Moodle.

|                  | Total (n=153) | Completers (n=138) | Noncompleters (n=15) | \(p\) |
|------------------|---------------|--------------------|----------------------|------|
| **Exam results (full marks: 435)** | | | | |
| Mean             | 415           | 409                | .69                  |      |
| **Login frequency (to orientation course)** | | | | |
| During orientation | 87.2         | 48.1               | .01*                 |      |
| During program course | 4.6          | 2.5                | .13                  |      |
| **Login frequency (to all courses)** | | | | |
| Month            |               |                    |                      |      |
| 1 month          | 66.4          | 27.9               | .05*                 |      |
| 2 months         | 144.6         | 66.1               | .91                  |      |
| 3 months         | 112.4         | 38.1               | .04*                 |      |
| 4 months         | 117.4         | 45.1               | .00*                 |      |
| 5 months         | 112.4         | 60.7               | .04*                 |      |
| **Week**         |               |                    |                      |      |
| Sunday           | 2776.0        | 1145.7             | .00*                 |      |
| Monday           | 2815.0        | 1197.1             | .00*                 |      |
| Tuesday          | 2853.5        | 1222.7             | .00*                 |      |
| Wednesday        | 2533.7        | 988.6              | .00*                 |      |
| Thursday         | 2070.8        | 829.3              | .00*                 |      |
| Friday           | 1826.9        | 732.0              | .00*                 |      |
| Saturday         | 2211.9        | 920.7              | .00*                 |      |
| **Hour**         |               |                    |                      |      |
| 0 am             | 696.0         | 351.9              | .02*                 |      |
| 1 am             | 417.7         | 180.7              | .02*                 |      |
| 2 am             | 262.6         | 147.5              | .12                  |      |
| 3 am             | 187.3         | 185.6              | .98                  |      |
| 4 am             | 180.0         | 177.2              | .97                  |      |
| 5 am             | 260.6         | 171.1              | .33                  |      |
| 6 am             | 338.3         | 99.1               | .06                  |      |
| 7 am             | 374.6         | 92.2               | .01*                 |      |
| 8 am             | 451.8         | 190.5              | .01*                 |      |
| 9 am             | 606.9         | 195.4              | .00*                 |      |
| 10 am            | 759.5         | 271.5              | .00*                 |      |
| 11 am            | 870.7         | 375.5              | .00*                 |      |
| 0 pm             | 902.6         | 357.6              | .00*                 |      |
| 1 pm             | 841.2         | 337.7              | .00*                 |      |
| 2 pm             | 895.4         | 275.0              | .00*                 |      |
| 3 pm             | 869.7         | 270.0              | .00*                 |      |
| 4 pm             | 908.4         | 335.7              | .00*                 |      |
| 5 pm             | 845.0         | 378.9              | .00*                 |      |
| 6 pm             | 846.0         | 320.5              | .00*                 |      |
| 7 pm             | 901.2         | 317.1              | .00*                 |      |
| 8 pm             | 1054.3        | 381.7              | .00*                 |      |
| 9 pm             | 1242.8        | 561.9              | .00*                 |      |
| 10 pm            | 1301.6        | 613.3              | .00*                 |      |
| 11 pm            | 1073.5        | 447.7              | .00*                 |      |

Making a learning plan

|                  |       |       |       |
|------------------|-------|-------|-------|
| Planning         | 136.0 | 83.6  | .19   |
| Re-planning      | 31.3  | 4.5   | .14   |

*p<0.05, Mann–Whitney U test
standardized beta \((B)\), standard error for the unstandardized beta \((SE B)\) and standardized beta \((\beta)\). A regression was calculated to predict Step 1 (Table 3) using login frequency (Thursday), login frequency (Sunday) and daily login frequency (1 am) as dependent variables based on whether or not learners completed the courses, \(b = 1.528, t (152) = 24.82, p = .00\). A significant regression equation was found \((F (1, 152) = 18.37, p = .00\), with an \(R^2\) of .29. Step 2 (Table 3) consisted of login frequency (Thursday) and “I always put down a thing related to learning contents” as SDL scale based on whether or not learners completed the courses, \(b = 1.652, t (152) = 13.79, p = .00\). A significant regression equation was found \((F (1, 152) = 13.73, p = .00\), with an \(R^2\) of .24.

A regression was calculated to predict Step 1 (Table 4) using login frequency (Sunday), daily login frequency (10 pm), login frequency (Monday), daily login frequency (2 am) and login frequency (Saturday) as dependent variables based on the scores in the program, \(b = 1.892, t (152) = 18.64, p = .00\). A significant regression equation was found \((F (1, 152) = 12.37, p = .00\), with an \(R^2\) of .34. Step 2 (Table 4) included “There is the place that I concentrate on it and can learn” as SDL scale based on the scores in the program, \(b = 1.932, t (152) = 11.66, p = .00\). A significant regression equation was found \((F (1, 152) = 4.79, p = .03\), with an \(R^2\) of .05. VIF was employed to check for multicollinearity. None of the VIF values were up to 10, and the mean VIF of the model was less than 2. This means there was no collinearity in the model.

4. Discussion

The results show that participant characteristics did not have an effect on completion, which was neither affected by e-learning experience nor learning support situation. By contrast, both orientation-course login frequency during the orientation period and login frequency during months 3–5 had a positive effect on completion. In light of these findings, we discuss how these data can be used to develop a learning support program particular to the nursing field.

The results of multiple regression analysis showed login frequency on Sunday and Thursday, and at 1 am, impacted course completion. If participants worked weekdays, a higher login frequency on Saturday and Sunday was expected. Higher login frequency on Saturday and Sunday correlated with course completion. Because nurses work in shifts and work on weekends, the results are consistent with nurses’ observed learning behaviors.

4.1 Direction for Use of Findings

Studies to date have pointed to the difficulty of using learners’ self-reporting on distance learning as a basis of research\(^{(17)}\). The findings of this study, by comparison, are based on learning history and results, and could therefore be used to design screening tools for distance learning suitability or risk prediction. This study suggests that login frequency during the learning period has an important completion effect. Thus, login frequency should be the factor of learning behavior, not the learning effect. An effective strategy would therefore be to encourage learners to login frequently to engage with the course content. In particular, since orientation course login frequency had an effect on completion, understanding a learner’s situation prior to the start of the program and encouraging the learner to login to the orientation course could be an early intervention before learning the course material. We suggest using the questionnaire about nurses’ work shifts and work environment to guess their course completion and appropriate supports. Further, it is also suggested that while login frequency immediately after the program courses start does not necessarily predict completion, it would be advisable to take prompt action to check on individual learning status if login frequency has fallen in the second month of the program.

Distance learning requires learners to be self-directed\(^{(4,5)}\). However, as the completion rate of the courses was more than 90% in this study, the focus was on improving learner self-efficacy and self-directed learning skills. The results complement one of Center A’s missions, which is for learners to continue self-improvement\(^{(18)}\).

Results showed the importance of learners being able to schedule learning time when they would be most effective, such as Sunday, and not to devote learning time to those periods during which they were least effective, such as midnight. With self-paced distance learning, learners need the self-agency to schedule and manage their time and to study when they will get the best results from time invested in the courses. Educators who are aware of the importance of scheduling and time management can share this information with learners
DISTANCE LEARNING FOR NURSES

4.2 Generalizability

The findings of this study are applicable to supporting lifelong learning via improved distance learning for healthcare professionals. The confluence of the need for ongoing education for healthcare professionals to address changes in the provision of healthcare and the difficulty of taking time away from work for specialized learning make distance learning an attractive workaround for institutions, educators, and learners based on instructional design.

4.3 Limitations

Given the shortage of nurses and the urgent need for training, this study evaluated the success of distance learning in terms of learners completing a course within the learning period. However, learners differed in the amount of time needed to acquire skills, resulting in insufficient data to evaluate the success of distance learning on this point alone. This study found no significant difference in performance in the program that depended completion within the learning period. That is, learners could ensure a certain quality of learning by taking the time they needed, and delaying completion was not necessarily something to be avoided.

5. Conclusion

This study on distance learning in the nursing profession demonstrated three key findings. In spite of expectations, demographic data did not affect the outcome of program completion in distance learning. Login frequency during the course orientation period had an effect on course completion, suggesting that orientation login frequency could be used as a predictor of successful program completion. A decline in login frequency three months after the start of the orientation correlated with delayed completion or failure to complete the pro-

Table 3. Summary of Multiple Regression Analysis for Variables Predicting whether or not Learners Completed the Courses.

| Step 1 | B   | SE B  | β     |
|--------|-----|-------|-------|
| Constant | 1.528 | .062  |       |
| Login frequency (Thursday) | .000 | .000  | .357*** |
| Login frequency (Sunday) | .000 | .000  | .249*** |
| Login frequency (1 am) | .000 | .000  | .173*** |

Step 2

| Constant | 1.652 | .120  |       |
| Login frequency (Thursday) | .000 | .000  | .360*** |
| I always put down a thing related to learning contents. | .069 | .020  | .311*** |

R² = .29 for Step 1, R² = .24 for Step 2 (ps = .00). *** p < .001.

Table 4. Summary of Multiple Regression Analysis for Variables Predicting Test Score.

| Step 1 | B   | SE B  | β     |
|--------|-----|-------|-------|
| Constant | 1.892 | .098  |       |
| Login frequency (Sunday) | .000 | .000  | .280*  |
| Login frequency (10 pm) | .000 | .000  | −.407*** |
| Login frequency (Monday) | .000 | .000  | −.227**  |
| Login frequency (2 am) | .000 | .000  | −.207**  |
| Login frequency (Saturday) | .000 | .000  |      |

Step 2

| Constant | 1.932 | .166  |       |
| There is the place that I concentrate on it and can learn. | .073 | .033  | .225*  |

R² = .34 for Step 1, R² = .05 for Step 2 (ps < .05). * p < .05, ** p < .01, *** p < .001.

during course orientations. By collecting frequency data on the learners during the orientation courses, educators can better predict course completion and modify course support appropriately.
gram, indicating a need to monitor learner status and provide suitable support. Additionally, analyzing the Moodle interaction data on collaborative tasks, discussion on online threads, and mutual evaluation would provide important information for designing suitable forms of support. Going forward, further research on distance-learning for nurses that addresses the skills required for success, including study skills for content mastery and timely completion, as well as self-regulated learning skills, will contribute important information to this field.

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DISTANCE LEARNING FOR NURSES

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