# Migration of Clusters from Pre-session to Post-session: An Analysis of Elderly Students' Perceived Digital Literacy

Makiko Miwa(✉), Emi Nishina, Hideaki Takahash, Yoshitomo Yaginuma, Yoko Hirose, and Toshio Akimitsu

Faculty of Liberal Arts, The Open University of Japan, Chiba-shi, Japan
{miwamaki, nishina, hide, yaginuma, hirose, akimitsu}@ouj.ac.jp

**Abstract.** The Open University of Japan has offered a face-to-face digital literacy training session (DLT) every semester at all 50 study centers since 2010. Each student attending DLT completes a checklist at the beginning and end of their session. The objective of this study was to identify how students migrated from one cluster to another, representing their self-reported perceived digital literacy skills. We analyzed responses from 1,417 students who submitted checklists between Semester 2, 2014 and Semester 2, 2016 and completed all 20 items on both the pre- and post-session checklists. We developed clusters for pre- and post-session ability, based on each student's reported ICT skill levels on the 20 checklist dimensions, using k-means with the Hartigan–Wong algorithm. We also analyzed how each of the pre-session clusters shifted to post-session clusters using a Sankey diagram. In addition, we analyzed students' post-session checklist comments on DLT using a co-occurrence network method.

**Keywords:** Digital literacy · Elderly students · ICT skills · Learning analytics

## 1 Introduction

The Open University of Japan (OUJ) offers distance-learning programs at undergraduate and graduate levels through accredited courses broadcast by television, radio, and online, in addition to face-to-face sessions offered at 50 study centers nationwide. About 300 courses are broadcast on television or radio, while some 3,000 face-to-face sessions are provided at study centers. Provision of online courses began in the first semester of 2015, and 15 courses are currently taught this way. The rapid popularization of the Internet and the progression of information and communication technology (ICT) have brought about virtual environments that support students' learning. OUJ has taken advantage of ICT for adult students who undertake lifelong learning. Almost all television and radio courses are also accessible on the Web. Students can access these courses by personal computer (PC), tablet, and smart phone. Wakaba, the online student information management system of OUJ, is used for course registration, confirmation of exam results, and reporting of students' information online. All


S. Kurbanoğlu et al. (Eds.): ECIL 2018, CCIS 989, pp. 369–378, 2019.
https://doi.org/10.1007/978-3-030-13472-3_35

students have access to the OUJ mail system using designated e-mail addresses. However, these online services have not been fully utilized by students. This is mainly because OUJ students are relatively old (Fig. 1) and some of them have had little opportunity to utilize PCs and mobile devices for learning. To cultivate these students to fully utilize the Web-based learning environments of OUJ and prepare to take online courses, we have offered a face-to-face 12-h intensive digital literacy training (DLT) session called "The Personal Computer for Beginners" in classrooms with networked PCs at 50 study centers since the second semester of 2010.

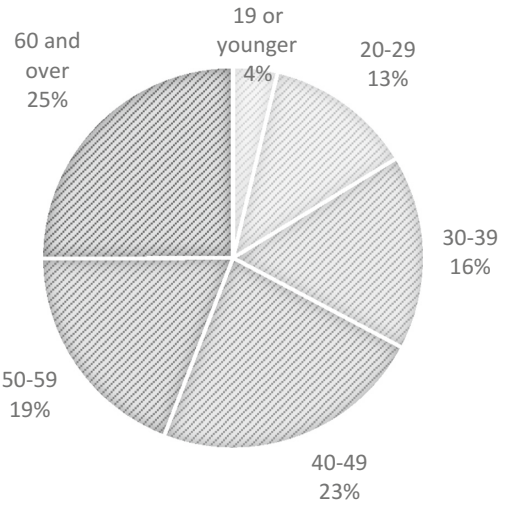


**Fig. 1.** Age distribution of OUJ students (spring, 2017)

The process of developing the DLT session has been reported in journal articles [1]. This paper reports the results of a study of students' learning assessment using students' perceived ICT skills pre- and post-session, which were self-reported between Semester 2, 2014 and Semester 2, 2016.

## 2 Literature Review

The term "digital divide" refers to the fundamental gap between those who have access to computers, the Internet, and online information and those who do not. Studies have reported older age as one of the significant sources of the digital divide in addition to gender, salary, education, and professional practices [2]. Schäffer suggested that generation-specific media use reflects what people learned during their adolescence and with the media available at that time [3]. Other studies identified cognitive abilities, computer self-efficacy, and computer anxiety as mediators of the digital divide [4].

Several studies have reported the effects of DL training for elderly people. Naumanen and Tukiain suggested that the learning program for the elderly be strongly

facilitated by peer support as well as having a jointly planned content that is tailored to the needs, motivation, and ability of learners [5]. In the USA, Echt et al. examined the improvements of computer skills by comparing different age groups (60–74 years vs. 75–89 years) and two types of training method in computer skills (animated multimedia CD-ROM vs. printed manual) [6]. When tested on their performance of skills learned, the younger age group made fewer errors, while the older group tended to have forgotten factual information they learned during the training sessions; however, there was no difference between the different training methods. Wong et al. compared differences in changes of perceived self-efficacy during basic-level computer training in Hong Kong using a pre- and post-survey method and noted that beginners' perceived self-efficacy tended to improve, while additional training for those who already had a certain level of ICT skills did not lead to improvement [7]. These findings indicate that acquisition of ICT skills is negatively associated with the age of the learner. Our study also found that elderly students tend to have lower ICT skills, but those who use a PC and the Internet more frequently retain the skills learned in the course [8]. Thus, existing studies support digital divide among learners due to age, and imply the need for special consideration of older students in improving their ICT skills.

## 3 The Personal Computer for Beginners

The Personal Computer for Beginners is a face-to-face hands-on training session designed to cultivate the basic ICT skills required for OUJ students to utilize PCs for access to the Web, the Wakaba information management system, and library services, and to prepare students to take online courses offered since the first semester of 2015. The average size of each DLT session is 20 students with one or two assistants. The session contents have been revised based on student performance. The session description follows:

> This hands-on training session is for students to learn to use a PC for the first time. It includes learning how to use the keyboard and mouse, how to find information on the Internet, how to use e-mail, how to use Word to write assignments, and how to manipulate PowerPoint to create a presentation with tables and figures. Students will be able to access broadcast television and radio courses online, learn to access Wakaba for course registration and examination results, and to utilize Digital Library Services.

Tailored textbook and model teaching materials were prepared by OUJ information literacy taskforce members. The textbook, designed for review lessons of the session, is provided to all students who attend the session. Lecturers can download the model teaching materials in PowerPoint from the dedicated Webpage and modify them for use in the classroom, where each student has access to a PC. Students can upload their assignments (e.g. PowerPoint presentation, short report) and mutually evaluate them.

The session consists of eight lectures with hands-on training, generally offered on weekends. Each lecture is designed to take 90 min. A brief description of each lecture is given in Table 1.

**Table 1.** Description of lectures

| | Lecture title | Description of lecture |
|---|---|---|
| Lecture 1 | How to use PC (keyboard & mouse) | How to manipulate PC and mouse to input data |
| Lecture 2 | Introduction to WORD | Basic operation of word processing software using Word |
| Lecture 3 | Web and e-mail | How to use browsers, Web search engines and e-mail |
| Lecture 4 | Security and etiquette | Knowledge on security and etiquette required for using PC |
| Lecture 5 | Wakaba and library service | How to use the student information system Wakaba and library online services |
| Lecture 6 | Advanced use of Word | Functions of word processing software for writing reports and essays |
| Lecture 7 | Presentation | Preparation of presentation materials and classroom presentation |
| Lecture 8 | Guide to further study | Access to television and radio courses on PC, Web-based learning system, and self-learning site |

The goals of this session are to:

- improve students' PC and Internet (Web) skills.
- prepare students to take online courses, and
- facilitate students' use of online course registration and administrative procedures.

## 4 Checklist for Assessing Student Performance

We used an instructional design method to develop the textbook and teaching materials. Specifically, we developed a list of learning goals for each chapter of the textbook, compatible with each lecture, and these were reflected in the learning materials (Table 2).

We developed a checklist to measure students' digital literacy skills for each of these learning goals. The students completed checklists before and after the intensive session to measure the attainment of their learning goals on a five-point Likert scale (1 = not at all; 2 = have done; 3 = sometimes; 4 = probably; 5 = yes, with confidence). In addition, students were asked to write free-response comments about the session in the post-session checklist. Both pre- and post-session checklists were accepted by the OUJ Research Ethics Review Board.

In total, 1,844 students submitted checklists for the DLT session between October 2014 and August 2016. Among them, 1,417 students completed all 20 items on both the pre- and post-session checklists. Free-response comments were reported by 108 students.

**Table 2.** Learning goals

| Item | Learning goals | Item | Learning goals |
|---|---|---|---|
| 1 | Boot, log on, and log off study center PC | 11 | Answer Web-based trial exam questions |
| 2 | Input Japanese letters using Word | 12 | Check out books using OUJ's Online Public Access Catalog |
| 3 | Run application software | 13 | Counteract computer viruses |
| 4 | Access OUJ Website | 14 | Explain etiquette for using the Internet |
| 5 | Search for information using search engine | 15 | Compose a simple essay using Word |
| 6 | Exchange e-mails using OUJ account | 16 | Write and print out own documents |
| 7 | Change own password at OUJ | 17 | Copy, save, delete, and move files |
| 8 | Access OUJ courses on the Internet | 18 | Create 5–6 slides using PowerPoint |
| 9 | Send questions on the OUJ Q&A site | 19 | Perform presentation using PowerPoint |
| 10 | Track own records on Wakaba | 20 | Use self-learning site |

# 5 Data Analysis

## 5.1 Cluster Analysis

For reliability, only data from checklists that were fully completed were used in the analysis. Table 3 lists the number of checklists submitted and analyzed for the study.

**Table 3.** Number of checklists submitted and analyzed

| Semester | Analyzed | Submitted |
|---|---|---|
| Semester 2, 2014 | 256 | 377 |
| Semester 1, 2015 | 342 | 476 |
| Semester 2, 2015 | 224 | 306 |
| Semester 1, 2016 | 388 | 409 |
| Semester 2, 2016 | 207 | 276 |
| Total | 1,417 | 1,844 |

We assume a vector of 20 dimensions based on each student's perceived level of ICT skills reported in pre- and post-session checklists is a student characteristic. Thus, we developed clusters for pre- and post-session ability, based on each student's reported ICT skill levels on each of the 20 checklist dimensions, using k-means with the Hartigan–Wong algorithm. Using the elbow method for k-means clustering, we determined the optimal number of clusters to be four, as presented in Fig. 2, where the horizontal axis shows the number of clusters and the vertical axis is the sum of the square error.

We also analyzed how each of the pre-session clusters shifted to post-session clusters using a Sankey diagram. In addition, we analyzed students' post-session checklist free-response comments on DLT using a co-occurrence network method.

Table 4 shows the number of students classified in each cluster. Pre-session clustering results are presented in Fig. 3 and post-session results in Fig. 4.

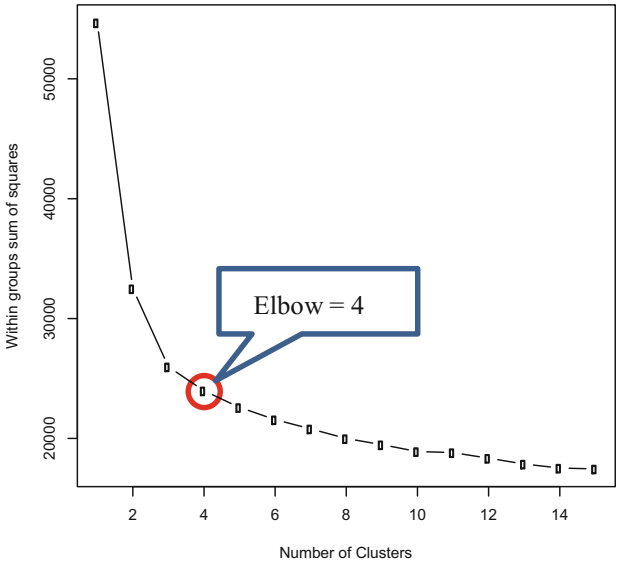


**Fig. 2.** Explained variance

**Table 4.** Number of students classified in pre-session and post session clusters

| Cluster (pre) | Number of students | Cluster (post) | Number of students |
|---|---|---|---|
| A | 201 | X | 483 |
| B | 300 | Y | 518 |
| C | 457 | Z | 303 |
| D | 450 | W | 113 |

Figure 4 shows students' perceived skill levels at the end of the session (post-session). Students were classified into four clusters: X (highest skill level), Y (high skill level), Z (low skill level), and W (lowest skill level). The differences among items were relatively small compared with the differences in pre-session clusters, particularly for cluster A. Perceived skill levels for items 18, 19, and 20 were improved for all clusters, probably due to hands-on experience in the class. Perceived skill levels on items 1 (Boot, log on, and log off study center PC) and 2 (Input Japanese letters using Word), which are basic PC skills, were improved even for the lowest skill cluster, W. On the

other hand, skill levels of item 9 (Send questions on the OUJ Q&A site) and 13 (Counteract computer viruses) decreased. Thus, the session contents related to these two items should be improved.

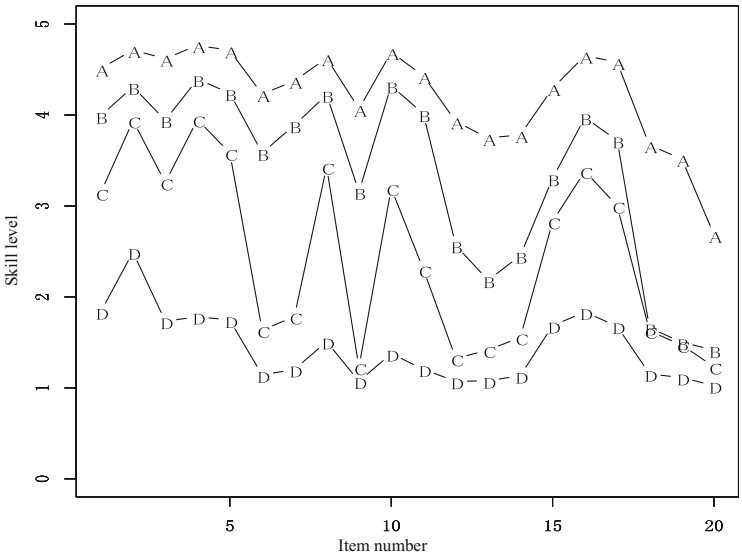


**Fig. 3.** Pre-session clustering results

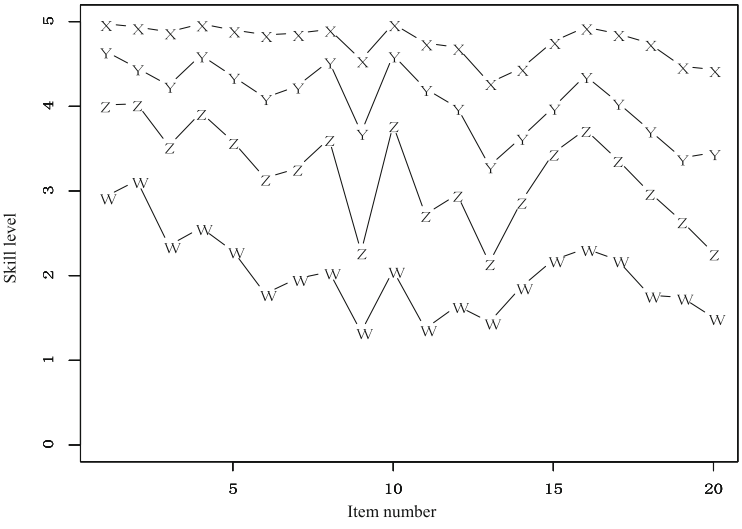


**Fig. 4.** Post-session clustering results

We also analyzed how each of the pre-session clusters shifted to post-session clusters using a Sankey diagram, as shown in Fig. 5. The number of students who migrated are shown, with their average age in parenthesis, in Table 5. As shown in Table 5, average age increased from left top column (A => X) to right bottom column (D = W), indicating that older students are left behind.

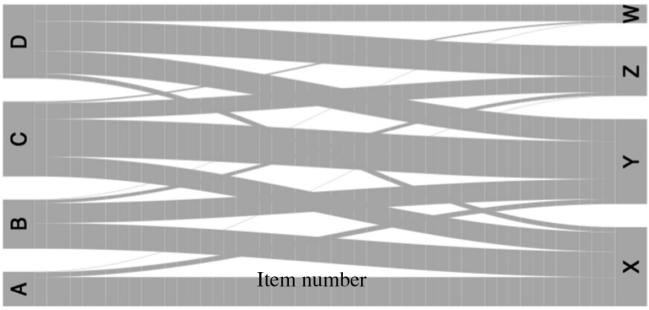


**Fig. 5.** Migration of clusters from pre-session to post-session

**Table 5.** Number of students migrated

| | X | Y | Z | W | Total |
|---|---|---|---|---|---|
| A | 177 (40.8) | 31 (44.0) | 2 (48.0) | 0 (-) | 210 |
| B | 156 (43.1) | 121 (48.1) | 21 (48.6) | 2 (51.5) | 300 |
| C | 120 (46.5) | 230 (50.5) | 98 (55.6) | 9 (60.4) | 457 |
| D | 30 (51.1) | 136 (55.2) | 182 (60.1) | 102 (63.5) | 450 |
| Total | 483 | 518 | 303 | 113 | 1,417 |

As shown in Fig. 5, almost all students in cluster A, the highest pre-session skill level, migrated to cluster X, the highest post-session skill level, while most of the students in the next-highest pre-session level, cluster B, migrated to one of the two highest post-session clusters, X or Y. About one-third of students in cluster C, the low pre-session skill level, migrated to X, Y, or Z post-session. On the other hand, about 20% of students in cluster D, the lowest pre-session skill level, migrated to cluster W, the lowest post-session skill level. This may be because some of the older novice students did not learn enough to be able to manipulate the PC by themselves.

In general, the number of students in the lower two pre-session clusters (cluster C = 457 and cluster D = 450) decreased post-session (cluster Z = 303 and cluster W = 113). Thus, the DLT session “The Personal Computer for Beginners” had an educational effect.

### 5.2 Content Analysis of Free-Response Comments

Only 108 students wrote free-response comments on DLT on the post-session checklist. We analyzed these comments using a co-occurrence network method. Figure 6 shows the network with Jaccard similarity coefficient 0.23 or higher.

Use of the words "presentation," "slide," and "PowerPoint" indicate students were impressed with learning PowerPoint presentation skills. Use of the words "first time" and "can" imply students learnt something new. The words "thank you" and "thanks" indicate that students were grateful to lecturers and assistants. On the other hand, use of the words "anxiety" and "future" reveal that some students need extra training.

To identify word differences between students of different skill levels, we counted word occurrences from groups of students who migrated from A to X (highest skill level) and those who migrated from D to W (lowest skill level). This is because the small number of students in each group made it impossible to perform word co-occurrence analysis. Thirteen students who migrated from A to X responded with comments. Their average age was 37.8 years. Two students said they had "used PowerPoint for the first time," four expressed "thanks" to the instructors, and one said they had "enjoyed the session." Meanwhile, 10 students who migrated from D to W commented. Their average age was 67.4 years. Three mentioned "using a PC for the first time" and three expressed "thanks" to instructors. However, negative expressions of "tired," "hard," and "painful" were reported by one student each.

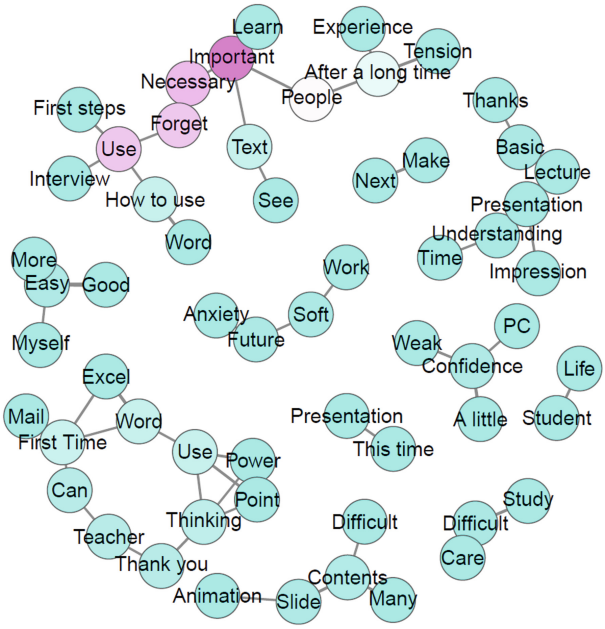


**Fig. 6.** Co-occurrence network of post-session free-response comments

## 6 Conclusion

An analysis of 1,417 students' self-reported perceived digital literacy skills was performed pre- and post-session to identify the educational effects of a DLT session between Semester 2, 2014 and Semester 2, 2016. We developed clusters for pre- and post-session ability, based on each student's reported ICT skill levels on each of the 20 checklist dimensions, using k-means with the Hartigan–Wong algorithm. We also analyzed how each of the pre-session clusters shifted to post-session clusters using a Sankey diagram. In addition, we analyzed students' post-session checklist comments on DLT using a co-occurrence network method. The results indicate that students' skill level had significantly improved, but some old novice students remained unskilled. These results are reflected on the future revision of session materials.

**Acknowledgements.** This study has been supported by the OUJ Center for Online Education. We are grateful to all students who attended the "The Personal Computer for Beginners" DLT session and completed the checklists.

## References

1. Miwa, M., et al.: Digital library training for elderly students at the open university of Japan. In: Kurbanoğlu, S., Grassian, E., Mizrachi, D., Catts, R., Špiranec, S. (eds.) ECIL 2013. CCIS, vol. 397, pp. 205–211. Springer, Cham (2013). https://doi.org/10.1007/978-3-319-03919-0_26
2. OECD: Learning a Living: First Results of the Adult Literacy and Life Skills Survey. OECD Publishing, Paris and Ottawa (2005). http://www.oecd.org/education/innovation-education/34867438.pdf
3. Schäffer, B.: The digital literacy of seniors. Res. Comp. Int. Educ. **2**(1), 29–42 (2007)
4. Czaja, S.J., et al.: Factors predicting the use of technology: findings from the center for research and education on aging and technology enhancement (CREATE). Psychol. Aging **21**(2), 333–352 (2006)
5. Naumanen, M., Tukiainen, M.: Practices in old age ICT education. In: Spector, J., Ifenthaler, D., Isaias, P., Kinshuk, S.D. (eds.) Learning and Instruction in the Digital Age, pp. 273–288. Springer, Boston (2010). https://doi.org/10.1007/978-1-4419-1551-1_17
6. Echt, K.V., Morrell, R.W., Park, D.C.: Effects of age and training formats on basic computer skill acquisition in older adults. Educ. Gerontol.: Int. Q. **24**(1), 3–25 (1998)
7. Wong, Y.C., Chen, H., Lee, V.W., Fung, J.Y., Law, C.K.: Empowerment of senior citizens via the learning of information and communication technology. Ageing Int. **39**(2), 144–162 (2014)
8. Miwa, M., et al.: Changing patterns of perceived ICT skill levels of elderly learners in a digital literacy training course. Libres **27**(1), 13–25 (2018). https://www.libres-ejournal.info/2525/