World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

Check for updates

An education program modified with e-learning brought equivalent outcomes in healthcare students' communication support for people with amyotrophic lateral sclerosis

Takemasa Ishikawa [1,*], Yugo Narita [2], Tamotsu Imura [3], Yuji Tanaka [4], Michiko Nakai [5] and Keiko Fukuroku [6]

[1] *Nana-r Home-visit Nursing Development Center, Tekix Corporation, Toyonaka, Osaka, Japan.*
[2] *Department of Neurology, Graduate School of Medicine, Mie University, Tsu, Mie, Japan.*
[3] *Faculty of Nursing and Rehabilitation, Chubu Gakuin University, Seki, Gifu, Japan.*
[4] *Health Supporting Center, Aichi University of Education, Kariya, Aichi, Japan.*
[5] *Faculty of Nursing, Suzuka University of Medical Science, Suzuka, Mie, Japan.*
[6] *Course of Nursing Science, Graduate School of Medicine, Mie University, Tsu, Mie, Japan.*

World Journal of Advanced Research and Reviews, 2025, 25(01), 024-036

Publication history: Received on 23 November 2024; revised on 28 December 2024; accepted on 31 December 2024

Article DOI: https://doi.org/10.30574/wjarr.2025.25.1.4043

Abstract

Introduction: Patients with amyotrophic lateral sclerosis (ALS) often require augmentative and alternative communication (AAC) to support impaired communication. We evaluated the effectiveness of an e-learning program for healthcare students on communication support for patients with ALS, which was adapted from a previous face-to-face program.

Methods: The program included an 85-min preparatory session, 165-min AAC practice session, and 40-min review session. Fifty-five healthcare students completed the program with pre-/post-tests, AAC practices using a transparent communication board (Flick), *Kuchimoji*, the communication device, subjective burden based on the visual analog scale (VAS), and free-response comments. The participants completed the practice twice over a 6-month interval. Data were analyzed using the Wilcoxon signed-rank sum and chi-square tests.

Results: The program was effective in improving knowledge and AAC skills, similar to the face-to-face version. The pre-/post-test scores significantly increased for beginners (from 70 to 80, P<.001) and experienced participants (from 75 to 80, P<.001). However, after 6 months, a significant decrease in the pre-/post-test scores was observed (from 80 to 75, P=.017). In AAC practice, the number of letters transmitted in 5 min significantly increased for Flick (beginner: 27, experienced: 30, P<.001) and *Kuchimoji* (beginner: 21, experienced: 24, P<.001), with a reduction in subjective burden according to the VAS ratio. Text mining revealed a high frequency of positive sentences in participants' feedback regarding communication devices.

Conclusions: The e-learning program effectively improved ALS communication support knowledge and skills, with a lower perceived burden than face-to-face training.

Keywords: Computer-Assisted Instruction; Students; Communication; Communication Aids for Disabled; Amyotrophic Lateral Sclerosis

* Corresponding author: Takemasa Ishikawa

1. Introduction

Amyotrophic lateral sclerosis (ALS) is a progressive neurodegenerative disease. Individuals with ALS experience various communication difficulties ranging from dysarthria to loss of physical expression because of generalized muscle weakness [1]. Augmentative and alternative communication (AAC) is used to support communication for individuals with ALS. However, a uniform approach to communication support for individuals with ALS is often ineffective, necessitating individualized strategies tailored to the specific needs of individuals and their families [2]. In practice, patients with ALS demonstrate various AAC usage patterns that are influenced by factors, such as age, symptom severity, and medical conditions. Some patients concurrently use multiple AAC methods to address their communication needs [3]. Additionally, maintaining the ability of patients with ALS to communicate, particularly in decision-making processes such as choosing to implement mechanical ventilation or gastrostomy, is essential [4]. To address the complex communication disorders and individual communication needs in patients with ALS, appropriate AAC assessment is necessary, considering the individual's physical function, socioenvironmental needs, and stage of disease acceptance [3, 5].

The AAC support provided by healthcare professionals for patients with ALS remains insufficient because of limited awareness, inadequate training, and lack of support [6, 7]. A survey that focused on people with ALS in the United States reported that although 74.2% were involved with speech-language pathologists, only 46% of 113 patients who used AAC devices received setup or training. Among 155 patients with ALS who were involved with speech-language pathologists, 74 (47.8%) received support only after experiencing the onset of speech difficulties [6]. Early referral for AAC has been reported to be important in communication support for ALS [5, 8]. However, even among patients with ALS who have extensive involvement with speech-language pathologists, communication support is not necessarily provided in the early stages [6]. A survey of 480 members of the Japan ALS Association reported that those who used or stopped using AAC devices had minimal experience with AAC support [7].

In a previous study, an educational program for healthcare students on communication support for patients with ALS was developed [9]. The program consisted of lectures and practice on AAC methods, and its effectiveness was evaluated through pre-/post-tests, assessments of the number of letters transmitted in 5 min, perceived burden, and text mining of free-response comments. The program was effective; however, it required >5 successive h of face-to-face participation (5.5 h, including breaks and preparation), placing a significant burden on both the participants and facilitators.

The coronavirus disease 2019 (COVID-19) pandemic, which began in 2019, necessitated a shift from face-to-face education to online platforms [10]. E-learning, which allows repeated learning at one's own pace and anywhere, has been reported to improve knowledge and skills in the medical and nursing fields [10-12]. Additionally, combining online and face-to-face education has been shown to be effective [14]. Furthermore, compared with face-to-face education, e-learning can be offered to large and remote groups of learners. Moreover, e-learning is superior to face-to-face education in terms of preparing educational materials and time commitment required by facilitators [15]. E-learning also enables content delivery that can be customized to meet the specific niches of each participant, thereby enhancing the overall effectiveness of training [12]. However, issues related to internet access and the information technology skills of participants have been reported in e-learning [16]. In contrast, in Japan, three declarations of a state of emergency, including movement restrictions, were issued between April 2020 and September 2021, leading to the widespread adoption of e-learning [17]. The environment and infrastructure for students to engage in e-learning have rapidly improved in the wake of the COVID-19 pandemic [18].

In this study, we aimed to create an educational program that allows participants to flexibly engage in self-learning during their spare time by adapting the face-to-face AAC support program to an e-learning platform. We aimed to verify whether an AAC educational program with e-learning could achieve similar effectiveness in terms of AAC knowledge and skills as the face-to-face program.

Table 1 Time-Table of the Program

	Time	**Contents**	**Workplace**	**Duration (min)**
Session 1 (e-learning)	0:00	Taking VAS test for expected burden before the course	Web & LB	5
	0:05	Pre-test	LB	10
	0:15	Lecture on the pathognomonic & clinical features of ALS and care for people with ALS	LB (YouTube)	15
	0:30	Quiz on the lecture contents	LB	5
	0:35	Watching "Gisoku" video on "What is the life of people with ALS?"	LB	10
	0:45	Leave reflective comments after watching "Gisoku"	LB	5
	0:50	Taking VAS test for expected burden before AAC introduction	LB (YouTube)	15
	1:05	Lecture on the basic concepts of AAC on multidisciplinary care	LB (YouTube)	10
	1:15	Leave reflective comments after watching videos	LB	5
	1:20	Preparation for Session 2: Video on transparent board method	LB (YouTube)	5
	1:25	End of the session 1		
				85 min
Session 2 (Web/in person)	0:00	Opening remarks: Guidance and attention to COVID-19 protection	Web & LB / in-person & LB	5
	0:05	Checking accomplishment of Session 1	Web & LB / in-person & LB	10
	0:15	Practice of low-tech AAC		
		How to communicate with a transparent board method (2nd time)	LB (YouTube)	5
	0:20	Taking VAS test before transparent board method practice	Web & LB	5
	0:25	Transparent board method practice (with partner, in 5 min)	Web & LB / in-person & LB	15
	0:40	Taking VAS test after transparent board method practice	Web & LB	5
	0:45	Watching the video on how to communicate with the *Kuchimoji* method	LB (YouTube)	5
	0:50	Taking VAS test before *Kuchimoji* method practice	Web & LB	5
	0:55	*Kuchimoji* method practice (with partner, in 5 min)	Web & LB / in-person & LB	15
	1:10	Taking VAS test after *Kuchimoji* method practice	Web & LB	5
	1:15	Leave reflective comments after two AAC practices (Transparent board and *Kuchimoji*)	LB	10
	1:25	End of the session 2		
				85 min

(break of 10 min, if necessary)				
Session 3 (Web/in person)	0:00	Introduction to communication devices (Let's Chat) and VAS	Web & LB / in-person & LB	5
	0:05	Instructions on how to use the device. Participants practice using it at the default speed of 15-s interval.	Web & LB / in-person & LB	15
	0:20	Taking VAS test after practice at default speed	Web & LB	5
	0:25	Instructions on how to change the speed of the device and taking VAS test for expecting burden for the device with the adjusted arbitrary speed	Web & LB / in-person & LB	5
	0:30	Practice of the device at the adjusted speed, measure the number of letters successfully communicated within 5 min, and report the speed into LB	Web & LB / in-person & LB	10
		Taking VAS test for experienced burden for the device at the adjusted speed	Web & LB	
	0:40	Leave reflective comments after device practice	LB	10
	0:50	Lecture on AAC variety and selection	LB (YouTube)	15
	1:05	Leave reflective comments after watching the video	LB	5
		(time for free-response reflective comments)		
	1:10	Leave reflective comments after Sessions 2 and 3	LB	10
	1:20	End of the session 3		
				80 min
Session 4 (e-learning)	0:00	Lecture on communication support in multidisciplinary teams	LB linking to the video on YouTube	15
	0:15	Leave reflective comments after watching video	LB	5
	0:20	Post-test	LB	10
	0:30	Taking VAS test after the entire course	Web & LB	5
	0:35	Leave reflective comments after completing the course	LB	5
	0:40	End of the session 4		
				40 min

Session 1 was delivered via e-learning and was made available 1 week before Sessions 2 & 3, which were conducted on the same day. Participants were expected to complete Session 1 before attending Sessions 2 & 3.

Session 4 was also an e-learning session and was scheduled to be completed within 2 days after Session 3.

During the practice sessions, participants engaged in communication practice using the three designated AAC methods. The number of letters successfully transmitted in each practice was measured over the 5-min period.

Web, use of internet websites for learning and practice; LB, LearningBox® (an online learning platform); VAS, visual analog scale (a tool for measuring subjective burden or discomfort); ALS, amyotrophic lateral sclerosis; AAC; augmentative and alternative communication; COVID-19, coronavirus disease 2019; Gisoku, a 9-min video produced by the broadcasting club at Nissei Gakuen Daiichi High School. Copyright is managed by the Mie ALS Association. The video depicts experiences related to ALS.

2. Materials and Methods

This study was conducted between September 2021 and March 2024.

2.1. Program with e-learning

The program, based on the face-to-face version, was structured into a preparatory session (approximately 85 min: session 1; Table 1), which covered topics such as 'Understanding and Caring for ALS,' 'Basic Knowledge of Communication Support,' and 'Interprofessional Collaboration.' The AAC practice session (approximately 165 min:

sessions 2 and 3; Table 1) included practice using three types of AAC. Finally, the review session (approximately 40 min: session 4, Table 1) focused on 'Stage-specific Approaches for ALS.' The participants completed a pre-test at the beginning of the preparatory session and a post-test at the end of the review session [9]. Learning BOX® (https://learningbox.online/) was used for this study. The preparatory and review sessions involved video-based learning using the Learning Box® linked to YouTube®, whereas the practice session was conducted with groups of two or four participants. In cases where only a single participant participated in the session, we arranged for a suitable partner, such as a faculty member or family member, to participate in the practice of using transparent communication boards and *Kuchimoji*. The participants completed the preparatory and review sessions at convenience using their own devices. Practice sessions were conducted remotely via a web connection or with in-person assistance from one or two researchers. Each participant completed the practice session twice within a 6-month interval.

2.2. AAC practice session

In AAC practice, three AAC methods used in a previous study were used [9]. Participants watched instructional videos on how to use the transparent flick-type communication boards (Flick) and *Kuchimoji* and practiced using them together. A transparent communication board is a commonly used low-tech AAC method in Japan that allows individuals to transmit letters using only their gazes. The Flick-type is modeled after the character layout commonly used on smartphones [19]. *Kuchimoji* is a Japanese unaid-AAC that combines blinking and/or mouth shapes to convey letters [20]. Participants alternated between playing the roles of the person with ALS (patient) and the caregiver, practicing conveying predetermined phrases from the 'patient' role to the 'caregiver' role. Let's Chat® (Panasonic AGE-FREE Co.), a scanning-type communication device with a single switch, was used. The researchers explained how to use the communication devices, after which the participants practiced text input individually. For each AAC, the number of letters transmitted within 5 min was measured. Additionally, the subjective burden before and after each AAC practice session was measured using a visual analog scale (VAS; 0-200, VAS Generator: http://www.vasgenerator.net/index_adv.php). Communication device exercises were conducted twice, with the first session using the default scanning speed and the second session allowing the participants to adjust the scanning speed themselves.

2.3. Pre-/post-test scores

Participants took the same test at the beginning and end of the program, similar to the face-to-face version, with only minor adjustments that did not change the core content after discussions among researchers [9, 20]. The test consisted of 10 questions, each worth 10 points, for a total of 100 points.

2.4. Participants

Participants were recruited from among healthcare students at five universities affiliated with researchers, including the faculty of medicine, nursing, rehabilitation, and education (Clinical Psychology stream). The eligibility criteria were age ≥ 18 years, ability to participate in both sessions of the program, and no prior experience with similar training or communication support. Those who were unable to attend the second session were excluded from the study. In the AAC practice, a researcher facilitated 25 participants (45.5%) remotely via the web, whereas one or two researchers facilitated the remaining participants in the same room.

All the participants provided written informed consent. Participation in the study was voluntary, without monetary or material incentives. Those taking the course for the first time were labeled 'beginners,' and those repeating the course 6 months later were labeled 'experienced.' The Mie University Faculty of Medicine Research Ethics Committee approved the study (U2021-023).

2.5. Analyses

Similar to a previous study, the effectiveness of the program was evaluated using pre-/post-test scores, the number of letters transmitted using each AAC in 5 min, the subjective burden of AAC using VAS values before and after each AAC trial, and free-text comments on impressions and awareness [9]. The VAS score was calculated as the VAS rate (VAS score after practice/VAS score before practice), with the score before each practice session serving as the baseline. Pre-/post-test scores, number of letters in 5 min, and VAS scores for the beginner and experienced groups were compared using the Wilcoxon signed-rank sum test. Data were analyzed using JMP Pro (version 17.2.0). Statistical significance was set at 5%. Similar to a previous face-to-face study, the program's overall effectiveness was assessed comprehensively, considering both quantitative results and qualitative feedback.

Free-text comments were analyzed using KH Coder®, the text-mining software [21]. A list of extracted words was used to identify characteristic terms, and coding rules were created to categorize sentences expressing positive or negative

expressions. Words that had no meaningful impact on the analysis when considered isolated were excluded. The number of sentences counted according to these coding rules was compared between the beginner and experienced groups using the chi-square test.

3. Results

Fifty-seven participants were enrolled in this study. After excluding two participants who did not complete the program, 55 participants were included in the analysis. The basic attributes of the participants are presented in Table 2. The rehabilitation students did not participate in the study.

Table 2 Demographic Characteristics of Participants

Category		**n**	**%**
Sex	Female	52	94.5
Faculty	Nursing	46	83.6
	Psychology	8	14.5
	Medical	1	18.2
Grade	Bachelor's course 2nd	16	29.1
	Bachelor's course 3rd	6	10.9
	Bachelor's course 4th	20	36.4
	M w/o clinical experience	7	12.7
	M w clinical experience	6	10.9

M w/o clinical experience, Master's course without clinical experience
M w clinical experience, Master's course with clinical experience

Table 3 shows the AAC skills and burden experienced by participants who were facilitated remotely versus face-to-face during the AAC practice. Although no statistical comparisons were made to avoid multiple testing, no distinct trends indicating that one group outperformed the other were observed.

Table 3 AAC Practice Results According to Remote and In-Person Facilitation

Group and Metrics				**Remote**	**In-person**
Beginner	Number of letters	Flick		26 [16.5-31]	27 [19-32.25]
		Kuchimoji		19 [17-24]	21 [19-23.25]
		Let's chat	default	14 [11.5-15.5]	16 [12.75-18.25]
			adjusted	25 [21-30.5]	27 [22.75-30]
	VAS	Flick	patient	1.25 [1.1-3]	1.4 [1.05-2.38]
			caregiver	1.4 [1-3.1]	1.1 [0.89-2.15]
		Kuchimoji	patient	1.6 [1.1-2.45]	1.1 [0.85-1.53]
			caregiver	1.5 [1.15-2.25]	1.1 [0.8-1.48]
		Let's chat	default	1.3 [1-2.2]	1.3 [0.54-1.93]
			adjusted	1.1 [0.8-1.9]	0.9 [0.3-1.29]
Experienced	Number of letters	Flick		32 [24-40.5]	28 [26-36.5]
		Kuchimoji		24 [19-29]	24 [12-28.75]
		Let's chat	default	14 [12-15]	15 [15-17]

			adjusted	25 [21.5-30.5]	28 [22.5-33]
	VAS	Flick	patient	1 [0.9-1.55]	1.15 [0.83-1.64]
			caregiver	1 [0.86-1.25]	1.06 [0.81-1.31]
		Kuchimoji	patient	1.3 [1.01-1.84]	1.11 [1- 1.4]
			caregiver	0.9 [0.82-1.1]	1.0 [0.9-1.2]
		Let's chat	default	1.15 [0.90-1.7]	1.07 [0.9-1.56]
			adjusted	1.1 [0.8-1.5]	0.92 [0.63-1.33]

Numerical data are shown median as [interquartile range].
AAC, augmentative and alternative communication; VAS, visual analog scale.

3.1. Pre-/post-test scores

The pre-/post-test scores for the beginner and experienced groups are presented in Table 4. Comparisons using the Wilcoxon signed-rank sum test indicated significant increases in test scores before and after the practice sessions for both the beginner and experienced groups (beginner: P<.001, experienced: P<.001). When comparing the post-test scores of the beginner group with the pre-test scores of the experienced group, a significant decrease in the test scores was observed (P=.017). However, no significant differences were found when comparing the pre-test or post-test scores between the beginner and experienced groups (pre-test scores: P=.486, post-test scores: P=.395). Table 5 shows the correct answer rates for each question along with the corresponding content.

Table 4 Summary of Pre-/Post-Test Scores

Participant Group		**Median (IQR)**	**min-max**	**n**
Beginner	Pre-test	70 [60-80]	30-100	55
	Post-test	80 [70-90]	40-100	52
Experienced	Pre-test	75 [67.5-80]	40-100	50
	Post-test	80 [70-100]	50-100	45

IQR, interquartile range

Table 5 Correct Answer Rates for Each Question in Pre-/Post-Tests

Contents	**Questions**	**pre-test 1**	**post-test 1**	**pre-test 2**	**post-test 2**
Concepts of support	Q1	92.7%	96.3%	90.2%	93.8%
	Q2	94.5%	100.0%	96.1%	100.0%
AAC without devices	Q3	74.5%	90.7%	82.4%	91.7%
AAC with devices	Q4	65.5%	66.7%	72.5%	77.1%
Multidisciplinary approach	Q5	74.5%	83.3%	90.2%	93.8%
	Q6	87.3%	81.5%	86.3%	87.5%
ALS stage-specific approach	Q7	21.8%	57.4%	29.4%	47.9%
	Q8	90.9%	81.1%	86.3%	87.5%
Social resources	Q9	18.2%	54.7%	19.6%	57.4%
Situational setting	Q10	100.0%	98.1%	100.0%	97.9%

AAC, augmentative and alternative communication; ALS, amyotrophic lateral sclerosis.

3.2. Number of letters

The number of letters transmitted within 5 min between the two groups was compared using the Wilcoxon signed-rank sum test. The number of letters transmitted by the experienced group was significantly high for Flick and *Kuchimoji* (Table 6).

Table 6 Comparison of Letters Transmitted by AAC Between the Beginner and Experienced Groups

AAC	Beginner (n=55)	Experienced (n=50)	P-value
Flick	27 [17-31]	30 [24.75-38]	<.001
Kuchimoji	21 [17-24]	24 [20.75-29]	<.001
Let's chat (default)	15 [12-16]	15 [14-16]	.605
Let's chat (adjusted)	25 [22-30]	27 [22-32.25]	.458

AAC, augmentative and alternative communication; Flick, Flick-type communication boards; Let's chat, switch controlled devices. *The table shows the number of letters transmitted in 5 min using each AAC by the beginner and experienced groups (n = 49). For each AAC method, the number of transmitted letters was compared between the two groups using the Wilcoxon signed-rank sum test. Numerical data are shown as median [interquartile range].*

3.3. VAS

Changes in the perceived burden of participants based on the VAS change rate are shown in Table 7. Comparisons of the burden between the beginner and experienced groups using the Wilcoxon signed-rank sum test indicated that the burden experienced by the experienced group was significantly lower than that experienced by the beginner group for the caregiver role using Flick and *Kuchimoji*.

Table 7 Comparison of VAS Change Rate on Subjective Burden of AAC Use Between the Beginner and Experienced Groups

AAC		Beginner	Experienced	P-value	n
Flick	patient	1.4 [1.1-2.58]	1.13 [0.9-1.6]	.086	47
	caregiver	1.3 [0.9-2.6]	1.02 [0.85-1.23]	.009	47
Kuchimoji	patient	1.3 [1.02-1.83]	1.18 [1-1.50]	.018	48
	caregiver	1.2 [0.9-1.8]	0.99 [0.86-1.146]	.002	48
Let's chat	default	1.3 [1-2]	1.14 [0.9-1.60]	.700	48
	adjusted	0.93 [0.5-1.7]	1.0 [0.736-1.4]	.746	48

AAC, augmentative and alternative communication; VAS, visual analog scale; Flick, Flick-type communication boards; Let's chat, switch controlled devices; The VAS change rate was defined as the ratio of the two VAS scores just after to just before using each AAC. This was used to evaluate the change in the subjective burden for each AAC. The Wilcoxon signed-rank sum test was used to compare the two groups (n = 48). Only Flick had 47 cases owing to missing values; Numerical data are shown as median [interquartile range].

3.4. Free-text comments

A total of 19,978 words were extracted using KH Coder®. However, frequently occurring words such as 'think' and 'feel,' which had no meaningful impact on the analysis when considered in isolation, were excluded. A total of 7,628 words were identified as analysis targets, and 1,290 words were extracted. The extracted words were reviewed sequentially, and sentences were classified as positive and negative based on the coding rules. The '|' symbol represents 'or,' and '&!' represents 'and not' in the coding rules.

3.4.1. Negative sentences

(burden &! (not | reduced | alleviated | less)) | difficult | tough | hardship | hard | challenging | confusing | (understand &! (not | difficult)) | (convey &! (not | difficult)) | tiring | (stress &! (not | less)) | (frustrated &! not) | (can do & (not)) | (fatigue &! less) | (trouble &! not) | (pain &! alleviated) | difficulty | troublesome | (inconvenient &! not) | irritated | confused | sad

3.4.2. Positive sentences

(burden & (not | reduced | alleviated | less)) | (understand & easy) | (good &! bad) | (convey &! (not | difficult)) | (alleviate & (frustration | stress)) | easy | (stress & (not | less)) | (frustrated & not) | (can do &! not) | fun | simple | (fatigue & less) | (trouble & not) | happy | relaxed | (pain & alleviated) | convenient

Table 8 presents a cross-tabulation of the number of sentences classified according to the coding rules for each group. A comparison between the two groups using the chi-square test indicated a significant difference in the number of negative sentences (chi-square value: 7.159, P=.008).

Table 8 Comparison of Negative and Positive Sentences Between the Beginner and Experienced Groups

Group	Negative sentences	Positive sentences	Number of sentences
Beginners	129 (34.5)	33 (8.8)	383
Experienced	97 (25.3)	25 (6.5)	374
Total	226 (29.9)	58 (7.7)	757
Chi-square value	7.159**	1.104	

Numerical data are the number of sentences in each category (%). **, P<.01; The number of sentences refers to the total number of sentences in each group, including sentences not classified as negative or positive sentences.

4. Discussion

Data from 55 participants were analyzed to verify the effectiveness and retention of the ALS communication support training program using e-learning. The program demonstrated effectiveness in communication support knowledge and AAC skills comparable to the face-to-face program, with a lower perceived burden than in a previous study [9]. Based on these results, the following considerations were made based on the findings of previous studies:

4.1. Pre-/post-test scores

The results of the pre-/post-test scores confirmed the effectiveness of the program after a single session. Studies in other countries that have evaluated the effectiveness of communication support education using e-learning have reported the effectiveness of a single session, suggesting that our results are consistent with previous findings [22]. However, the scores significantly decreased after 6 months, indicating that the retention of knowledge was insufficient. The items that showed a significant decrease in correct answer rates over 6 months were related to stage-specific approaches for ALS (Q7) and social resources (Q9) (Table 5). In contrast, the correct answer rates for questions related to AAC methods/devices (Q3, Q4) and interprofessional collaboration (Q5) improved compared with the initial session. These results are similar to those observed during face-to-face training in 2021 [9]. In a study by Wenzel et al. on the e-learning effects of cardiopulmonary resuscitation training, test scores significantly decreased after 6 months [23]. However, several studies have highlighted the usefulness of repeated learning for knowledge retention [24, 25]. Reinforcing acquired knowledge can promote knowledge retention. Interprofessional collaboration has been reported as an important component of university nursing education curricula, and learning objectives in various fields have incorporated this aspect [26]. The improved correct answer rates after 6 months in this program likely resulted from the combination of learning from this program and additional interprofessional collaboration education within the university curricula. Furthermore, previous studies have reported that patient experience and simulation-based learning effectively enhance and retain knowledge and skills [14, 27, 28]. The improvement in AAC method-/device-related items appears to stem from a combination of experiences gained through AAC practice. Conversely, the difficulty in retaining knowledge about stage-specific approaches to ALS and social resources may be linked to the lack of opportunities for repetition and application within the usual university curricula [26]. Ensuring follow-up and opportunities for repetition after the program should be considered to improve knowledge retention.

Several studies have reported that e-learning is more beneficial than the traditional face-to-face lectures [29]. In this study, the scores at each stage were higher than those in the face-to-face program (mean [standard deviation] of scores in the face-to-face program: pre-test: beginner, 5.1 [2.0]; experienced, 6.0 [2.1] and post-test: beginner, 6.9 [1.9]; experienced, 7.2 [1.8] (out of 10 points)). The benefits of e-learning, including the ability to repeat lectures and study at one's own pace, may have been reflected in their scores. However, despite the lack of significant differences in score changes, a ceiling effect was observed for some questions, which may have limited further score improvements.

4.2. AAC practice

The number of letters transmitted using Flick and *Kuchimoji* increased significantly with experience. Similar to the face-to-face program, once the participants gained experience using AAC, they were able to retain their skills for up to 6 months. Additionally, perceived burden decreased for the caregiver role when using Flick and *Kuchimoji*, suggesting that prior experience with AAC could reduce the burden associated with using AAC. However, the number of letters transmitted in both types of AAC was lower in this study than in the face-to-face program. Conversely, perceived burden tended to be low in this study. We hypothesized that the absence of social facilitation, which occurs in face-to-face programs because of the presence of others, contributed to this difference because the study was conducted in small groups of 2-4 participants, with approximately half of them being facilitated remotely by researchers [30]. Instead, the participants were able to relax, as evidenced by the VAS score changes and text-mining results. Furthermore, no distinct differences were observed between the remote and face-to-face facilitation methods, suggesting that AAC practice can be effectively conducted remotely.

Regarding communication devices, no significant differences were observed between the two groups in terms of the number of letters transmitted and the perceived burden. However, the number of letters transmitted by beginners using communication devices tended to be higher than that in face-to-face training. Text mining revealed few negative sentences and more positive sentences regarding the communication devices. Previous studies have also reported that communication devices can be easily used by university students during AAC training [31, 32]. The lack of significant skill differences, owing to their experience with communication devices, may be because they are relatively easy to master. Unlike previous studies, this study was conducted after the spread of remote learning owing to the COVID-19 pandemic and the associated emergency declarations. Widespread adoption of e-learning during the COVID-19 pandemic has been reported to improve students' skills with information technology [18]. The timing of the study may have influenced the initial skills in using communication devices.

4.3. Limitations, strengths, and future directions

4.3.1. Impact of COVID-19

In a previous study, there were challenges regarding sample size; however, this study was conducted during the COVID-19 pandemic, which significantly limited the ability to recruit participants from classes handled by the researchers. Restrictions on in-person interactions and overall uncertainty during the pandemic made recruitment particularly challenging. Additionally, unlike in previous studies, no financial incentives were used for recruitment, which may have further affected the ability to attract students. To overcome these challenges, we extended the study period and expanded recruitment efforts across the five institutions. These efforts allowed us to secure the number of participants similar to that of a previous study. Despite the difficulties faced during recruitment, meaningful outcomes were achieved in this study. The subjective burden associated with AAC practice was lower than that reported in a previous study, indicating that adjustments made during recruitment and the study design may have contributed to the enhanced learning experience.

4.3.2. Participant characteristics

In a previous study, nursing students accounted for 60.3% of the participants [8], whereas in the current study, this proportion increased to 83.6% (Table 1). Rehabilitation students typically receive communication support in their curriculum, and its absence may influence their learning outcomes. The overall learning effect in this study may have been lower than that in a previous study including rehabilitation students because of the absence of rehabilitation students in this study. Moreover, unlike previous studies, 23.6% of the participants in this study were graduate students. The presence of graduate students with potentially high readiness for learning may have led to an underestimation of the learning effects in this study. This factor should be considered when interpreting the results as it may have influenced the overall evaluation of the program's effectiveness.

4.3.3. Strengths of e-learning and future directions

In a previous study, participants had to complete a schedule of >5 h in person; however, in this study, the real-time components took only approximately 2 h, and the total time, including self-study, was <4 h [9]. Additionally, participants could complete the program at their own pace and time, which likely contributed to a lower perceived burden than in the previous study. Unlike in-person training, the absence of preparation, venue setup, and repeated lectures reduced implementation costs. Moreover, in terms of AAC practice, no distinct differences in AAC skills or perceived burden were observed between remote and face-to-face facilitation (Table 3). This suggests that the entire program can be completed using e-learning, without the need for face-to-face facilitation. In the future, development of training programs for healthcare professionals working in busy clinical settings should be considered. Unlike students, healthcare

professionals differ in their specialties and practice settings, leading to varying demands across professions. Therefore, personalized e-learning is likely to be effective in addressing the specific needs of each profession [33].

5. Conclusion

We developed an ALS communication support education program with e-learning for healthcare students and verified its effectiveness. The program demonstrated effectiveness in communication support knowledge and AAC skills, similar to the face-to-face program. Additionally, the perceived burden of AAC practice indicated that small-group practice with e-learning is potentially more effective than group exercises in face-to-face settings. Communication support education for ALS is expected to become accessible and widely applicable through e-learning platforms.

Compliance with ethical standards

Acknowledgments

No potential conflict of interests are reported by the author(s). We would like to thank Editage (www.editage.jp) for English language editing. This study was supported by the Japan Society for Promotion of Science (grant number 20K03025).

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Beukelman D, Fager S, Nordness A. Communication support for people with ALS. Neurol Res Int. 2011; 2011:714693. doi:10.1155/2011/714693.

[2] Eshghi M, Yunusova Y, Connaghan KP, Perry BJ, Maffei MF, Berry JD. Rate of speech decline in individuals with amyotrophic lateral sclerosis. Sci Rep. 2022; 12:15713. doi:10.1038/s41598-022-19651-1.

[3] Ishikawa T, Konishi K. Latent class analysis of communication methods and devices among Japanese patients with amyotrophic lateral sclerosis: A cross-sectional survey. Speech, Language and Hearing. 2024:1-12. doi:10.1080/2050571X.2024.2403239.

[4] Paynter C, Mathers S, Gregory H, Vogel AP, Cruice M. How people living with motor neurone disease and their carers experience healthcare decision making: a qualitative exploration. Disabil Rehabil. 2022; 44:3095-103. doi:10.1080/09638288.2020.1855261.

[5] Fried-Oken M, Mooney A, Peters B. Supporting communication for patients with neurodegenerative disease. NeuroRehabilitation. 2015; 37:69-87. doi:10.3233/NRE-151241.

[6] Peters B, O'Brien K, Fried-Oken M. A recent survey of augmentative and alternative communication use and service delivery experiences of people with amyotrophic lateral sclerosis in the United States. Disabil Rehabil Assist Technol. 2024; 19:1121-34. doi:10.1080/17483107.2022.2149866.

[7] Imura T. [Analysis of the situation and support for using communication aids in ALS patients]. J Japan Intractable Illness Nurs Soc. 2015; 20:125-38. Japanese.

[8] Maresca G, Pranio F, Naro A, De Luca R, Maggio MG, Scarcella I, et al. Augmentative and alternative communication improves quality of life in the early stages of amyotrophic lateral sclerosis. Funct Neurol. 2019; 34:35-43.

[9] Ishikawa T, Narita Y, Imura T, Tanaka Y, Nakai M, Fukuroku K. A half-day education program for healthcare students on communication support for people with amyotrophic lateral sclerosis. J Commun Healthc. 2021; 14:114-25. doi:10.1080/17538068.2021.1892423.

[10] Aristovnik A, Karampelas K, Umek L, Ravšelj D. Impact of the COVID-19 pandemic on online learning in higher education: a bibliometric analysis. Front Educ. 2023; 8:1225834. doi:10.3389/feduc.2023.1225834.

[11] Kokoç M. Flexibility in e-learning: modelling its relation to behavioural engagement and academic performance. Themes in eLearning. 2019; 12:1-16. doi:10.1177/0047239519840573.

[12] Salem M, El-Dohdar M, Enshasy H, Serdah K, Qazaer R. Effects of using e-learning on students' academic performance in university college of applied sciences. In: Explore Business, Technology Opportunities and Challenges After the COVID-19 Pandemic. International Conference on Business and Technology. Lecture Notes in Networks and Systems. Cham: Springer; 2022. p. 219-30. doi:10.1007/978-3-031-08954-1_20.

[13] Webb L, Clough J, O'Reilly D, Wilmott D, Witham G. The utility and impact of information communication technology (ICT) for pre-registration nurse education: a narrative synthesis systematic review. Nurse Educ Today. 2017; 48:160-71. doi:10.1016/j.nedt.2016.10.007.

[14] Terry VR, Terry PC, Moloney C, Bowtell L. Face-to-face instruction combined with online resources improves retention of clinical skills among undergraduate nursing students. Nurse Educ Today. 2018; 61:15-9. doi:10.1016/j.nedt.2017.10.014.

[15] Regmi K, Jones L. A systematic review of the factors – enablers and barriers – affecting e-learning in health sciences education. BMC Med Educ. 2020; 20:91. doi:10.1186/s12909-020-02007-6.

[16] Mlinar Reljić N, Drešček Dolinar M, Štiglic G, Kmetec S, Fekonja Z, Donik B. E-learning in nursing and midwifery during the COVID-19 pandemic. Healthcare (Basel). 2023; 11:3094. doi:10.3390/healthcare11233094.

[17] Goda Y, Takabayashi T, Suzuki K. Impact of the COVID-19 pandemic on education in Japan and the role of the Japan Society for Educational Technology. In: Dennen V, Dickson-Deane C, Ge X, Ifenthaler D, Murthy S, Richardson JC, eds. Global Perspectives on Educational Innovations for Emergency Situations. Cham: Springer; 2022. p. 383-98. doi:10.1007/978-3-030-99634-5_27.

[18] Sharma A, Alvi I. Evaluating pre and post COVID-19 learning: An empirical study of learners' perception in higher education. Educ Inf Technol (Dordr). 2021; 26:7015-32. doi:10.1007/s10639-021-10521-3.

[19] Ishikawa T, Sano F, Narita Y, Nagano S, Mochizuki H, Kowa H, et al. A case series study of the utilization of 50-letter and Flick type transparent communication boards in patients with amyotrophic lateral sclerosis. Int Symp Affect Sci Eng ISASE2023. 2023;1-4. doi:10.5057/isase.2023-C000030.

[20] Narita Y, Nakai M, Imura T, Tanaka Y, Ishikawa T, Fukuroku K. Education program for students in multiple healthcare fields to support communication with patients with amyotrophic lateral sclerosis - Can a pre-/post-test evaluate knowledge gained through education sessions? Int J Affect Eng. 2019; 18:161-70. doi:10.5057/ijae.IJAE-D-19-00003.

[21] Higuchi K. A two-step approach to quantitative content analysis: KH Coder tutorial using Anne of Green Gables (part I). Ritsumeikan Social Sci Rev. 2016; 52:77-91.

[22] Dada S, Flores C, Bastable K, Tönsing K, Samuels A, Mukhopadhyay S, et al. Use of an intelligent tutoring system for a curriculum on augmentative and alternative communication: feasibility for implementation. Int J Lang Commun Disord. 2024;1-15. doi:10.1111/1460-6984.13084.

[23] Wenzel V, Lehmkuhl P, Kubilis PS, Idris AH, Pichlmayr I. Poor correlation of mouth-to-mouth ventilation skills after basic life support training and 6 months later. Resuscitation. 1997; 35:129-34. doi:10.1016/s0300-9572(97)00044-0.

[24] Khalafi A, Fallah Z, Sharif-Nia H. The effect of spaced learning on the learning outcome and retention of nurse anesthesia students: a randomized-controlled study. BMC Med Educ. 2024; 24:322. doi:10.1186/s12909-024-05290-9.

[25] [25] Volerman A, Kappel N, Tayal A, Rosenwinkel M, Salem E, Vipond L. Student knowledge gains among first-time and repeat attendees of school-based asthma education program. BMC Pulm Med. 2023; 23:249. doi:10.1186/s12890-023-02544-y.

[26] Ministry of Education, Culture, Sports, Science and Technology, Japan. Nursing education model core curriculum [Internet]; c2017 [cited 25, Sep, 2024]. Available from: https://www.mext.go.jp/component/a_menu/education/detail/__icsFiles/afieldfile/2017/10/31/1217788_3.pdf.

[27] Ruth M. Simulation and its effects on knowledge retention and critical thinking skills. Int J Nurs Health Care Res. 2023; 6:1426. doi:10.29011/2688-9501.101426.

[28] Mehdipour-Rabori R, Bagherian B, Nematollahi M. Simulation-based mastery improves nursing skills in BSc nursing students: a quasi-experimental study. BMC Nurs. 2021; 20:10. doi:10.1186/s12912-020-00532-9.

[29] Marawa'a A. E-learning experiences among nursing students: a scoping review. Adv Med Educ Pract. 2024; 15:369-79. doi:10.2147/AMEP.S453153.

[30] Triplett N. The dynamogenic factors in pacemaking and competition. Am J Psychol. 1898; 9:507-33. doi:10.2307/1412188.

[31] Schäfer MC, Sutherland D, McLay L, Achmadi D, van der Meer L, Sigafoos J, et al. Research note: attitudes of teachers and undergraduate students regarding three augmentative and alternative communication modalities. Augment Altern Commun. 2016; 32:312-9. doi:10.1080/07434618.2016.1244561.

[32] Achmadi D, van der Meer L, Sigafoos J, Lancioni GE, O'Reilly MF, Lang R, et al. Undergraduates' perceptions of three augmentative and alternative communication modes. Dev Neurorehabil. 2015; 18:22-5. doi:10.3109/17518423.2014.962767.

[33] Cook DA, Levinson AJ, Garside S, Dupras DM, Erwin PJ, Montori VM. Internet-based learning in the health professions: a meta-analysis. JAMA. 2008; 300:1181-96. doi:10.1001/jama.300.10.1181.