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Original article

Evaluation of the effectiveness of an e-learning regarding specific pharmaceutical care for individuals with visual impairment on students' confidence and skills

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Keywords
Visual impairment
E-learning
Kirkpatrick model
Branching scenario
Pharmaceutical care

Summary

Background > Trainings related to visual impairment are limited in scope, with pharmacists frequently lacking awareness regarding the requirements of this population. An e-learning course on visual impairment and patient-specific pharmaceutical care, comprising educational videos and clinical cases, has therefore been developed. The objectives were (1) to identify areas for improvement in the initial e-learning, and (2) to measure the effect of the e-learning on students' satisfaction, confidence, and self-assessed and measured skills.

Material and methods > The e-learning effectiveness was evaluated according to levels 1 and 2 of Kirkpatrick's model. Forty-nine students were randomly divided into two groups. Group 1 received the initial version of the e-learning and Group 2 received the modified version, based on the evaluation of the initial version. Satisfaction and confidence questionnaires, in addition to a pre-test and two post-tests, were completed by participants. Student's t-tests for paired and independent samples were performed using IBM® SPSS 29 Advanced software.

Results and discussion > Students' participation rate was 96% (47 students completed the e-learning in its entirety), and the overall satisfaction level was recorded at 80%. An increase in confidence was observed in both groups (Group 1: +35.4%; Group 2: +37%), as well as an improvement in skills measured by the gain in points between the pre- and post-tests (Group 1: +33%; Group 2: +41%). Over a four-month period, no significant loss of knowledge was observed in either group. This study highlights the positive impact of the e-learning on students' confidence and skills in managing visual impairment and delivering patient-specific pharmaceutical care.

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Mots clés
Déficience visuelle
Formation en ligne
Modèle de Kirkpatrick
Scénario en branchement
Soins pharmaceutiques

Résumé

Évaluation de l'efficacité d'un e-learning sur les soins pharmaceutiques spécifiques pour les personnes avec une déficience visuelle sur la confiance et les compétences des étudiants

Introduction > *Les formations concernant la déficience visuelle sont limitées, les pharmaciens étant souvent peu sensibilisés aux besoins de cette population. Un cours en ligne sur la déficience visuelle et les soins pharmaceutiques spécifiques à ces patients, comprenant des vidéos éducatives et des cas cliniques, a donc été développé. Les objectifs étaient : (1) d'identifier les éléments à améliorer dans la formation initiale et (2) de mesurer l'effet de la formation sur la satisfaction, la confiance et les compétences auto-évaluées et mesurées des étudiants.*

Matériel et méthodes > *L'efficacité de l'apprentissage des étudiants a été évaluée selon les niveaux 1 et 2 du modèle de Kirkpatrick. Quarante-neuf étudiants ont été répartis au hasard en deux groupes. Le groupe 1 a reçu la version initiale de la formation et le groupe 2 a reçu la version modifiée sur la base de l'évaluation de la version initiale. Les participants ont rempli des questionnaires de satisfaction et de confiance, ainsi qu'un pré-test et deux post-tests. Des tests* t *de Student pour échantillons appariés et indépendants ont été réalisés avec le logiciel IBM® SPSS 29* Advanced.

Résultats et discussion > *Le taux de participation des étudiants était de 96 % (47 étudiants ont complété la formation dans son entièreté) et le niveau de satisfaction global a été évalué à 80 %. Une augmentation de la confiance a été observée dans les deux groupes (groupe 1 : +35,4 % ; groupe 2 : +37 %), ainsi qu'une amélioration des compétences mesurées (groupe 1 : +33 % ; groupe 2 : +41 %). Sur une période de quatre mois, aucune perte significative de connaissances n'a été observée dans les deux groupes. Cette étude souligne l'impact positif de l'apprentissage en ligne sur la confiance et les compétences des étudiants dans la gestion de la déficience visuelle et la dispensation de soins pharmaceutiques adaptés à chaque patient.*

Introduction

The role of the community pharmacist has evolved significantly in recent years to meet societal expectations, particularly by considering the patient as a partner in care [1] and by offering new services, such as medication reviews and vaccination [2]. The primary responsibility of the pharmacist has now evolved towards a service focused on patient information and advice, to promote the appropriate and rational utilisation of medications. Additionally, the pharmacist is tasked with the prevention and resolution of issues pertaining to medication use, including drug–drug interactions, duplicate prescriptions, and inadequate therapeutic adherence [3]. The pharmacist's role is to promote healthy lifestyle among patients and the provision of personalised support [3], shifting from product-centred activities to patient-centred activities [4,5], known as "pharmaceutical care''.

In light of these considerations, pharmaceutical care should be tailored to the specific needs of individuals with visual impairment (VI). Therefore, community pharmacists must identify patients with VI and adapt care. Applying French prevalence estimates for VI to the Belgian population counted by Statbel on 1st January 2022 (11,584,008 inhabitants) [6] results in an estimated 220,096 individuals with VI. With 4,656 community pharmacies reported by the Belgian Pharmaceutical Association in July 2022 [7], this corresponds to a theoretical average of around 47 patients with VI per pharmacy. However, this figure is purely indicative and does not account for geographical disparities, differences in medication use among patient, or alternative supply channels (e.g., online purchasing). Furthermore, pharmacists' estimations of the number of patients with VI in their own practice appear to be substantially lower than these projections, which may influence both the perceived need for training and the retention of acquired skills. Several studies have highlighted the lack of disability care training in healthcare curricula. According to Rotoli *et al.* [8], few universities include such content, a gap also observed among practicing professionals. For example, in Belgium, community pharmacists reported limited awareness and training related to VI [9]. The findings of the study conducted by Kentab *et al.* [10] in Saudi Arabia suggest that the information and services provided by community pharmacists were judged to be insufficient by 46% of respondents with VI. A study of English-speaking populations

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has revealed that pharmacists are not always aware of their patients' instances of VI [11]. Indeed, in practice, it can be difficult to recognise that a person has VI. Furthermore, these individuals often fail to disclose this information to their pharmacist [12]. Similarly, 83.3% of dental students expressed a desire for hands-on experience with patients with disabilities during their studies [13]. Nursing students also reported insufficient guidance and inadequate preparation for managing these patients, particularly in clinical practice [14]. Focus groups on Europe and the United States involving individuals with VI underscored the need for specific training among healthcare providers [15,16]. Consequently, several authors recommend integrating practical disability-focused education, including communication techniques and care adaptations, into university programs [15,17,18].

In this context, an e-learning course regarding VI and patient-specific pharmaceutical care was developed for students in Pharmaceutical Sciences. The objective of this study was (**1**) to identify areas for improvement in the initial e-learning, and (**2**) to measure the effect of the e-learning on students' satisfaction and confidence in their learning, as well as students' self-assessed and measured knowledge and skills.

Material and methods

The e-learning course was developed as part of a doctoral research project focused on VI. The lead author completed a university certificate in low vision, and the teaching team was composed of pharmacists, a PhD pharmacist university professor, and educational technologists.

The development of the programme followed the ADDIE model (Analysis - Design - Development - Implementation - Evaluation), a structured approach frequently utilised in the design, development, and evaluation of learning programmes or courses. The study methodology is therefore presented according to this model.

Analysis

The analysis of pharmacists' training needs with a focus on the improvement of pharmaceutical care for individuals with VI was conducted through comprehensive literature searches and a series of studies undertaken by our research team in collaboration with these individuals and healthcare professionals [9,19–22].

Design and development

Following Bloom's Taxonomy [23], four training objectives have been defined regarding students' abilities at the end of the course.

- **Objective 1**: Know. To define VI and cite its causes and distinctive signs.
- **Objective 2**: Understand. To interpret visual acuity and classify individuals according to their VI category.
- **Objective 3**: Apply. To use the recommendations and tools provided and adapt pharmaceutical care to a person with VI.
- **Objective 4**: Analyse. To analyse a prescription in the context of a person with VI and structure their pharmaceutical care.

The initial e-learning material consisted of educational videos and clinical cases. Students were provided with validated versions of two sets of recommendations: **a)** recommendations on caring for individuals with VI at the pharmacy [24], and **b)** recommendations on assistive products useful in pharmacy practice [25]. Furthermore, a medication decision table (MDT) regarding ocular adverse drug events and complex dosage forms to use was provided, as well as one summary sheet. All this material was accessible online via Moodle®, the institution's Learning Management System.

The educational videos consisted exclusively of theoretical content to provide students with knowledge. Four educational videos were created.

- **Video 1**: VI (10 minutes). It defines VI by detailing the different categories of VI described by the World Health Organisation and explores the epidemiology and aetiology of VI.
- **Video 2**: VI and medications (7 minutes). It looks at the difficulties encountered by people with VI when using medications and their dosage forms, as well as the ocular adverse drug events of medications.
- **Video 3**: Managing a person with VI in a pharmacy (13 minutes). It gives some recommendations on access to the pharmacy, identifying a person with VI, communication with a person with VI, and specific pharmaceutical care.
- **Video 4**: Assistive products (18 minutes). It defines assistive products and presents in more detail all those that could be transferred to pharmacy practice.

The clinical cases were developed using Twine® 2.10.0 software and exported in SCORM format to be added to Moodle® (cases 1 and 2) and using H5P® plugin (HTML5 Package) for Moodle® (cases 3 and 4). The cases were presented in the form of a branching scenario, structured like a tree with several different pathways. Throughout the cases, students were asked to answer single and multiple-choice questions to help them learn how to communicate appropriately with a person with VI, determine the category of VI and whether they require appropriate pharmaceutical care, carry out specific management tasks, and use the recommendations and MDT. Feedback was also provided throughout the cases to offer correct answers and additional information. Four clinical cases have been created.

- **Case 1**: Mrs Macula. Asthmatic patient accompanied by her husband to the pharmacy for an initial prescription of Symbicort® (*budesonide + formoterol*) 160 µg/4.5 µg.
- **Case 2**: Mrs Iris. A regular patient of the pharmacy who comes with her guide dog for a cough syrup.
- **Case 3**: Mr. Schlemm. Glaucoma patient who comes to the pharmacy for a refill of his medication.

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- **Case 4**: Mrs Retina. Patient who comes to the pharmacy with her white cane and a prescription for Xadago® (*safinamide*) 100 mg.

Implementation

A prospective longitudinal interventional study was conducted to ascertain the level of satisfaction, confidence, and skills exhibited by students related to their learning about VI and patient-specific pharmaceutical care. The study involved all Master 2 students in Pharmaceutical Sciences at the University of Mons in the 2024–2025 academic year. The cohort initially comprised 49 students. The study was conducted by randomly dividing students into two groups, based on a list. The group 1 followed the training initially planned (four educational videos and four clinical cases). The results of this group were analysed with a view to making modifications to improve the training. The second group underwent the modified training to evaluate the effectiveness of the modifications that had been made to it (*figure 1*).

Access restrictions and completion conditions were configured on Moodle®, necessitating students to fully complete one activity before accessing the next. To test the functionality of these settings, the e-learning was completed internally by the research team who had not been involved in creating the course (three research pharmacists). This validation enabled the parameters to be adjusted and a summary sheet to be developed, entitled "Determining the type of VI and visual acuity''. The validation process by a community pharmacist also enabled the assessment of the relevance of the clinical cases developed. The participation in the study was voluntary and non-discriminatory. Indeed, any student who did not wish to participate or who was excluded from the study due to non-compliance with the dates was given access to all the teaching resources at the end of the study. Furthermore, students were requested to consent to the utilisation of their data for research purposes, in accordance with the stipulations of the General Data Protection Regulation.

Evaluation

The effectiveness of the e-learning was evaluated using the Kirkpatrick model's Level 1 and Level 2 criteria [26].

Measuring confidence and satisfaction (Level 1)

Prior to and following the e-learning, students completed a questionnaire designed to assess their self-confidence in learning. At the end of the e-learning, students completed a satisfaction questionnaire. These questionnaires (Appendix A; see supplementary material associated with this article online), adapted from the French-language version of the Self-Confidence in Learning Scale and Self-Satisfaction in Learning Scale respectively [27], consisted of five questions graded on a Likert scale from 0 to 10, for a maximum total of 50 points. The satisfaction questionnaire included two additional open questions on: **a)** what students appreciated most about the course and **b)** what could be improved in the course. All questionnaires were made available on Moodle®, and students' answers were subsequently extracted and coded into an Excel® file.

Measuring knowledge and skills (Level 2)

For each training objective, students evaluated their level of skills prior to and following the e-learning on a Likert scale ranging from 0 to 10, with a maximum total of 40 points (Appendix B; see supplementary material associated with this article online). To evaluate the measured knowledge and skills, students completed a pre-test (Appendix C; see supplementary material associated with this article online) and a post-test (Appendix D; see supplementary material associated with this article online). Four months later, students completed a second post-test (Appendix E; see supplementary material associated with this article online) to assess the extent to which their knowledge had been internalised over time. The three tests, available on Moodle®, were identical in structure, comprising four sections each, with each section designed to evaluate a specific training objective. The maximum total possible for the three tests was 20 points, with a distribution of 5 points per objective. Students' answers were subsequently extracted into an Excel® file.

Statistical analyses

To verify adherence to the normal distribution, the Shapiro-Wilk test was employed (sample size < 50) for each continuous variable, as well as the QQ plot and the moustache box. On this basis, continuous variables following a normal distribution were presented as the mean (standard deviation), while continuous variables not following a normal distribution were presented as the median [interquartile range]. Numbers and percentages were utilised to report categorical variables.

A paired-samples Student's *t*-test was conducted to analyse changes in self-assessed and measured knowledge and skills, as well as changes in confidence within each group. An independent samples Student's t-test was also conducted to compare the pre- and post-tests results of the two groups, as well as the responses to the confidence and self-assessed skills questionnaires. A 20-point weighting was applied to each variable, and a *P*-value < 0.05 was considered statistically significant for all these tests. The psychometric quality of the questionnaires was then assessed using Cronbach's α for internal consistency and Spearman's ρ for the correlation of competence and confidence scores between runs. Cronbach's α was satisfactory when greater than 0.7 [28], while Spearman's ρ was indicated to be high when greater than 0.7 (*P*-value < 0.05) [29]. All statistical analyses were performed using IBM® SPSS 29 Advanced software.

Results

The detailed study process is illustrated in *figure 1*. Of the 49 students in the cohort, 47 completed the e-learning in its

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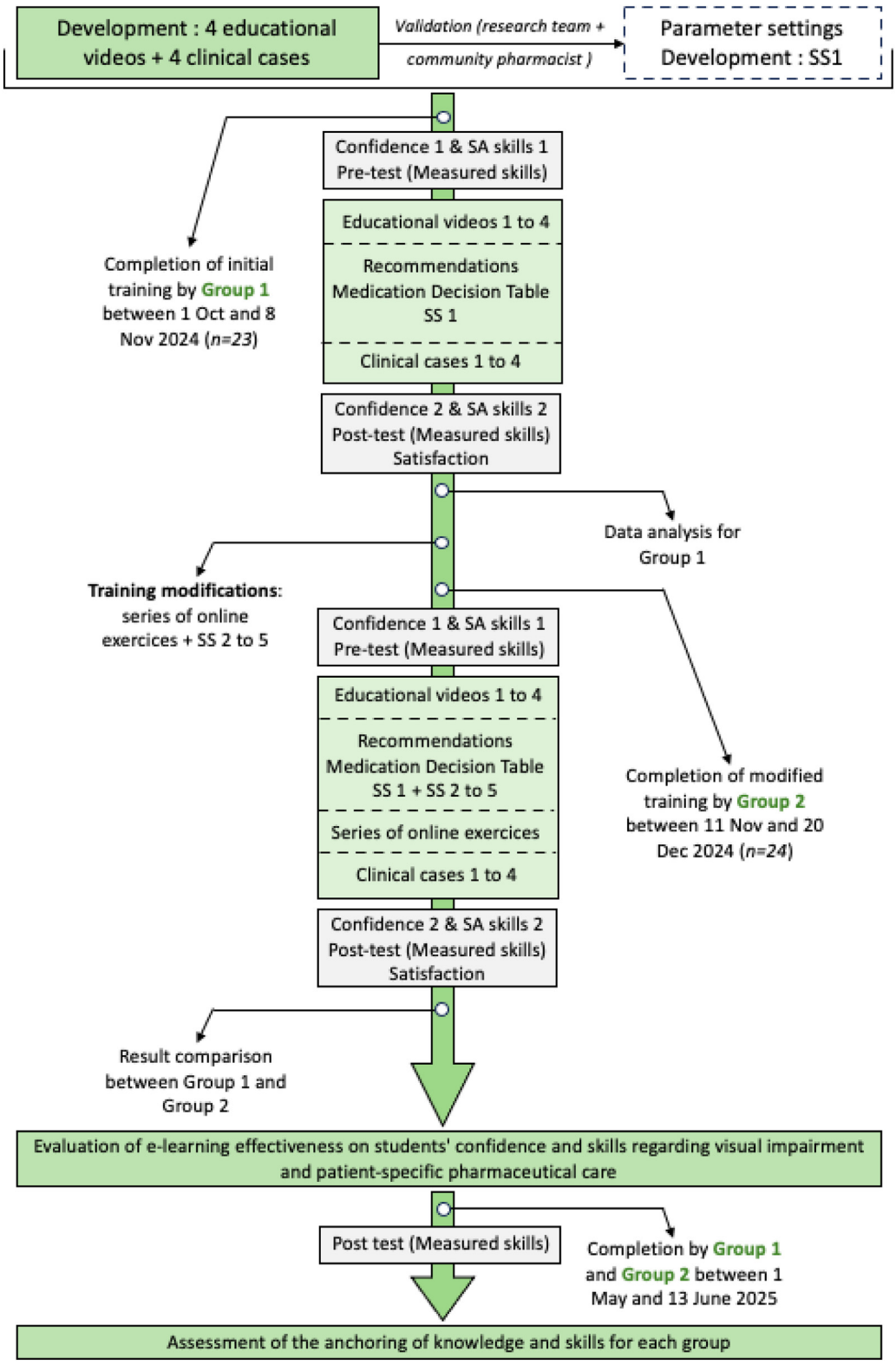

FIGURE 1

Detailed process for completing the e-learning, for Group 1 and Group 2. SA: self-assessed, SS: summary sheet

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entirety, representing a participation rate of 96%. Only two students were excluded on the grounds that they had failed to complete the e-learning course within the stipulated timeframe. The results obtained in the pre-test were analysed to ascertain that the mean and standard deviation of each group were similar. Consequently, it can be posited that students' level could be considered equivalent for both groups: 23 students in Group 1 and 24 students in Group 2, who followed e-learning between 1 October and 8 November 2024 and 11 November and 20 December 2024, respectively. The same students completed the second post-test: 22 students in Group 1 and 21 students in Group 2, between 1 May and 13 June 2025.

All variables exhibited a normal distribution ($P > 0.05$ in the Shapiro-Wilk test), excepted for the variable pertaining to student satisfaction ($P = 0.001$ in the Shapiro-Wilk test). In this instance, a P-value greater than 0.05 allows the null hypothesis to be upheld, and the assertion to be made that the variables in question do indeed follow a normal distribution.

Changes in skills and confidence

Assessment within Group 1

A statistically significant change in students' self-assessed and measured skills was noted, rising from 46.5% to 80.5% ($P < 0.001$) and from 32% to 65% ($P < 0.001$), respectively. To a greater degree of particularity, a statistically significant change was observed for each objective defined ($P < 0.001$), excepted for Objective 3 (Apply) (mean score of 2/5 in the pre-test and 2.6/5 in the post-test, $P = 0.160$) which was based overall on the use of the MDT. This is evidenced by the minimal increase in points allocated to this objective (12%), in comparison to the other objectives. In a similar vein, the increase in points for Objective 4 (Analyse) was negligible (28%), given that the questions necessitated a search for information in the MDT. These results are presented in *Table I*. Furthermore, the students' self-assessment of their skills proved to be a more significant predictor than their measured skills. Statistically significant changes were noted in relation to the level of confidence, which increased from 46.5% to 80% ($P < 0.001$).

Changes to the e-learning

After the results obtained by Group 1, modifications were made to the e-learning. The results obtained for questions pertaining to the utilisation of the MDT were not satisfactory. A series of online exercises was therefore incorporated into the e-learning with the objective of enabling students to acquire the necessary skills for its effective utilisation. The series of online exercises was carried out using H5P® software and consisted of a detailed video presentation of the MDT followed by six exercises on how to use it. For example, students were asked to identify an ocular adverse drug event for a given molecule, cite difficulties in administering a given dosage form, and identify problems associated with a given prescription. The exercises were presented as multiple-choice questions, with corrections provided via demonstrative videos.

Four additional summary sheets were also produced for students who expressed a desire for written content. These sheets provide a synopsis of the theoretical information contained within the videos, encompassing the aetiology of VI, its manifestations, assistive products, and multidisciplinary support. Group 2 thus undertook the modified e-learning, which comprised four educational videos, one series of exercises, four clinical cases, and five summary sheets.

Assessment within Group 2

A statistically significant change in students' self-assessed and measured skills was noted, rising from 46% to 83.5% ($P < 0.001$) and from 36% to 77% ($P < 0.001$), respectively. A statistically significant change was also observed for each defined objective ($P < 0.001$) in relation to the skills measured. This observation included Objective 3 (Apply), for which the mean score increased from 1.7/5 in the pre-test to 3.6/5 in the post-test ($P < 0.001$). This is evidenced by the elevated attainment of points (38%) for this objective, as well as for Objective 4 (Analyse) (42%). These results are presented in *Table II*.

Table I

Results obtained by Group 1 students in the pre-test and post-test and points gained for each training objective defined. The values in brackets correspond to the standard deviation

Group 1 *(n = 23)*	Pre-test	Post-test	Gain points (%)	*P*-value
Objective 1. Know (/5)	2.1 (1.6)	4.5 (0.6)	48%	$P < 0.001$
Objective 2. Understand (/5)	0.4 (0.9)	4.0 (1.5)	72%	$P < 0.001$
Objective 3. Apply (/5)	2.0 (1.0)	2.6 (1.5)	12%	$P = 0.160$
Objective 4. Analyse (/5)	1.4 (1.0)	2.8 (1.4)	28%	$P < 0.001$
Total (/20)	6.4 (2.7)	13 (3.4)	33%	$P < 0.001$

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Table II
Results obtained by Group 2 students in the pre-test and post-test and points gained for each training objective defined

Group 2 *(n = 24)*	Pre-test	Post-test	Gain points (%)	*P*-value
Objective 1. Know (/5)	3.0 (1.6)	4.4 (0.9)	28%	$P < 0.001$
Objective 2. Understand (/5)	1.0 (0.9)	4.4 (1.3)	68%	$P < 0.001$
Objective 3. Apply (/5)	1.7 (1.0)	3.6 (0.9)	38%	$P < 0.001$
Objective 4. Analyse (/5)	1.3 (1.0)	3.4 (1.1)	42%	$P < 0.001$
Total (/20)	7.2 (3.2)	15.4 (2.7)	41%	$P < 0.001$

The values in brackets correspond to the standard deviation.

Additionally, students demonstrated higher levels of self-assessment of skills than the measured skills. A statistically significant change was observed in the level of confidence, which increased from 47% to 84% ($P < 0.001$).

Comparison of changes between groups

Table III presents the results obtained (/20) by students on questionnaires for self-assessed skills and confidence levels, as well as the results of the pre- and post-tests. Despite the absence of statistically significant differences between the two groups, a higher level of self-assessed and measured skills and confidence levels was observed in Group 2 following the completion of the e-learning. *Table IV* shows the detailed results obtained by students in the pre-test and post-test for each defined training objective. A statistically significant difference was identified for Objective 3 (Apply) between Group 1 and Group 2 in the post-test ($P < 0.001$).

Knowledge and skills anchoring

While this was not significant ($P = 0.105$), the means for the anchoring post-test were 13.3 (SD 3.5) for Group 1 and 14.3 (SD 4.4) for Group 2. The mean was therefore virtually identical to that of the first post-test for Group 1 ($P = 0.411$) and slightly lower for Group 2 ($P = 0.093$).

Assessment of overall satisfaction

The satisfaction level of students with the e-learning was found to be high, with an overall median score of 18/20 [16.4; 20]. In the satisfaction questionnaire, students were invited to indicate what they liked about the e-learning. The interactive clinical cases (22/47) and educational videos (13/47) were appreciated by students. Furthermore, to enhance the quality of the e-learning experience, it was suggested that students be provided with additional clinical cases, written material, and seminars that are delivered in the form of simulations within the teaching pharmacy.

Table III
Results obtained by students for self-assessed and measured skills, as well as for their level of confidence, before and after completing the e-learning course

	Total *(n = 47)*	Group 1 *(n = 23)*	Group 2 *(n = 24)*	*P*-value
Self-assessed skills				
SA Skills 1 (/20)	9.3 (3.9)	9.3 (3.7)	9.2 (4.0)	$P = 0.577$
SA Skills 2 (/20)	16.4 (2.5)	16.1 (2.5)	16.7 (2.4)	$P = 0.726$
Measured skills				
Pre-test (/20)	6.8 (2.9)	6.4 (2.7)	7.2 (3.2)	$P = 0.241$
Post-test (/20)	14.2 (3.2)	13 (3.4)	15.4 (2.7)	$P = 0.187$
Confidence				
Confidence 1 (/20)	9.4 (3.4)	9.3 (3.6)	9.4 (3.2)	$P = 0.387$
Confidence 2 (/20)	16.4 (2.2)	16 (2.2)	16.8 (2.2)	$P = 0.865$

SA: self-assessed. The values in brackets correspond to the standard deviation.

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Table IV
Results obtained by students in the pre-test and post-test for each defined training objective. The values in brackets correspond to the standard deviation

	Total *(n = 47)*	Group 1 *(n = 23)*	Group 2 *(n = 24)*	*P*-value
Pre-test				
Objective 1. Know (/5)	2.6 (1.7)	2.1 (1.6)	3.0 (1.6)	$P = 0.975$
Objective 2. Understand (/5)	0.9 (1.1)	0.4 (0.9)	1.0 (0.9)	$P = 0.091$
Objective 3. Apply (/5)	1.9 (1.0)	2.0 (1.0)	1.7 (1.0)	$P = 0.442$
Objective 4. Analyse (/5)	1.4 (1.0)	1.4 (1.0)	1.3 (1.0)	$P = 0.823$
Post-test				
Objective 1. Know (/5)	4.5 (0.7)	4.5 (0.6)	4.4 (0.9)	$P = 0.093$
Objective 2. Understand (/5)	4.2 (1.4)	4.0 (1.5)	4.4 (1.3)	$P = 0.352$
Objective 3. Apply (/5)	3.2 (1.4)	2.6 (1.5)	3.6 (0.9)	$P < 0.001$
Objective 4. Analyse (/5)	3.0 (1.3)	2.8 (1.4)	3.4 (1.1)	$P = 0.136$

Psychometric quality of measuring instruments

For the self-assessed questionnaires pertaining to skills, confidence, and satisfaction, Cronbach's α exceeded 0.7, thus indicating excellent internal consistency. However, Cronbach's α was found to be 0.597 and 0.599 for the pre-test and post-test, respectively, suggesting that these questionnaires exhibited poorer internal consistency. This phenomenon may be attributed to the incorporation of open-ended questions within the survey instrument. The utilisation of such questions may have had the potential to introduce variability into students' responses. Furthermore, Spearman's ρ for the interval between the pre-test and the post-test was 0.177 ($P = 0.234$), indicating a non-significant correlation. This finding indicates that students' learning experiences during e-learning did not align in a uniform manner. However, a statistically significant Spearman's ρ coefficient was obtained for both the self-assessed skills questionnaire and the confidence questionnaire. This finding indicates that all students assessed themselves more favourably after completing the e-learning, and that their gains in confidence were practically identical. These results are presented in *Table V*.

Discussion

The present study sought to assess the effectiveness of e-learning on students' skills and confidence in learning about VI and patient-specific pharmaceutical care. The study involved a cohort of 49 students, with a very high participation rate (96%).

Table V
Psychometric data for the measurement instruments used in the study

	Internal consistency	Correlation between passings	
	Cronbach' α coefficient	*Spearman' ρ coefficient*	*P*-value
SA Skills 1	0.912	–	–
SA Skills 2	0.814	0.312	$P = 0.033$
Pre-test	0.597	–	–
Post-test	0.599	0.177	$P = 0.234$
Confidence 1	0.823	–	–
Confidence 2	0.906	0.420	$P = 0.003$
Satisfaction	0.907	–	–

SA: self-evaluated.

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The evaluation of the e-learning was conducted using Kirkpatrick's model of training evaluation. This model is most frequently employed to evaluate a training programme in the medical field [26,30,31]. It comprises four complementary levels of analysis, thereby enabling an increasingly detailed and rigorous evaluation of teaching interventions [32]. In this study, the effectiveness of the e-learning was evaluated based on Level 1 and Level 2 of this model.

The first level of Kirkpatrick's model, named "Learner Reactions", pertains to satisfaction and confidence. According to Kirkpatrick, the effectiveness of training is determined by its ability to elicit a positive response from the learner [33], as indicated by a satisfaction level exceeding 80%. In the context of this study, the overall level of satisfaction was recorded at 90%. However, it should be noted that a positive assessment of satisfaction does not necessarily equate to successful learning [34]. Additionally, the study demonstrated that e-learning was responsible for a significant gain in confidence in Group 1 (35.5%) and Group 2 (37%).

The second level of Kirkpatrick's model, named "Learner learning", measures the self-assessed and measured knowledge and skills acquired during training [34]. The aim is therefore to check that the training objectives have been achieved by students. This study demonstrated that the e-learning initially created was responsible for a significant gain in points in Group 1 (33%), and therefore for an improvement in students' knowledge and measured skills. A substantial increase in points was observed for three out of the four specified training objectives in Group 1. A non-significant increase of only 12% was evident for Objective 3 (Apply). The objective of the study was predicated exclusively on the utilisation of MDT. Similarly, although substantial, the points gained for Objective 4 (Analyse) were only 28%. This phenomenon can be elucidated by the necessity for the subjects to locate specific information within the tool and the recommendations. Consequently, the research team developed new pedagogical support with the objective of enhancing training. The study demonstrated that the modified e-learning intervention resulted in a substantial increase in performance metrics in Group 2 (41%), which exceeded the gains observed in Group 1. This discrepancy can be attributed, at least in part, to the impact of the online exercise on the utilisation of the MDT. Students in Group 2 exhibited a notable enhancement in their ability to employ this tool, thereby underscoring the significance of the modifications implemented in the e-learning. Furthermore, a detailed analysis of the points obtained for each training objective reveals a substantial increase in the number of points gained for Objective 3 (Apply) and Objective 4 (Analyse) in Group 2, with increases of 38% and 42%, respectively.

The present study also demonstrates an enhancement in students' self-assessed competencies, with Group 1 exhibiting a 34% increase and Group 2 demonstrating a 37.5% increase. Despite students' self-assessment of skills exhibiting a slight increase over the actual measurements, a positive correlation was identified between the enhancement in self-assessed skills and the increase in confidence.

Additionally, a knowledge and skills anchoring test was administered four months after the completion of the e-learning course. Although a slight decline was observed in Group 2, it was not statistically significant and does not suggest a real loss of knowledge. These findings suggest that the knowledge and skills acquired during the e-learning are retained over time, thereby affirming the efficacy of the educational approach employed. During this period, students were on placement; it is possible that they were able to apply the skills and knowledge acquired with real patients, which may have influenced the results of the second post-test. This stability lends further credence to the efficacy of such a pedagogical approach in cultivating enduring skills in students. Future iterations of the training could include brief refresher sessions at regular intervals to reinforce skill anchoring and practical application.

Study limitations

Despite the study's strengths, including high participation and low attrition, there are some limitations to consider. The students in the two groups did not complete the pre-test and post-test concurrently, which may have allowed information sharing between groups and introduced a bias into the completion of these tests. Especially, Group 2 students were found to have obtained a higher overall score in the pre-test. Nevertheless, despite this slight discrepancy, the two groups remained comparable. Furthermore, the evaluation of e-learning has only been carried out according to Level 1 and Level 2 of Kirkpatrick's model. The evaluation at Levels 3 and 4 may be conducted at a subsequent point, following the integration of e-learning into the university curriculum. This approach would ensure a genuine assessment of behavioural changes, the transfer of learning, and the impact on the care of individuals with VI.

E-learning strengths and improvement area

The primary strength lies in the diversity of activities, which include educational videos, clinical cases and a series of exercises. Nevertheless, there is an area for improvement in the form of further diversification of the learning activities. This diversification of activities would facilitate the incorporation of learning methods specific to each student, thereby enhancing the efficacy of the training programme. For instance, a variety of exercises could be proposed for the interactive clinical cases, written supports could be provided, awareness sessions could be carried out, and seminars in the form of simulation in the teaching pharmacy could be added. Indeed, as Juniat *et al.* [35] have highlighted, simulation-based training is an effective method of raising medical students' awareness of the challenges faced by people with VI. The educational approach employed utilised simulated scenarios to enhance the comprehension and emotional intelligence of future healthcare

professionals regarding individuals with VI, whilst concurrently preparing them to deliver adapted and inclusive care. This aspect has not been addressed in the context of e-learning and therefore represents a significant area for improvement. Simulation-based activities could complement e-learning by providing repeated, hands-on practice of adapted communication and dispensing tasks in realistic contexts, which may support skill anchoring and confidence, particularly when real-life encounters with patients with VI remain infrequent. Additionally, the integration of individuals with VI (expert patients) into the design of educational programmes and the training of students would constitute a significant asset for the development of future training courses that are more inclusive. Their participation could enhance the authenticity of training content by integrating lived experience into the formulation and validation of recommendations and adapting scenarios, thereby improving their relevance, acceptability, and applicability to real-world pharmacy practice. Finally, future developments could explore interprofessional training approaches, with profession-specific adaptations of clinical cases, to promote a more consistent and patient-centred care for individuals with VI.

Conclusion

This longitudinal study demonstrated the effectiveness of an e-learning in improving students' confidence and skills about VI and patient-specific pharmaceutical care. This e-learning, which can be reused from year to year and requires no special supervision, offers real added value in the training of Pharmaceutical Sciences students in subjects that are currently covered only in a limited way in their university curriculum. Furthermore, it could be beneficial to make this e-learning accessible in continuing education to assist pharmacists in enhancing their knowledge and skills concerning VI and patient-specific pharmaceutical care.

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Human and animal rights: The authors declare that the work described has been carried out in accordance with the Declaration of Helsinki of the World Medical Association revised in 2013 for experiments involving humans as well as in accordance with the EU Directive 2010/63/EU animal experiments.

Informed consent and patient details: The authors declare that this report does not contain any personal information that could lead to the identification of the patient(s) and/or volunteers.
The authors declare that they have obtained written informed consent from the patients and/or subjects referred to in this article. The authors also declare that all personal details of the patient(s) and/or volunteers have been removed.

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Supplementary data
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