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IMPROVEMENT AND ASSESSMENT OF VIRTUAL PATIENT TOOL IN TEACHING OF SKILLS FOR PRACTICE OF PHARMACEUTICAL CARE

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ABSTRACT

In pharmacy courses, the use of virtual patients (VPs) allows students to enhance their clinical, pharmacotherapeutical, and communication skills. Therefore, to enhance and evaluate the use of the virtual patient (VP) tool — *PharmaVP Software* — in the teaching of skills for the practice of pharmaceutical care (PC). A methodological development study was conducted in five stages: enhancement (pre-tests), evaluation of software by developers and mentors; application; quantitative assessment, qualitative assessment, content analysis and improvement (post-tests). Nine enhancements (pre-tests) were conducted on the system. In all, 31 students resolved the clinical cases of the VP. The evaluation demonstrated that the software is functional, enables learning, and is operational, attractive, effective, productive, and satisfactory and showed positive results regarding students'acceptance, use, learning, and satisfaction. These results were confirmedby the qualitative analysis of the VP. *PharmaVP Software* was improved and evaluated satisfactorily for the teaching skills required for the practice of PC.

Keywords: education; virtual patient; pharmaceutical care.

INTRODUCTION

In recent years, research has revealed that a large number of drug-related problems may be linked to a lack of competencies (knowledge, skills, and attitudes) of pharmacists to manage pharmacotherapy. [1- 4] In 2001, Mobach had stressed the need for educational strategies to be provided, which brought the pharmacist closer to the "real world", providing knowledge and tools geared toward patient care, particularly through teaching pharmacotherapy management in "Pharmaceutical Care" (PC) courses. [5] PC has been defined as the responsible provision of drug therapy for the purpose of achieving definite outcomes that improve a patient's quality of life. [6] PC involves collaboration among healthcare professionals; cooperation with the patient in designing, implementing, and monitoring a therapeutic plan; and patient education on his/her medication and disease state. [7] Thus, PC requires several factors such as a) a change in traditional professional attitudes, b) a re-engineering of the pharmacy environment, c) the use of new technologies, and d) the acquisition of knowledge as well as skills in the areas of patient assessment, clinical information, communication, adult teaching, and psychosocial aspects of care. [7] To address these needs of pharmacists, the use of virtual educational tools has been considered are levant teaching alternative for the development of various skills, from clinical [8, 9] to behavioral. [10] In pharmacy courses, the use of virtual patients (VPs) allows

students to enhance their clinical, pharmacotherapeutical, and communication skills. [9] These skills and abilities are crucial to the delivery of appropriate PC, which directs the actions of a pharmacist to patient care. [11, 12] In a recent systematic review, Jabour-Lopes et al. [13] found only seven publications [9, 14-19] that supported the use of VP for developing skills and knowledge in the field of pharmacy. Of these, only two publications [14, 15] addressed this type of educational tool for the practice of PC and none of the studies were conducted in Latin America. Given the above, in 2010, the Laboratory of Education and Research in Social Pharmacy, Federal University of Sergipe, Brazil, developed a pilot study for the development and implementation of a VP software application called "*PharmaVP Software*" for teaching PC-practicing skills. [20] This software was developed by a multidisciplinary team, consisting of researchers from the field of computer science and pharmacy from this university, and it performed well during its application. However, the results demonstrated the need for further studies to optimize the system. Therefore, the objective of this study was to evaluate the use of the VP tool—*PharmaVP Software* — in the teaching of skills for the practice of PC and propose updates to improve this software.

METHODS

Study site and population: We conducted a study of the methodological development from January to December 2012. The study population consisted of the entire of students in the academic discipline of PC of the College of Pharmacy at the Federal University of Sergipe, Sergipe – Brazil.

Study phases: The study was divided in five phases:
Phase 1: **Improvement of *PharmaVP Software* (pre-testing):** The first version of the software had the following links: Clinical Case Register, Class Register, Consultation Rating (on screen tutors), and Case Study Analysis Template (on the students' screen). The educational tool *PharmaVP Software* was enhanced in partnership with the Department of Computer Science, Federal University of Sergipe, which developed the system. The improvement stage included the detailed planning of the project and a detailed definition of the software's new architecture. For this, we used the three layers of the system: user interface, controls, and data. The interface layer uses the *Java Server Faces (JSF)* technology. [21] The control layer uses Java language, [22] and the data persistence layer uses *Enterprise Java Beans* (EJB) technology, [23] with a MySQL database. The new system architecture was based on the documentation process of the practice of PC, called "*Pharmacotherapy Workup*". [11] During this stage, the features and restrictions that the system should include were provided by the researcher. Furthermore, the researcher validated the interface and features implemented in the system and were responsible for entering information from clinical case scenarios for the building of the database. Real clinical cases of patients having chronic illness and reflected true-to-life professional practice scenarios simulating patient care in the community were introduced in *PharmaVP Software*. [24]

Phase 2: Evaluation and comparison of quality of *PharmaVP Software* by system developers and mentors: After the improvements, the *PharmaVP Software* was evaluated and compared with the previous version, [20] by the system developers and mentors through a tool (Appendix A) adapted from the ISO/IEC 9126. [25] The developers and mentors of the system were PhD professors (DPLJ, LMAS, MD), a PhD student (BJBR), and graduate students (EMS, WC, JRN) from the fields of pharmacy and computer science. The tool that was used consists of 15 questions that assessed the following:
External Metrics:
- Functionality (interoperability, access security, and functionality - related compliance);
- Reliability (maturity, fault tolerance, recoverability, and reliability - related compliance); and
- Usability (intelligibility and usability – related compliance).

Internal Metrics:
- Efficiency (behavior with respect to time, resource utilization, and efficiency – related compliance);
- Maintainability (analyzability, changeability, stability, testability, and maintainability - related compliance); and
- Portability (adaptability, ability to be installed, coexistence, ability to replace, and portability - relatedcompliance).

The results were expressed using a Likert scale [26] ranging from 01 (totally disagree) to 05 (totally agree).

Phase 3: Application: Protocol for use of PharmaVP *Software:* In the implementation phase of the system, tutors and users (students) were involved. The instruction manual of *PharmaVP Software* (Appendix B) was provided, and a tutorial on the features of the system was delivered with a work load of 16h for presentation, training, and

handling of the system by tutors and students. The tutors, PhD (BJBR, GCB) and MSc students (VGG) with experience in PC, were responsible for the registration, amendment of clinical cases, and review of the VP consultations performed by the students. After the training of the tutors and students, the computers of the Laboratory of Education and Research in Social Pharmacy were made available for the use of VPs in practical session's of the academic discipline of PC. Further, students had remote access to the Web-based version of *PharmaVP Software* for any-time use via the link "www.lepfs.ufs.br". The procedure for using VPs included four separate visits: [11]

1. Assessment — during their first access to *PharmaVP Software*, students registered themselves on the system, performed the login process, and then selected one of the virtual clinical cases. Shortly after, information on the selected VP (age, gender, medical conditions, pharmacotherapeutic profile, subjective experiences with medications, allergies, laboratory and physical test results, etc.) was made available in the system so that the students could assess the VP corresponding to the first visit of PC.
2. Care Plan — in the second visit, new information related to the drug therapy problems of the VP was posted on the system for the creation of care plans by the students. A care plan included the following: identification, prevention, and/or resolution alternatives of the drug therapy problems; pharmaceutical interventions performed, and identification of the stake holders (patient, physician, and other healthcare professionals) required to be involved in the process to solve the drug therapy problems.
3. Follow-up Evaluation — in the third visit, new information on the clinical course of VPs was made available in the system for students to carry out the follow-up evaluation: analyzing the situation of the Drug Therapy Problems, setting the date of the next appointment with the VP, and drafting the Personal Journal of Medicinal Products.
4. Letter of Reference to Other Healthcare Professionals — in the fourth hand last visit, fields were arranged in the system for the preparation of a technical report to be sent to a doctor or to other healthcare professionals. This report contained the following: VP information; motives for referral appointment; proposed resolution alternatives for the drug therapy problems; name, contact, and registration number of the fictitious pharmacist; and references.

The students were allowed three attempts for each service, and with each new attempt. After each attempt, the templates with corrections and comments from tutors were available in the software for students to access.

Phase 4: Evaluation of teaching tool *PharmaVP Software:*

Quantitative evaluation: A quantitative evaluation of *PharmaVP Software* was performed by tutors and students on the basis of a combination of three adapted instruments: ISO/IEC 9126, [25] Hussein and Kawahara, [15] and Zary, Johnson, Boberg, and Fors. [17] The adapted version of the ISO/IEC 9126 [25] contained nine objective questions (Appendix C) that evaluated the following:

External Metrics:

- functionality (suitability and accuracy) and
- usability (learnability, operability, and attractiveness).

Quality of Use:

- effectiveness;
- productivity;
- security; and
- satisfaction.

The responses were given according to a Likert scale [26] ranging from 01 (totally disagree) to 05 (totally agree). In this study, the second and third instruments added up to 17 objective questions, of which ten were adopted from Hussein and Kawahara [15] and seven were adopted from Zary, Johnson, Boberg and Fors [17] (Appendix D). These instruments were used for assessing students 'acceptance of, use of, learning of, and satisfaction with VPs. The responses were provided using a Likert scale [26] ranging from 01 (totally disagree) to 05 (totally agree).

Qualitative evaluation: For a qualitative evaluation, responses to essay questions, like "justify your answer," included in the 26 objective questions of the three instruments mentioned above [15, 17, 25] were collected. Subsequently, the data were subjected to a content analysis [27, 28] based on Bardin: [29]

Pre-analysis:

- fluctuating reading;
- guided reading;
- transcript of the questionnaires to files;
- editorial process; and
- preparation of materials such as speech clippings and encoding.

Exploration of materials
- indication of pre-categories and formation of categories;
- prioritization and organization into groups of issues by relevance and repetition;
- transformation of the data from speeches to organized groups;
- identification of categories; and
- formation of themes—consolidated.

Processing and interpretation of results
- discussion; and
- inferences.

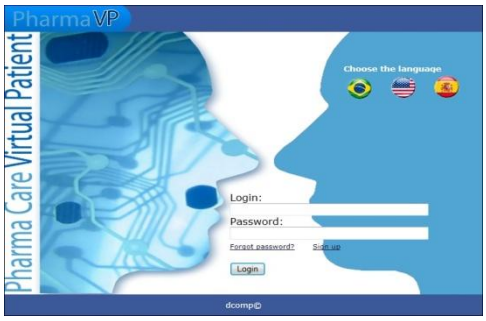
Phase 5 — Improvement of *PharmaVP Software* (after testing): After the implementation phase, *PharmaVP Software* was enhanced on the basis of the suggestions and reviews from students and tutors of the system, collected from the qualitative analysis of VPs. The changes made were classified, when possible, according to the quality criteria [25] that they belonged to: functionality, reliability, usability, effectiveness, productivity, security, and satisfaction. The updates requested by more than one student were counted only once.

Ethical aspects: This study was submitted to the Ethics in Research Committee of the Federal University of Sergipe as an extension of the masters project titled "*PharmaVP in the teaching of skills for the practice of Pharmaceutical Care: a pilot study*", approved under number CAAE-0007.0.107000-10. All student volunteers who agreed to participate in the study were previously informed about the goals and the nature of the study and guaranteed confidentiality and anonymity of the VP assessment, signed a consent form in accordance with Resolution CNS nº 196/96 (Appendix E). Furthermore, the clinical cases introduced in the *Software PharmaVP* were obtained from a study of Pharmaceutical Care approved to the Ethics in Research Committee of the Federal University of Sergipe (Protocol No. 0137.0.107.000-07) (24).

Statistical analysis: The results of the quantitative assessment of *PharmaVP Software* were expressed using descriptive statistics: mean, standard deviation, and the first (p25) and the third quartiles (p75). A nonparametric Mann-Whitney test was used for comparing the results of the assessment of the system mentors and developers (differences between the first and the second versions of *PharmaVP Software*).

RESULTS

The phase of the enhancement of *PharmaVP Software* (pre-test) lasted nine months—from January to September 2012. In this period, 14 virtual clinical cases were registered and 9 amendments were made in the system features: evolution from two to four visits by VPs; reformulation of the software on the basis of the Pharmacotherapy Work-up documentation models; [11] inclusion of graphics-text and avatars of patients; inclusion of objective templates for the attendance of the VP; possibility of including—saving—new student responses to the system's official template; insertion of the following links in VP screens: "See Case Study" (allows access by tutors to the complete clinical case after registration), "Response of Query" (allows access by tutors to the history of student responses), "Add Options"(allows tutors to include new templates to the VP database), and "Reply to Questionnaires" (allows students to access the instruments for system evaluation) (figure 1 and 2).



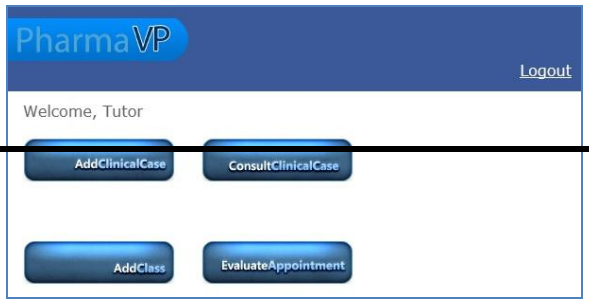
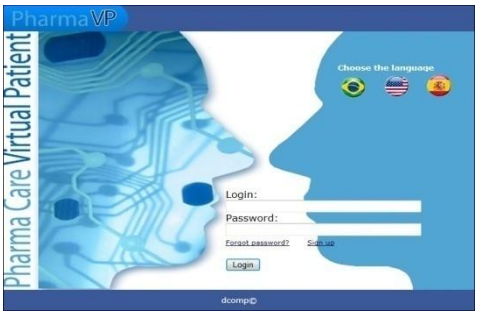
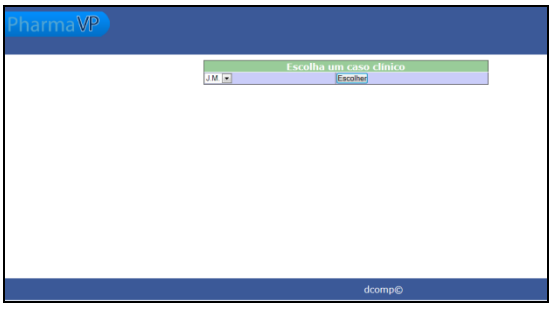


Figure 1. Fragments of the second version of *PharmaVP Software*: home page and tutors screen.





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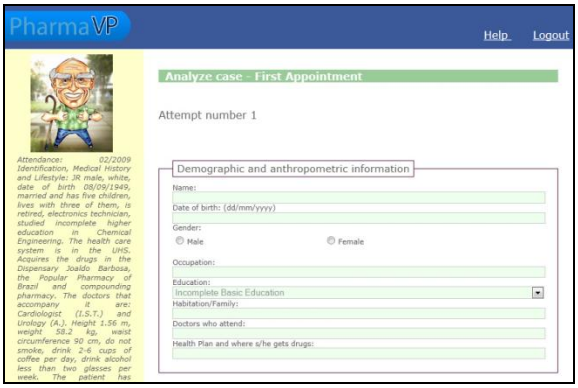

Figure 2. Fragments of the second version of *PharmaVP Software*: student screen and analysis of the clinical case screen.

The evaluation and comparison between the first and the second versions of *PharmaVP Software* as performed by the system developers and mentors showed no statistically significant differences ($p < 0.05$). The averages of the metrics functionality, reliability, and usability showed the biggest differences between versions of the VP. (Table 1). The application of *PharmaVP Software* in the PC course was carried out for six lectures (two for the training of students and four for the discussion of the virtual clinical cases) and six practical lessons (two for the training of students and four for performing VP consultations) distributed over six weeks. In all, 31 students constituted the final sample and were divided into eight groups (*Cipolle*, *Maxcef*, *Hórus*, *PharmaCare*, *PharmaCareUFS*, *Pharmacists Care*, *PharmaLife*, *and ZeroDTP*); all concluded the VP activity. The socio-educational data revealed that the students' age ranged from 22 to 32 years, with a predominance of students aged 22 (n = 12; 38.7%). Most of the students were female (n = 20; 64.5%) and frequently accessed the Internet from home (n = 31; 100%) and the Faculty (n = 21; 67.7%). Two groups (*PharmaLife* and *ZeroDTP*) needed a second attempt to end the first VP visit and one group (*PharmacistsCare*) required the second attempt to perform both the second and the third VP visits. The time spent by students and tutors during the use of VPs is presented in Table 2.

Table 1. Evaluation of the versions of the *PharmaVP Software* by the developers and mentors of the system (n = 06, versão 1.0; n = 04, versão 2.0) using a tool adapted from ISO/IEC 9126 (2001).

Metrics	**Issues**		**Versão 1.0 Mean (SD)***	**Versão 2.0 Mean (SD)***	**p****
External Metrics	**Functionality**	Access Security	4,5 (0,54)	4,2 (0,5)	0,374
		Conformity related functionality	3,6 (0,81)	4,5 (0,5)	0,082
	Reliability	Maturity	2,1 (0,98)	2,5 (1,7)	0,457
		Recoverability	2,6 (0,81)	3,5 (1,0)	0,120
		Conformity-related reliability	3,0 (0,63)	3,7 (0,9)	0,168
Internal Metrics	**Usability**	Intelligibility	3,8 (0,40)	4,2 (0,5)	0,067
		Conformity related to usability	3,5 (0,54)	3,7 (0,5)	0,374
	Efficiency	Behavior with respect to time	4,0 (0,00)	4,0 (0,0)	0,500
		Use of resources	4,0 (0,63)	4,0 (1,5)	0,297
		Conformity related to efficiency	3,6 (0,51)	3,7 (0,5)	0,415
	Maintainability	Modifiability	4,5 (0,54)	4,7 (0,5)	0,168

	Testability	4,5 (0,54)	4,5 (0,5)	0,261
Portability	Adaptability	4,0 (1,09)	4,2 (0,5)	0,334
	Ability to be installed	4,3 (0,81)	4,5 (0,5)	0,457
	Coexistence	4,5 (0,54)	4,5 (0,5)	0,374

*Responses based on a Likert scale with 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree.

** Statistical significance: $p < 0.05$

Table 2. Time spent in minutes by students groups and tutors in the answers and correction of clinical cases, respectively, Software PharmaVP.

Consultations	**Minutes - Mean ± SD* (p25 – p75)**	
	Student groups (n = 08)	**Tutors (n = 03)**
1º	34 ± 2,1 (33,7 - 35,2)	14 ± 3,4 (12,2 - 15,7)
2°	49 ± 24,2 (31,5 - 59,5)	09 ± 4,2 (05 – 13)
3°	64 ± 10,0 (57,2 – 72)	09 ± 7,1 (4,7 – 12,2)
4°	38 ± 24,9 (18,5 – 51)	06 ± 1,8 (05 – 7,2)

With respect to the quantitative assessment of the *PharmaVP Software* using the adapted version of ISO/IEC 9126, [25] all mentors (n=3) of the system agreed or strongly agreed that the software is functional; enables learning; and is operational, attractive, efficient, and productive, and they reported being satisfied with the system. Sixty-seven percent (n = 02) of the mentors strongly agreed that the software is safe. More than 90% (n= 28–30) of the students agreed or strongly agreed that the software is functional; enables learning; and is operational, attractive, and productive, and they reported being satisfied with the system. Eighty-seven percent (n = 27) of the students agreed or strongly agreed that the software is effective. (Table 3).

Table 3. Evaluation of the *PharmaVP Software* by the Tutors (n = 03) and Students (n = 31) of the system using a tool adapted from ISO/IEC 9126 (2001),

Metrics	Issues		Tutors Mean ± SD* (p25 – p75)	Students Mean ± SD* (p25 – p75)
External Metrics	Functionality	Adequacy	4,6 ± 0,5 (4,5 - 5)	4,3 ± 0,6 (4 - 5)
		Accuracy	4,6 ± 0,5 (4,5 - 5)	4,4 ± 0,5 (4 - 5)
	Usability	Learnability	5,0 ± 0,0 (5 - 5)	4,6 ± 0,6 (4,5 - 5)
		Operability	4,6 ± 0,5 (4,5 - 5)	4,6 ± 0,6 (4 - 5)
		Attractiveness	4,6 ± 0,5 (4,5 - 5)	4,2 ± 0,7 (4 - 5)
Quality in Use	Effectiveness		4,6 ± 0,5 (4,5 - 5)	4,0 ± 0,9 (4,5 -5)
	Productivity		5,0 ± 0,0 (5 - 5)	4,7 ± 0,6 (5 - 5)
	Security		4,0 ± 1,7 (3,5 - 5)	4,7 ± 0,5 (5 - 5)
	Satisfaction		4,6 ± 0,5 (4,5 - 5)	4,3 ± 0,6 (4 - 5)

*Responses based on a Likert scale with 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree.

Software evaluation results, based on the adapted instrument of Hussein and Kawahara, [15] demonstrated that more than 80% (n = 25–30) of the students agreed or strongly agreed with seven (questions 1, 2, 4, 5, 7, and 10) of the ten items assessed by this instrument. Furthermore, 84% (n = 26) of the students disagreed or strongly disagreed that "The technological approach utilized *PharmaVP Software* with respect to data collection consumed too much time" (question 6). Questions 3 and 9 respectively had 68% (n = 21) and 77% (n = 24) agreement or strong agreement by the students. The software evaluation based on Zary, Johnson, Boberg, and Fors [17] revealed that more than 80% (n = 25–27) of the students agreed or strongly agreed with all items evaluated by this instrument. It is noteworthy that 96.7% (n = 30) of the students strongly agreed with the item "I found the cases in *PharmaVP Software* realistic". The results of the quantitative analysis performed using the above mentioned instruments are presented in Table 4.

Among the 26 essay questions used for the qualitative analysis of VP, the students provided adequate justification on 19 (73%). Nine categories were identified and grouped into three main themes: teaching and learning of PC; the *PharmaVP Software* system; and clinical cases of *PharmaVP Software*. The presentation of the results includes quotations, which are given within quotes. The most articulate quotation was selected in each case in order to avoid redundancy. However, this does not mean that the other students did not express the same idea in other words and did not merely agree (Figure 3).

Table 4. Assessment *PharmaVP Software* by students using the tool adapted from Hussein, Kawahara (2006) and Zary, Johnson, Boberg, Fors (2006).

Tool	Student Evaluation	Mean ± SD* (p25 – p75)
Hussein, Kawahara (2006)	1. The teaching approach used in the *PharmaVP Software* was significantly different from other approaches that I have encountered in the past.	4,3 ± 1,0 (4 – 5)
	2. The Care Plan template that was used helped me organize my thoughts as my group worked on complicated patient cases.	4,4 ± 0,9 (4 – 5)
	3. The patient case scenarios helped me understand that patients do not always respond like the textbook say they should.	4,0 ± 1,2 (3 – 5)
	4. The *PharmaVP Software* helped me gain more confidence in my ability to apply the information therapies.	4,2 ± 1,0 (4 – 5)
	5. The technology used in the *PharmaVP Software* was operational (functioned properly) 75% of the time or more.	4,5 ± 0,7 (4 – 5)
	6. The technology approached utilized in the *PharmaVP Software* with regard to data collection consumed too much time.	1,5 ± 1,1 (1 – 1)
	7. The technology approach utilized in this sistem with regard to data collection made this *PharmaVP Software* more realistic than other courses that include written case presentations/discussions.	4,2 ± 0,9 (4 – 5)
	8. The approach utilized in the *PharmaVP Software* with regard to the fact that patient outcomes were affected by my work (i.e., assessment, placing medical and laboratory orders) made me concentrate and pay more attention to details, and thus enhanced my learning process.	4,6 ± 0,5 (4 – 5)
	9. The *PharmaVP Software* challenged me.	4,0 ± 1,1 (4 – 5)
	10. The *PharmaVP Software* enhanced my understanding of topics or diseases that were covered in other classes.	4,2 ± 1,0 (4 – 5)
Zary et al., (2006)	11. I had no problems learning to use the *PharmaVP Software.*	4,4 ± 1,0 (4 – 5)
	12. I found the cases in *PharmaVP Software* engaging.	4,2 ± 0,8 (4 – 5)
	13. I found the cases in *PharmaVP Software* realistic.	4,9 ± 0,2 (5 – 5)
	14. I found the cases in *PharmaVP Software* instructive.	4,3 ± 0,7 (4 – 5)
	15. I found *PharmaVP Software* fun to use.	4,0 ± 0,8 (4 – 5)
	16. I think that I learn from using *PharmaVP Software.*	4,8 ± 0,3 (5 – 5)
	17. My overall opinion of *PharmaVP Software* is 1= very bad, 5 = very good	4,3 ± 0,4 (4 – 5)

*Responses based on a Likert scale with 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, and 1 = strongly disagree.

STATEMENTS OF STUDENTS	CATEGORIES	CONSOLIDATED THEMES
"It's a totally unique opportunity, a new way to test your skills and knowledge without necessarily being personally with the patient, but having access to real cases."	Knowledge construction	The *PharmaVP Software* helps in the teaching and learning of PC
"Before I was confused and not knowing where to start, but the PharmaVP Software facilitated the development of the plan of care."		
"Enough close to an actual patient care, showing how it would be our practice."	Similarity / approximation to reality	
"Although it is a virtual patient, it is the story of a real case, and then decisions are made in a careful way. We can make mistakes without major consequences."		
"It sure is innovative tools in the learning of Pharmaceutical Care and facilitates better student understanding, bringing us closer to a real situation."	Innovative tool	
"It's an interesting and innovative way to analyze clinical cases, making it more practical than other analysis tools."		
"The program is very good, but I do not believe that manages confidence to apply the therapeutic information in the real world."	Downsides / vulnerable	
"It would be more engaging if we follow up with real people"		
" I would like to answer more clinical cases. Patients with more drugs, more complex clinical cases. Other patient information, if possible even not reported by them. "		
"I think it has potential to be very useful and reproducible on a large scale. It can be very lucrative ".	Motivation	The system *PharmaVP Software* has advantages and disadvantages
"It was very different and exciting."		
"So many times the system jammed and once we had to repeat the registration data three times, because I was giving error".	Problems encountered with the tool	
"I felt a dependence on tutors for handling PharmaVP Software "		
"I wish the PharmaVP Software were a more interactive tool, further improve learning, and it would be more challenging and realistic. It would be interesting also that there was dialogue between the patient and the pharmacist and not just a case written. "	Suggestions for improving the *PharmaVP Software*	
"The PharmaVP Software could bring more information about the lifestyles, especially to help in time of table creation of drugs."		
"The fact that the cases were real was of fundamental importance for the understanding of the method and seriousness."	Strengths of clinical cases	Clinical cases of *PharmaVP Software* simulate reality, but require degrees of complexity
"By using real cases, the software is very close to reality and gives us the impression that we face a real case. This can be proved by the facts that are reported in the subjective part of the case. "		
"The cases are compelling, but perhaps if they were more complex, the involvement would be greater."	Need to rework / revise clinical cas	
" I would like to answer more clinical cases. Patients with more drugs, more complex clinical cases. Other patient information, if possible even not reported by them. "		

Figure 3. Perceptions of students of Pharmacy about *PharmaVP Software*.

After the implementation phase, 71 updates were proposed for improving *PharmaVP Software* (post-testing). Of these, the majority (n=47) were suggested by the tutors. During the registration of clinical cases, 58% (n=7) of the enhancements were related to the system's reliability. In the VP use stage, 69% (n=41) of the enhancements were related to the editing of the registered clinical cases and the addition of new answers suggested by the students to the software's official template (Figure 4)

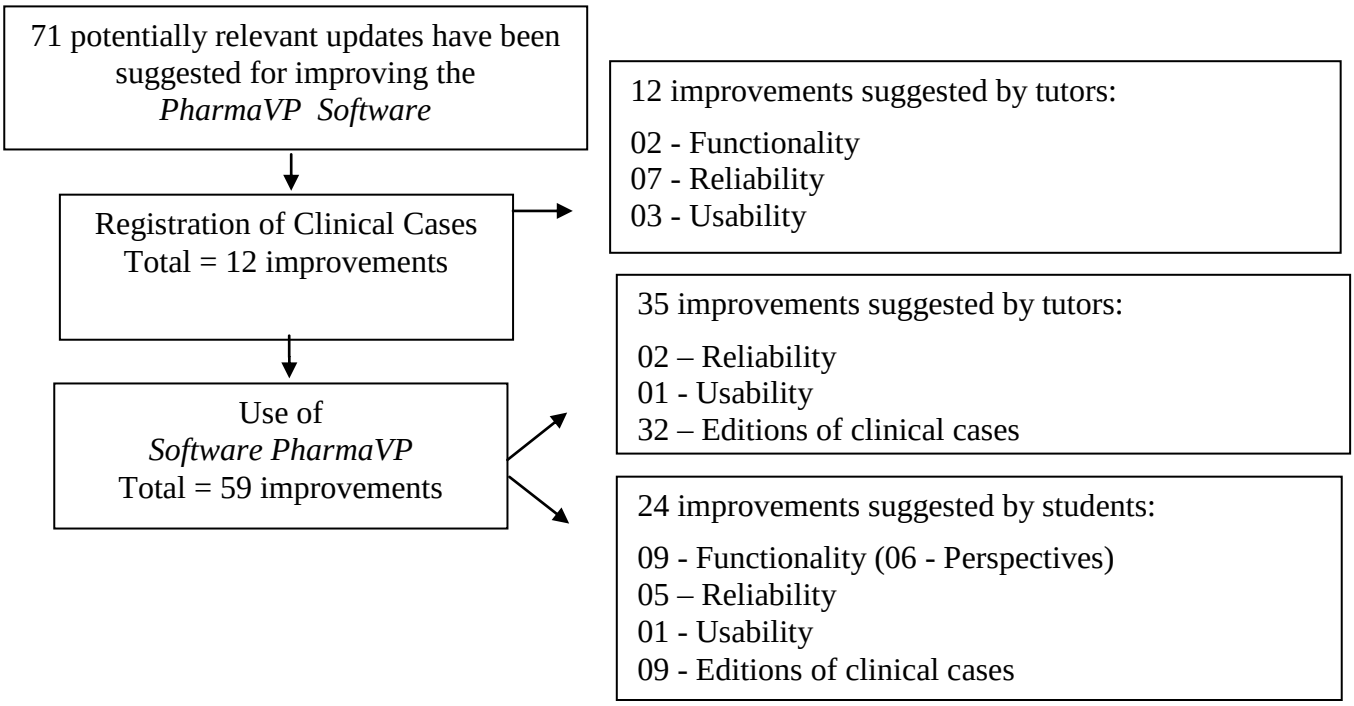

Figure 4: Improvements performed in *PharmaVP Software* after the implementation phase.

Functionality-related enhancements (n=9) to the system were the most requested by the students, and six were classified as prospects for the software, e.g., increasing the number of attendances of VP; adding surprise questions during the VP attendance that could appear as dialog boxes and have limited time for response; qualifying clinical cases at different levels of complexity; and creating a software application to be used on mobile phones. It is noteworthy that the addition of more interactive features—audio-visual and animation—was the most recurring request among the students (n=23).

DISCUSSION

The evaluation of the first version of the system has demonstrated the need for adjustments to the metrics of functionality, reliability, and usability of *PharmaVP Software*, mainly emphasizing that the set of functions of this product did not completely satisfy the needs for the intended purpose and that its performance was not fault tolerant. [25, 30, 31] In response to these needs, the enhancements to *PharmaVP Software* were predominantly made for improving the above mentioned metrics. However, because of the small sample size of evaluators (system developers and mentors), it was not possible to identify statistically significant differences between different versions of the VPs.

Some of the key factors for the successful implementation of a software application such as *PharmaVP Software* are cost, access, security, scalability, and flexibility. [17] In this study, the Java methodology used allows platform independence and is in the public domain, facilitating access, cost, portability, and scalability of the tool. Furthermore, MySQL makes the database flexible, allowing edits and enhancements to the software. These technological tools allow the system to be developed for the Web, permitting its remote and decentralized access by students and tutors when applied in

practice. Together, these factors may have contributed to the achievement of satisfactory results in the evaluation of the second version of the software by the system's developers and mentors.

The improvements made to *PharmaVP Software* on the basis of the "Pharmacotherapy Work-up" model [11] allowed the training of students to interactively document the process of PC. Documentation is a critical component for improving the process of PC and is central to the assignment of values in practice and facilitates communication between professionals. [32, 33] In addition to the documentation process, students were trained in written communication, through the drafting of reference letters to physicians and other health professionals. Studies have shown that the development and maintenance of cooperative relationships between pharmacists and other healthcare professionals will facilitate a change in the practice of community pharmacies. [34, 35]

The statements derived from the qualitative analysis performed in this study demonstrated that a VP is an interactive and dynamic tool that assists students in understanding disease states and managing drug therapy regimens, and allows them to apply what they have learned in classroom lectures to realistic situations. These findings are ratified by several studies in which the use of case studies encourages critical thinking about real clinical situations rather than just memorizing facts. [9, 18, 36, 37]

Although students point out that *PharmaVP Software* plays a supplementary role and does not replace the experience of dealing with real patients, as in other studies, they agree that this educational tool provides an important advantage of promoting practice in a safe environment with no risk to the patient or the student and where mistakes are allowed. [17, 38] The main changes suggested by the students (more interactive VP, changes to the layout, and more complex clinical cases) can make the software more attractive, close to reality, and more in line with the expectations of its target audience. In a qualitative study involving the use of VPs carried out by Botezatu, Hult, and Fors, [38] the authors demonstrated that media presence is essential to authenticity, that realism starts with the patient's photo, and that a video recording is a must in certain circumstances.

In this study, tutors had an important role in guiding the students during the application of *PharmaVP Software.* Semeraro and colleagues [39] emphasized the importance of preceptors in familiarizing students with the use of VP scenarios to practice and improve their clinical knowledge and communication skills. Moreover, preceptors provided feedback on student performance, virtual counseling sessions, and the strengths and weaknesses of using virtual patient technology for teaching students. [9, 19]

The time spent by students during the application of VPs was considered to be feasible within the context of 60-min classes. Moreover, the objectivity of theVP template makes the correction of visits by tutors an easy and quick task. This innovation may be easily transferred to and duplicated by other schools. The main features of VP systems are that they allow for the repetitive and deliberate practice of "clinical" skills by any learner (e.g., nurses, physicians, and dentistry students) irrespective of the time of day, physical location, or position in the health science curriculum. [17] For example, in the study of Botezatu, Hult, and Fors, [38] medical students perceive the VP as an important learning and assessment tool, fostering clinical reasoning, in the preparation for their future clinical practice as young doctors.

The assessment of student satisfaction with the use of VPs is necessary to identify its strengths and weaknesses and to improve VP teaching methods. [40] Several lessons have been learned during the six weeks of application of *PharmaVP Software*, and steps have been taken to improve the quality of the VPs. Student feedback from surveys has been useful in determining these changes. [9] Among the improvements made after the application of VPs, adjustments related to system reliability that have made this product more fault tolerant are noteworthy. [25, 30, 31] Moreover, the possibility of inserting new answers suggested by the students into the software's official template enables the system's database to be updated continuously.

The limitation of the program is that it can only provide information from a database of standardized patients according to pre-set criteria. It cannot provide additional information concerning patients or their symptoms. Consequently, students are unable to ask the patient additional questions to confirm their diagnosis. [18] Further, using virtual patients in patient encounters did not provide the students with practice in interpreting patients' nonverbal communication. [9] Thus, it is noteworthy that VPs should be used in a complementary manner while teaching PC or any other clinical practice and that their use does not invalidate the need for the monitoring real patients. [36]

PharmaVP Software was enhanced, implemented, and evaluated satisfactorily with respect to the

academic discipline of PC. The results demonstrated that the introduction of VPs to pharmacy education could potentially offer an effective method for teaching students and to assist them in developing the skills and abilities necessary to practice the PC. The use of innovative technological tools such as VPs can contribute to the training of students and healthcare professionals, particularly for the development of the knowledge and communication skills necessary for PC practice.

Limitations

In research involving the evaluation of softwares, the lack of instruments that are not validated in the literature is a limitation and should be considered in future studies. The evaluators of the software during the development phase, were the same people who participated in the drafting system. This can be a source of bias in the results for this evaluation. Moreover, the absence of a statistical calculation to define the sample size may negatively impact the robustness and reliability of the results. Future studies on *PharmaVP Software* should include more sophisticated graphics and multimedia (sound, animation, text, and avatars of patients) in order to enhance human interactions with virtual patients and learning. Furthermore, this technology needs to be tested using a statistically significant number of students in order to allow for the internal and external validation of the program as an effective teaching tool.

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