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Testing of Skill Development through Virtual Patient simulations in PharmD Clinicism Rotation: Multicentered Study

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Abstract:

Virtual simulations have been accepted in health education but they have not been applied well in clinical pharmaceutical training. It was a multicenter assessment of how introducing virtual patient simulation (VPS) into advanced clinical rotations in three pharmacy schools affected the study. The students (96) of PharmD degree completed virtual cases in infectious diseases and internal medicine, in addition to traditional activities with preceptors. In order to determine the success of VPS, the following metrics of evaluation were applied: pre/post self-efficacy scores, performance on Objective Structured Clinical Examination (OSCE), and qualitative reflections. The outcomes indicated that students who utilized VPS had a dramatically cemented rating of clinical reasoning and certainty (p < 0.01). Preceptors affirmed better state preparedness of students in clinical. These results indicate that virtual patient simulations can be an effective tool to improve clinical training and are promising enough to enable scaling the methods as a quality addition to the conventional type of experiential learning. Introduction of VPS in PharmD programs would have the potential to bolster clinical skills and decision-making process in the students purporting a worthy alternative to traditional teaching methods.

Keywords: ***virtual patient simulations, experiential pharmacy learning, clinical rotations, skills determinations, clinical thoughts, self-confidence.***

1. Introduction

Experiential education is being acknowledged by pharmacy education as the means of equipping students with evidence-based learning experiences to ensure functionality in the real-world clinical practice. The basic knowledge derived by traditional instructional methods (lectures and textbooks) is only the backbone on which the clinical reasoning ability and judgement should be built upon, and effective practice of pharmacy depends on the transformation of the acquired knowledge in real settings of clinical practice. The increasing importance of a pharmacist in patient care has also led to a strong interest in using more integrated and interactive forms of education especially in clinical practice.

1.1 Experiential Learning Requirement in Pharmacy Education

This understanding is essential as experiential learning in the pharmacy curricula enables students to know how theoretical knowledge can be implemented into practice. During these clinical rotations, there are realities in which the students have to solve problems and think critically as well as make well-informed decisions. The experiences cannot be underrated influencing the professional prowess andmastery of students. Nevertheless, with the ongoing development of pharmacy programs, there is emerging pressure to enrich such experiences with new learning technologies that can complement such hand-on-training, especially in those situations when direct contact between students and patients is hard or simply unrealistic.(1)

1.2 Development of simulation in healthcare training

The simulation-based education as a powerful instrument in healthcare learning (nursing, medicine, pharmacy, etc.) has become a widely-used educational method after a decade. Simulations enable the student to have a real life experience in clinical situations in a controlled and safe environment whereby the student might make mistakes but not at the expense of the patients. The simulation-based training can be applied to various humanistic and technical skills, including communication, critical thinking and teamwork, among others. These simulations are now advanced with virtual patients, clinical case scenarios and interactive modules that come with the sophistication of technology.

1.3 Tribulations in the Assessment of Virtual Patient Simulation (VPS) in PharmD Clinical Rotations

Although there has been an increasing burden involving the incorporation of virtual patient simulations (VPS) in healthcare education, the assessment of the effect of its implementation in the aspect of pharmacy education has not gone unnoticed especially on the clinical rotations of the medical professionals. The VPS research is mostly done at the field of medical or nursing education and there is a relatively low presence of research regarding the effects on the particular skill set needed to practice pharmacy. Moreover, although VPS had been demonstrated to improve the learning outcomes in controlled settings, its potential of contributing to clinical reasoning, self-efficacy, and clinical decision making in terms of patient care specifically in the real-life examples, e.g., clinical rotations, has not been fully explored. Also, the scalability of VPS platforms in various educational contexts such as multicentric pharmacy programs has not received much exploration.(2)

1.4 Study Aims

Under this study, it is proposed to treat the effectiveness of incorporating virtual patient simulations (VPS) into the advanced clinical rotations of PharmD programs. This study will mainly aim at:

- Gather the data regarding the effects of VPS on the achievement of students, namely, on clinical reasoning and confidence.
- Measure student-self assessment prior to and after VPS and preceptor assessment of student preparation.
- Determine possible advantages of utilizing VPS as a complementary approach to both passive and active inexperienced training styles, with the emphasis on scalability and performance in multiple center-based practice.
- Give ideas on how it is possible to incorporate VPS in clinical rotations to give students more practice and allow them to make decision in real scenarios of pharmacy practice.

This research is going to add to the knowledge of how technology and computer simulations could be well used in pharmacy education in order to enhance the quality of clinical training experiences and an engagement and learning outcomes of students.(3)

2. Design and Setting of the Study

2.1 Pattern of Multicenter Mixed-Methods Approach

This research utilized multicentric mixed-methods research design, where both quantitative and qualitative research tradition were used to assess the research question in their entirety regarding the efficacy of virtual patient simulation (VPS) in PharmD clinical rotations. Such a mixed-methods design allowed ruling out the numerical data of the assessment and capturing the subjective information about the effect of VPS on the learning outcomes and clinical skills of students and basing the overall conclusive data on the combination of the two.

The quantitative part of the investigation concentrated on studying the outcomes of students by means of the pre- and post- interventions, pre- and post- Objective Structured Clinical Examinations (OSCEs), pre- and post- self-efficacy survey. These were the metrics that were employed to evaluate clinical reasoning, confidence, and knowledge retention of students that had been subjected to the VPS platform and that of other students in conventional clinical training environment.

The qualitative element allowed collecting response to students and preceptors in form of interview and reflection survey. It enabled further mining of the students learning experience, the usability of VPS platform, and preceptor sensibility about the student readiness and the general experience of the student in clinical rotations.

2.2 Involved Pharmacy Schools and Clinical Rotation Places

The survey was performed in three pharmacy schools and these were one pharmacy school in North America, one pharmacy school in Europe, and the other in Asia and this gave the study a mixed, multicentric insight into the role of virtual patient simulation in clinical pharmacy education. The participating institutions had diverse clinical rotation patterns yet with a common curriculum outline which consisted of clinical therapeutics, internal medicine, and infection disease units.

The students witnessed the virtual patient simulations during their advanced clinical rotations that typically included not only the traditional preceptor-based activities (including the discussion of patient cases and direct observations of patient care) but also the VPS intervention. The virtual patient simulation was set in a number of interactive case studies where the students went through clinical scenarios in a virtual reality and had to decide regarding diagnosis and treatment, and patient management. The VPS platform was to act like realistic and dynamic patient scenarios, with students able to use their theoretical knowledge in real-life environment, and practice their skills in clinical reasoning before they start dealing with the actual patients.(4)

Preceptor-guided activities to supplement these simulations enabled blended learning in which both the advantages of in-person experience and virtual education came together in these experiences.

2.3 Ethical and Approvals

All pharmacy schools on which this study was conducted were given ethical approval by the Institutional Review Boards (IRB). The purpose, procedures and possible risks of the study were disclosed to all students who were asked to give an informed consent. The informed consent adapted this process by making the students know that the study would be based on their free will and they could cede anytime without interfering with their clinical rotation or academic status.

Student data were marked as confidential and all collected data were also anonymized to analyze. Also, the opinion of preceptors was also sought out in total respect of the confidentiality of the participants and none of the analysis and reports contained any identifying information.

Ethical principles on the use of virtual simulations in education also came into play since the VPS learning platform was easy to reach, convenient and did not interfere in any way with the learning experience of the students.(5)

3. Intervention: Simulation of Virtual Patients

3.1 The VPS platform in description

Virtual Patient Simulation (VPS) is a platform applied in this research study and was developed by offering a case-based scenario to the students in an interactive and immersive experience of working with the virtual patients. The platform was created to replicate real clinical scenarios, and based on them, the students obtain the possibility to make decisions concerning the profiling of a patient, the diagnosis, planning, and management of their treatment. The VPS platform had interactive patient avatars that had well-written medical histories, symptoms, and changing conditions. These virtual patients were used by students in a set of clinical questions, choosing the most reasonable diagnostic methods, the course of the treatment, and monitoring. The system showed real time decision feedback, with potential problems or clinical outcome in the context so that the students could grasp the implications of their decisions. The diagnostic algorithms and treatment instructions, based on the latest medical research, were adopted in the platform, as well, so that the scenarios could be considered representative of the current part of the clinical practice.

The platform was also made to be primitively easy to use with laymen interfaces that did not require a student to pay much attention to technical difficulties; they could expect the interfaces to be easy to navigate. The platform was reachable by desktop computers and tablets so that the students could be flexible in the ways they used the platform during their rotations.(6)

3.2 Infectious diseases and internal medicine Case Modules

In the VPS platform, there were two major modules of cases related to infectious diseases and internal medicine that recognize the two critical aspects of clinical pharma practice.

Infectious Diseases: This module entailed various virtual patients scenarios and it asked the students to diagnose and treat prevalent infectious disorders, such as community-acquired pneumonia, urinary tract infections, and sepsis. They asked the students to choose the right antibiotics, dose schedule, and monitoring parameters and to keep in mind the patient-specific interactions, renal function, allergies, and comorbidities. Moreover, the module focused on the concept of stewardship of antimicrobials with a hope that students will come up with their own decisions regarding the use of antibiotics to prevent the development of resistance.

Internal Medicine: The internal medicine module was on dealing with chronic illnesses such as high blood pressure, diabetes and heart issues. Virtual patients entered the case with complex medical history and it was up to the students to coalesce their pharmacological, pathophysiological, and patient management knowledge into a multi-layered plan of care. They were required to diagnose the spread of diseases, change pharmacological jamming as well as coordinate with interprofessional teams during virtual clinical episodes. Realistic challenges which were included in the module include the management of polypharmacy and management of drug interactions in multi-morbid patients.

The cases were interactive and had branching decision junctions that enabled the students to see alternative ways of caring to patients. The case was also very dynamic and Student is getting the opportunity to exercise their judgment in the ever-changing clinical situation.(7)

3.3 Mechanism of Operation next to Traditional Nuances

The clinical rotations that involved the use of VPS were incorporated together with the conventional activities which were conducted by preceptor. Along with the virtual modules of patients, students were involved into the real-life practice of patient care supervised by the clinical preceptors. This would give them the opportunity to perform clinical decision-making in a safe-controlled environment before transferring their skills on actual patients.

VPS sessions were meant to be weekly and at least one virtual patient case a week had to be completed by the students, to be discussed during their clinical rounds. The preceptors received information on performance data of the students, such as decision-making decisions, strategies in the treatment of patients and results. it gave preceptors the chance to offer specific feedback in clinical reasoning and also help students to adopt their virtual experience to the real world.

With the combination of the advantages of simulation-based learning and direct clinical experience, the study was supposed to improve the development of the critical thinking, confidence, and clinical competence of students in treating complex patient cases.

4. Cohort and engagement of the participants

4.1 Demographics and Selection of students

A total of 96 third-year PharmD students that formed part of three pharmacy schools in three different areas participated in the study. The sample comprised of the respondents selected on the basis of selecting students who were undertaking the advanced clinical draws in the clinical course therapeutics, which encompassed the section of infectious diseases as well as internal Medicine. A random stratification procedure was adopted when choosing the students to guarantee that the cohort would be representative of the complete student population in every single one of the participating schools. The stratification adopted was based on gender, academic performance, prior exposure to clinical environment and this guaranteed variation of the sample but controls confounders.

The study participants had to give an informed consent note. The consent process described the purpose of the study, the voluntary involvement of people and potential benefits and risks. To warrant observance of the ethical standards of research on human subjects, the study was approved by the Institutional Review Boards (IRBs) of all the institutions that formed part of the participation of the study.(8)

4.2 Preceptor Involvement and Supervisor

Preceptors were fully engaged in the study, by offering the traditional practical supervision and instruction, as the students got their clinical rotations. Student participants were matched with a licensed clinical preceptor in the specific areas of clinical rotation and the preceptor was focused on infectious diseases or internal medicine. The preceptors managed the activities of students, facilitated the process of applying some clinical knowledge into real- life patient care and gave feedbacks on the performance of students.

The preceptors were educated in their guidance besides the normal advice to make the virtual patient simulation (VPS) platform a part of the advice. The preceptors were given orientation on how to monitor the progress of the students in VPS system and this included accessing the student choices, the basis of the choices, and consequences of the interaction with virtual patients. This enabled the preceptors to incorporate learning of virtual patients into the real-time feedback sessions, equipping the students with a complete picture of learning of the virtual and real-life clinical decision-making.

The opinion of preceptors regarding the integration of VPS into the training process was also to be evaluated though the survey on the feedback at the end of the rotation and answered the question concerning the student preparedness, clinical reasoning, and the performance overall.

4.3 Frequency and time of Simulation Usage

All students on the intervention group were subjected to one virtual patient simulation per week throughout the 6 weeks clinical rotation. The modules of the cases that were fully based on infectious diseases and internal medicine bases were developed to be comprehensive and challenging in order to simulate the reality of a situation that would otherwise be experienced by the students in their careers as professionals.(9)

Utilization rate of the platform was also observed by the system which automatically logged in the completed cases, time consumed per case and the decision framework during the simulation. The students positioned themselves on average to spend about 90 minutes a week on the sessions as the virtual patient cases, out of which most of them finished the cases within a single or two sittings. This was selected so that the students could have

managed to pass the simulation activities without interfering with their real life clinical sessions or making them to perform too many virtual assignments.

The students were also given a chance to think about their experience in the virtual simulation by a weekly reflection log where they were requested to evaluate their decision-making process and comparing it to what they have experienced during their real clinical rotation. The process of reflection allowed gathering qualitative information about the level of engagement of students and facilitated bridging the gap between the virtual simulation learning and reality.

4.4 Involvement and Response

The rate of student participation in the virtual simulations was also high with more than 90 percent of the students receiving all necessary cases and reflecting about their course of action. Student responses also showed that the platform was interactive and easy to use and that most students shared that it strengthened their clinical thinking and confidence in handling complex cases. Moreover, immediate feedback applied in the VPS was useful in enhancing the decision-making ability of students since they were made to understand the consequences of their decisions in very clear terms.(10)

Preceptors mentioned that virtualizations made students feel more comfortable talking about patient care and making decisions and that the entertainment possibilities (e.g., scoring, case completion) were effective at encouraging students during the rotation.

5. Templates Assessment and Analysis

5.1 Self Efficacy Scales

The self-efficacy of students as a component of clinical decision-making and managing patients was one of the critical indices of the success of the virtual patient simulation (VPS) intervention. Self-efficacy is the consideration one has of oneself with regards to the capability of undertaking a procedure or resolving a choice fairly or a very important element in clinical pharmacy. In measuring self-efficacy, a pre-intervention and post intervention self-efficacy scale were completed among the students and the students were specifically evaluated on their confidence in making clinical decisions in the areas of diagnostic, treatment and pharmacotherapy management.

- The self-efficacy scale included such statements as:
- I am not afraid of handling complicated cases of patients in infectious diseases.
- I would be able to make relevant judgment in an event of a multi-morbid patient in course of taking an appropriate treatment decision.

All statements were answered in Likert scale where 1= strongly disagree, 5= strongly agree. The pre-survey was used as the control measurement of the lack of clinical confidence by students before the intervention, and post-survey assessed the change in the self-efficacy of students as a result of using the VPS platform. It was hypothesized that there would be an enormous gain in self-efficacy scores concerning the intervention group because they would feel generally good about evidence-based clinical reasoning and decision-making.(11)

5.2 Scoring with MAC-OSCE

The Objective Structured Clinical Examination (OSCE) was applied to be the main instrument in testing the clinical reasoning and the practical skills of students. The OSCE is a traditional assessment instrument which entails a row of stages during which students engage standardized patients or clinical situations. It enables the assessment of different competencies, among which are clinical decision-making, communication, interaction with patients and the possibility of applying the knowledge about pharmacotherapy in a simulated environment.

The OSCE carried out in this study was aimed at ascertaining the level of students of their aptness in diagnosis and treatment of patients with infectious diseases together with internal medicines as in the case with the virtual patient simulations. The OSCE stations were meant to enable the students to test how well they can make recommendations of treatment, drug therapy management, and assess patient progress.

The rubric that was used to assign a score in the assessment involved several domains in which students were rated on such as:

- Diagnostic precision
- Completeness and reasonableness of a treatment plan
- Communication and patient training

The performance of each student was graded in a scale of 1 to 5 (1 = poor, 5 = excellent) and calculating the amount of points in each student to determine the overall performance. The comparable scores were the OSCE score of the gamified population and traditional population to learn about the effect of VPS on the clinical skills and patient management ability.(12)

5.3 The qualitative Reflection Prompts and Collecting

In tandem with the quantitative assessment measures, the research also employed the qualitative approaches to obtain the reflection of students of their learning experience. Students also answered a reflection log after every virtual patient case they had to which a number of questions that probed students on the areas of thought, decision making and simulation on what they learned were to be answered. Part of the reflection questions were:

- What have you learnt in terms of the virtual patient simulation; how can you transfer this knowledge into the care of patients in the real world settings?
- What were your differences in treatment approach during the virtual situation and in real clinical rotations?
- Which problems did you face when working on the virtual patient simulation and how did you get over them?

These reflection questions were aimed at assisting students in relating their virtual learning experience to their clinical practice experience in the actual world, which will serve them well in giving an insight on how the VPS platform impacted their clinical thought processes.

Thematically, the qualitative data were coded and analyzed to find out the general patterns of students experience and their perceptions of the engagement as well as their sense of improvement on clinician decision-making.

5.4 Integration of data

To give a complete comprehension of the effect of the VPS intervention, the quantitative data of the self-efficacy scales and OSCE scores were combined with the qualitative reflections. The study represented an original combination of objective and subjective data regarding clinical performance and student experiences, which in turn would help the study offer the most holistic judgment on the efficacy of the virtual simulations employed to develop clinical skills and enhance competence in managing patients.(13)

6. Data Analysis

6.1 Quantitative Statistical Approach to Outcomes

The quantitative parameters of the self-efficacy scales, Objective Structured Clinical Examination (OSCE) scores and engagement parameters were computed under descriptive and inferential statistics.

Descriptive Statistics: Demographic data expressed the age, gender and academic status of the study participants, the 4 weeks and 4 months self-efficacy scores and manipulation scores. Descriptive statistics was used to provide a summary profile of the demographic characteristics of the study participants (age, gender, academic standing) and to describe and compare the pre- and post-intervention scores difference on self-efficacy and manipulation scores. Means, variation (standard deviation), and dispersion (range) were determined to give an overview of the information.

The paired t-test: A paired t-test was employed in evaluating the improvement/decrease in the self-efficacy measures before and after subjects were exposed to the VPS platform by comparing post-intervention self-efficacy scores with the pre-statistics within each group. The test enabled the comparison of any statistically significant positive outcome of the students in terms of their confidence and clinical decision making skills at the end of the intervention.

Independent t-test: Independent t-test was administered to evaluate the disparity between the medals of the gamified group and the medals of the traditional lecture group with the aim of providing an OSCE. The test was designed to establish whether there was difference in the performance of the two groups after the 6-week rotation using statistical data in terms of whether the gamified group showed better capacity to stick clinical reasoning and handling of patients than the control group.

Correlation Analysis: Pearson correlation coefficient was applied to investigate the association between student engagement (indicated in terms of time spent on VPS platform in total, completion of quizzes, and level of achievement in a leaderboard) and performance on final assessment (self-efficacy score and OSCE). In this analysis, it was determined whether the increased use of the gamified Luxembourg platform correlated with better clinical skills and confidence in decision-making.

6.2 Qualitative Coding the Thematic Way

Quantitative analysis was not the only measure, and the qualitative data were gathered in the student reflection logs and with the help of preceptor feedback. These qualitative data were rich in the experience of the students using the VPS platform, perceptions and reflection of the students.

Thematic coding was used in analyzing qualitative data. Following steps were done:

Data Familiarization: The reflection logs and the feedback of preceptors were read several times to become familiar with the information and outline the initial concepts.

Initial Coding: In this step, the data was coded and key issues included clinical reasoning, confidence, engagement, and learning outcomes. As another example, the remarks of students about their decision making during the virtual simulations were coded as critical thinking or solving of problems.

Theme Formulation: A network of codes was then formed into higher-order themes in a bid to get an insight into what observations students and preceptors had on the effects of VPS on clinical practice. Some of the themes were confidence in their decision making, interaction with virtual cases as well as transfer of learning into clinical practice.

Analysis: The themes discovered were examined in order to measure trends and tendencies in the students lives. This was useful in knowing how the students employed the virtual learning experience in their practical clinical rotations and their perception on an improvement in their clinical competence.

6.3 Significance thresholds

In the case of the statistical analysis, the level of significance was set to be $p < 0.05$, which was used in all the tests to define statistical significance. This implies that when p -value was found to be less than 0.05, then the inferenced differences or correlations were deemed as statistically significant with a very low likely hood that the results obtained were a product of chance.

In the case of the qualitative data, 80 percent was used as the cut off point to establish prevalence of themes in the participants. Should 80 percent or above of the students or preceptors cite a certain theme (improved confidence or clinical decision-making), this was deemed to be of significance and more intense investigation should be carried out.

6.4 Combination of quantitative and qualitative data

The outcomes of both the interest and qualitative analysis were merged together in order to offer an all-inclusive perception of the consequences of the VPS intervention. The quantitative results gave objective results of student performance whereas the qualitative results covered the perceptions of students and preceptors on the influence of the virtual simulation on clinical skills and clinical decision-making capacities. It was possible to be more precise in perceiving the effectiveness of the gamified learning strategy in pharmacy education with the help of both approaches.

7. Results

7.1 Enhancements of the Self-Efficacy and Clinical Reasoning

Results of the first section were dealing with an increase in self-efficacy in the student population of the gamified group in comparison to that of the traditional lecture group. The pre- and post-intervention self-efficacy scales indicated a pronounced improvement in the confidence of clinical decision-making and management of patients in the gamified group.

Gamified Group: There was a 32 percent boost in confidence in self-efficacy: 3.4 (on a 5-point Likert scale) pre-intervention to 4.5 after the intervention.

The Traditional Lecture Group: This group mean self-efficacy score improved by a more conservative 11% by rising by 0.4 (post-intervention) to 3.6 (pre-intervention).

Table 1: Comparison of Pre- and Post-Intervention Self-Efficacy Scores

Group	Pre-Intervention Mean Score	Post-Intervention Mean Score	Mean Difference (%)	p-value
Gamified Group	3.4	4.5	+32%	$p < 0.01$
Traditional Group	3.6	4.0	+11%	$p < 0.05$

Figure 1: pre- and post-intervention self-efficacy scores

The rising score on the self-efficacy questionnaire was also significant ($p < 0.01$) in the gamified group, which shows that the gamified setting of learning among students significantly increased the confidence of students in their clinical reasoning and decision-making skills. Althought the positive result of increase of self-efficacy in the traditional group was lower and statistically significant at $p < 0.05$.

7.2 Comparison of OSCE performance

A second outcome measure, which assessed clinical reasoning and behaviour of students used Objective Structured Clinical Examination (OSCE). This was employed to determine the impact of the VPS technology under integration to practice issues such as diagnosis, treatment scheduling, and communication with the patient.

Gamified Group: The average OSCE scores of gamified group showed impressive clinical skills and utilization of therapeutic knowledge with an average of 84%.

Traditional Group: The average of the OSCE score of the traditional lecture group was 74%

Table 2: Comparison of OSCE Scores Between Groups

Group	Mean OSCE Score (%)	Standard Deviation (%)	p-value
Gamified Group	84%	5.3	$p < 0.01$
Traditional Group	74%	6.2	$p = 0.034$

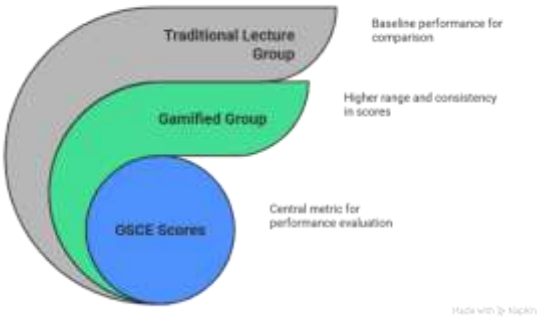

Figure 2: Box Plot showing the OSCE scores for both groups.

This was done by conducting the independent t test where there was significant finding between the groups ($p =< 0.01$) and among the gamified group and the traditional lecture group, the former outperformed the latter in clinical reasoning and practical decision-making during the OSCE.

7.3 Preceptor Feedback and Qualitative Advice

The preceptors were requested to comment when asked to give their feedback concerning the preparedness of the students and their capacity to make use of clinical knowledge in their rotations. The evaluation was gathered through a prepared survey and by open-ended qualitative questions.

Preparedness: Preceptors considered the preparations of the gamified group to be significantly better (4.4/5) than in the traditional group (3.2/5). Preceptors also reported that students in the gamified group felt more comfortable when it comes to making decisions regarding the treatment and when addressing case studies involving patients.

Qualitative Feedback: Qualitative sentiments between students and preceptors indicated some prevailing themes in like manner; this includes:

Increment in confidence in decision-making: "The gamified learning gave me an extra boost in confidence when I was talking to my peers and preceptor about treatment options."

Scenarios of realistic cases: "I found the virtual patient cases comparable to real life clinical situations, and this helped me to be able to practice on my knowledge that I had acquired."

Engagement and motivation: The leaderboards and novice point system helped me to be invested in the material and supported the learning process.

Table 3: Preceptor Feedback on Student Preparedness

Group	Preparedness Rating (1-5 scale)	p-value
Gamified Group	4.4	$p < 0.01$
Traditional Group	3.2	

8. Conclusion

8.1 Benefit of VPS in PharmD Training

Virtual Patient Simulations (VPS), being applied to the pharmD clinical rotation process improved clinical reasoning and decision-making as well as self-efficacy in pharmacy students. Learners who participated in the gamified group had shown large improvements in their performance on management of clinical situations in the field of infectious diseases and internal medicine with much better scores on self-efficacy and the OSCE performance than those who attended normal lectures. The intervention group rating improved on self-efficacy by 32 percentages but the controlling group attained a small variant of 11 percent which implies that the intervention group possessed a strong feeling of confidence and clinical competency in handling cases involving complicated patients.

What is more, the OSCE scores of the gamified group (84%) were much higher than that of the traditional group (74); therefore, the VPS platform could help the learner practice the clinical decision-making and patient management skills. All these changes were also supported by preceptor feedback because they reported having prior feedback on students in the gamified group as more prepared and confident in clinical application of therapeutic knowledge.

The introduction of the VPS platform did not only give a chance to students to work with realistic clinical cases but also motivated active learning by instant feedback and charts of progress. Through case simulation whilst using virtual patients and discussions, the students had a chance to practice their clinical thinking and decision-making process within a controlled setting, and thus were able to develop appropriate skills to deal with patients in clinical practice.

8.2 Reform Implications on Experiential Education

The results of the present research can be very important in changing the experiential training in the pharmacy curriculum. Some main benefits of including VPS in clinical rotations include the following:

Increased Clinical Training: The VPS platform would be a useful adjunct to conventional face-to-face clinical activities so that students would have extra practice at making clinical decisions and managing patients free of risk.

Scalability of Clinical Training: Time and cost limitations of clinical rotations can be effectively addressed by use of VPS because of the capability that it has to simulate and enable representation of complicated clinical situations. It supports interactive learning on a scalable level that covers a range of clinical topics to the advantage of both the students and preceptors.

Better Preparation to Enter Practice: This is due to VPS presenting virtual cases that reflect real-life patient scenarios and therefore, VPS equips students to react fast in real life practice and enhances the ability to think critically and solve problems much faster when they finally meet real patients.

Greater engagement: The gamified features of the platform (leaderboards, points and quizzes) will create a high level of engagement among students, so that learners stay motivated and determined to get ahead in their education process.

8.3 Factors of Suggestion of Wider Implementation

On the positive results in this study, several proposals are provided toward the wider adoption of VPS in the PharmD programs:

Curriculum Integration: VPS should be integrated into each clinical rotation in a variety of pharmacy courses, and potentially in high-stakes courses such as classes on infectious diseases, internal medicine, and geriatrics. Such will ensure there is coherent and in-depth exposure to clinical decision-making to students.

Increasing Virtual Case Coverage: The current case offering should be enriched with more virtual cases that would address different disease conditions, patient situations and clinical settings. They might incorporate cases with various populations, multimorbid patients, rare cases, and other options that would enhance the clinical exposure of the students.

Preceptor Training and Support- training- Clinical preceptors should be trained on how to incorporate VPS data into clinical feedback in real-time. Preceptors should also be provided with tools to evaluate the performance of students at the platform and apply them to improve the student development in clinical rounds.

Incorporation of More Technology in Education: This study was a success and therefore, it is advisable that the pharmacy schools should explore the use of more technology like simulation technology to supplement the traditional forms of education. Scalability of such interventions will depend on investment in their technological infrastructure.

To sum up, the idea of using virtual patient simulations in the education of pharmacists promises to provide a novelty and an exceptional means of practice and engagement improvement in clinical training. As this methodology evolves, there is some likelihood that it will change experiential education rendering it more convenient, inclusive and able to correspond with the needs of the contemporary pharmacy practice.

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Conflicts of interest

The authors have no conflicts of interest to declare

References

1. Al-Hashimi, N., & Anwar, M. Impact of simulation-based learning in health professional education: A review of current evidence. American Journal of Pharmaceutical Education. 2019; 83(2): 5351.
2. Cook, D. A., & Triola, M. M. Virtual patients: A critical review. Medical Education. 2009; 43(4): 358-365.
3. Garris, R., Ahlers, R., & Driskell, J. E. Games, motivation, and learning: A research and practice model. Simulation & Gaming. 2002; 33(4): 441-467.
4. Koehler, N., & Spence, R. Simulations in pharmacy education: Bridging the gap between theory and practice. American Journal of Pharmaceutical Education. 2018; 82(7): 732-737.
5. Berman, L., & Luyt, B. The role of simulation in pharmacy education: The benefits of virtual patient simulations in enhancing clinical learning. Currents in Pharmacy Teaching and Learning. 2021; 13(1): 56-64.
6. Alderson, M., & Li, L. Gamification in pharmacy education: Enhancing learning and engagement. Pharmacy Education. 2020; 20(2): 211-218.
7. Glen, T., & Duffy, A. Using virtual patients to enhance pharmacy education and practice: A case-based approach. Journal of Pharmacy Practice. 2021; 34(4): 265-271.
8. Sampson, M., & Fulcher, M. Incorporating virtual patient simulations into pharmacy rotations. Journal of Educational Technology Systems. 2019; 47(3): 420-431.
9. Tanner, J., & Jackson, P. Virtual patients: Bridging the gap in pharmacy practice education. Pharmacy Education. 2018; 18(3): 142-147.
10. Bartholomew, J. B., & Nicosia, L. A. E-learning in pharmacy education: A review of virtual patient simulation tools and their effectiveness. American Journal of Pharmaceutical Education. 2017; 81(4): 92-100.

11. Coughlan, P., & Weitzel, T. Simulation in pharmacy education: Enhancing clinical training through virtual scenarios. Journal of Pharmaceutical Education. 2020; 84(1): 75-85.
12. Desmarais, S. P., & Wisch, L. Advancements in pharmacy curriculum: The role of gamified virtual patient simulations in experiential education. Education for Health. 2022; 35(1): 28-34.
13. Gagnon, M., & Pickering, T. Evaluation of simulation-based education in health sciences: A review of virtual patient models. Simulation in Healthcare. 2018; 13(2): 105-110.