Virtual Patients in Clinician's Education: Theory, Knowledge and Self-efficacy in Anxiety Diagnosis

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Abstract—This paper aims to investigate the extent to which the use of a virtual patient (VP) improves the level of theoretical knowledge and confidence (self-efficacy) of psychology and medicine students to perform clinical diagnostics. We created two classes on an e-learning Moodle platform, presenting as a virtual patient the evaluation of the same panic disorder case. One class used a linear VP, the other, a branched VP (a decision-tree type). The sample consisted of 159 volunteer participants, a mix of psychology and medicine students, randomly assigned to one of three conditions: control, linear virtual patient (PVL) and branched virtual patient (PAD). Before and after the training with the virtual patient sequence, a questionnaire investigated the theoretical knowledge and the self-efficacy levels. For self-efficacy evaluation, we used the Session Management sub-scale of Counsellor Activity Self-Efficacy Scales, by Robert W. and Clara E. Hill.

Both types of VPs are associated with a statistically significant increase of knowledge about panic disorder diagnostic criteria, reinforcing the fact that the virtual patient has an impact on the cognitive profile (declarative knowledge) and on self-efficacy (related to procedural knowledge). Still, the study does not prove that one of the two types of virtual patient have a significant better outcome.

Keywords—virtual patients, self-efficacy, anxiety diagnosis

1 Introduction

A Virtual Patient (VP) as used in health education is a generic term for computer-based programs simulating real-life clinical scenarios, delivered in different formats, on a continuum from text based – low interactive – to high-fidelity simulations, i.e. a virtual world type [1]. VPs can be used in teaching and in evaluation to deliver and assess theoretical knowledge competencies, such as clinical reasoning, communication, or examination skills [2].

There are meta-analyses and systematic reviews that show that Internet-based learning is effective. Evidence does not clearly identify all the principles to guide future implementations, but a few relevant elements are interactivity, practice of exercises, repetition, and feedback [3].

In a published synthesis of proven guidelines for e-learning developers, Clark, Mayer, and Thalheimer (2003) [4] describe, when it comes to Internet-based learning products and multimedia, two pitfalls. Those are the pitfall of too much of a good thing – too many multimedia effects (animation, audio and visual effects) and the pitfall of not enough of a good thing – too much text, a real "wall of words" and not enough visual/audio effects. Balancing these extremes is the real art when designing IBL (Internet-based learning) tools.

It is important to note that fundamental educational principles of learning apply broadly to health professions as well, although the topics or learning objectives vary from one field of study to another. Virtual patient systems offer clinical skills training, clinical reasoning and decision-making experiences that are difficult to gain elsewhere, according to Ref. [5]. The ideal role of virtual patients in the hierarchy of learning sources, is between knowledge acquisition and practice with models/peers; then the student may use standardized patients; and finally, real patients, as stated in Ref [6].

Despite the use of on-screen simulations of clinical settings for educational purposes since the 1970s, only in the last 10 years have VPs had an real ascendant trend [7], with an increasing number of publications and presentations or even dedicated symposiums at large conferences such as AMEE's [8].

Over this time, international collaboration increased, enabling interoperability, accessibility and reusability of VPs across universities, as Zary et al. (2009) [9] note. As creation tools and costs became easily accessible, VPs are finally replacing the "paper" cases in medical problem-based learning [10].

Since there is already a multitude of types of virtual patients, a common language and a standard terminology needs to be defined in order to facilitate international collaboration or run systematic reviews and meta-analyses for evidence–based VPs. A framework was set by Kononowicz, Zary, Edelbring, Corral and Hege [2] and was continued by some researchers from this group with a qualitative analysis [11].

Virtual patients, as a method of IBL, are associated with certain improved learning outcomes compared to no intervention; while compared to traditional methods or other Internet-based instruments the results are inconsistent, further studies need to be done to investigate which type of VPs are more efficient, according to a meta-analysis performed by Cook, Erwin and Triola [12]. For example, studies could investigate if design with or without branching, or with or without feedback have better learning outcomes [13].

Usually studies investigate the level of knowledge, but some also investigate the self- efficacy that students gain using virtual patients, showing that interviews with VPs online are associated with better outcomes in knowledge and self-efficacy than role-play with peers [14]. Self-efficacy, when balanced, is considered a predictor for a good performance according to the social cognitive career theory of Lent, Brown and Hackett [15]. VPs are expected to have a moderate increase of self-efficacy, not overconfidence. Overconfidence is usually thought to occur when difficult judgment tasks are too simplified, whereas under-confidence may occur when the students have to solve only easy tasks or tasks not linked to practice [16].

The use of virtual patients is recommended not only for developing clinical skills for diagnostic interviews, but also for psychotherapy learning [17]. The same authors explain in another article that it is useful to combine virtual patients, in order to make them more accurate, with a virtual reality design. A good example is "Justina" – a virtual patient simulating Post Traumatic Stress Disorder [18]. Indeed, meta-analyses show encouraging results for the use of VPs, as well as virtual reality [19].

Our study objective is to evaluate the cognitive profile of students after the learning sequence with two types of VP, and the impact of this sequence on the students' self-efficacy in performing an interview with a real patient.

The design of the VP used in our study takes in account the findings of the literature and tries to avoid the pitfalls of e-learning mentioned by Clark, as well as the pitfall of over-confidence. We developed two VPs (case presentations). One is linear and the other a branched one in order to offer, in a blended manner, theoretical and procedural knowledge to learn how to perform a clinical interview, based on the DSM 5 criteria for anxiety.

The VP designs are simplistic ones, just text and images. The information has a step-by-step structure with questions to choose from to investigate symptoms, alternating with feedback and hints on how to develop a good therapeutic relationship. The interactivity is low in the linear VP and increased in the branched VP, and feedback is offered in a standardized manner immediately after the selection of a question and answer, explaining why it is not the best option).

2 Method

The study design is an experimental one; dependent variables are measured before and after the intervention. The control group has only test and re-test for the two dependent variables.

Dependent variables are the level of theoretical knowledge on the subject and the level of self-efficacy to manage an evaluation session using the knowledge acquired.

2.1 Participants

We selected students in Psychology and Medicine who volunteered online by sending an email address and details like name/age/study year. They were informed that sending this information is an agreement for their study involvement. We recruited a total number of 159 people, randomly assigned to one of three groups: a control group, a group that studied using linear virtual patients (PVL), and a group that studied using a branched (decisional tree) virtual patient (PAD).

The sample size for each group was calculated a-priori using G Power for t tests for two groups. We set the effect size d = 0.7 (medium) (d = 0.5 for matched pairs), err probability $\alpha = 0.05$, statistical power = 0.95, and the recommended sample size is 45 persons in each group. For the control group, since it is only test-retest with no variable manipulation, we decided to have 19 participants, with effect size d = 0.8

2.2 Tools

In order to investigate the cognitive profile of students after the learning sequence with a VP and the impact of this sequence on the students' self-efficacy for an interview with a real patient, we developed two VPs on an open source e-learning platform (Moodle), a linear and a branched one, illustrating a Panic Disorder case. It was a highly standardized case, without co-morbidities.

The courses were developed on a Moodle platform (accessible at https://psivp.gnomio.com), using a generic user vizitator2, password vizitator2 (courses are in the Romanian language).

The dependent variables are measured by questionnaire, before and after the course, and the knowledge test comprises of 10 multiple-choice questions whose contents refer to theoretical information from the learning sequence (the criteria for panic disorder and the clinician's skills that enhance the therapeutic relationship).

The self-efficacy test follows the knowledge test; the trainee must quote, from 1 to 10, how well they think they would perform in a near-future evaluation session to diagnose panic attack disorder. Questions are actually on the session management sub-scale of the Counselor Activity Self-Efficacy Scale, a technique with high validity, as developed by Robert W. and Clara E. Hill, and which is used in this study with the authors' consent

2.3 Procedure

We included each of the two virtual patient scenarios developed in a Moodle online course, and the dependent variables were measured with tests of Theory knowledge and Self -Efficacy before and after the VP exercise. Participants had access to an additional bibliography and the option to offer feedback for the course.

The test-retest phase was performed with participants randomly assigned to a control group; questionnaires were completed online on different days. Only after the statistical analysis, that proved that the test-retest process has no significant difference, did the online virtual patients courses start.

During the course, in order to have a good variable control we asked participants to follow the steps Test-VP exercise-Test; to ensure that order, the second and third steps needed passwords, which were offered at the end of the previous step. In order to prevent offering the correct answers to tests to other participants, we displayed only a percentile feedback of performance after completing the tests. To avoid a ceiling effect, we aimed the course at students in the first year of studies.

For the course, we disabled the forum and did not provide personalized feedback in order to offer similar conditions for all participants.

For all participants, during the period of time when the course was available (four weeks), we offered technical support via email, and emailed enrolled users weekly reminders to complete the course. The flow chart of the experiment is presented in Fig.1.

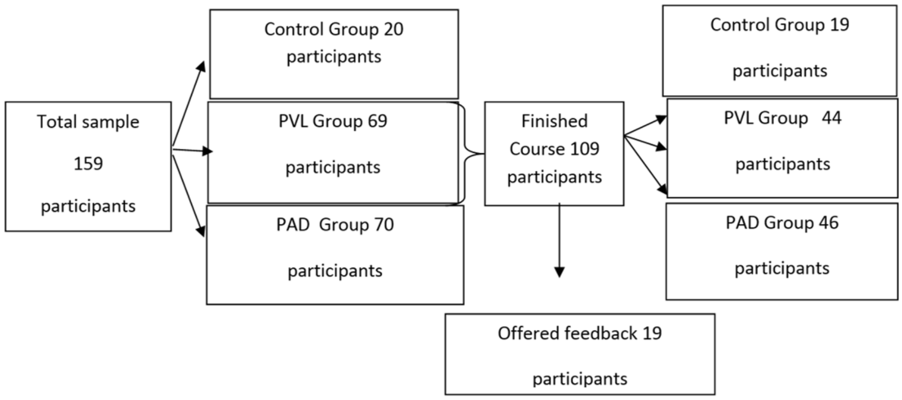

Fig. 1. Flow Chart

3 Results

3.1 Statistical Analysis

Only the data for the participants that completed the course were used in the statistical analysis, performed with R.3.3.0 x 64.

The study had 159 participants, 133 women and 26 men, the mean age being 23.84 (flow chart presented in annexes). For the first variable, theoretical knowledge, the pre-course mean is 4.309 and standard deviation is 1.51, the post-course mean is 5.387, standard deviation is 1.57. For the second variable, self-efficacy, the pre-course mean is 6.36, standard deviation is 1.76, the post-course mean is 7.23, and standard deviation is 1.43. The details are presented Table no. 1, in which PAD means Branched virtual patient experimental group and PVL means Linear virtual patient experimental group.

For both dependent-variable series of data we used the Shapiro-Wilk normality test, the results of which show that all series of data are normally distributed. You can see for details the Table no.2 - Shapiro-Wilk normality tests , in which PAD means Branched virtual patient experimental group and PVL means Linear virtual patient experimental group.

Statistical analysis performed using one-way Anova tests revealed that there are statistically significant differences between the three groups for Knowledge and Self-efficacy post-course. You can see for details the Table no. 3 – Anova tests, in which PAD means Branched virtual patient experimental group and PVL means Linear virtual patient experimental group.

A series of t-tests were performed to identify in which groups there are significant differences pre-/post-course. We performed t-tests between groups also to see which one of the two types of VPs had a significant better outcome. You can see for details the Table no.4 – T-tests, in which PAD means Branched virtual patient experimental group and PVL means Linear virtual patient experimental group.

Table 1. Means and Standard Deviation of Theory knowledge and Self- Efficacy

Group	N	M/ SD	Pre-course Theory Knowledge	Post-course Theory Knowledge	Pre-course Self-Efficacy	Post-course Self-Efficacy
Control	19	M	3.973	3.921	6.279	6.5
		SD	1.348	1.14	1.809	1.763
PAD	46	M	4.76	6.445	6.43	7.439
		SD	1.682	1.707	1.7	1.261
PVL	44	M	4.193	5.795	6.384	7.752
		SD	1.506	1.869	1.768	.278
Total mean			4.309	5.387	6.364	7.23

Table 2. Shapiro-Wilk normality tests

Group	N	Pre-course Theory Knowledge	Post-course Theory Knowledge	Pre-course Self-Efficacy	Post-course Self-Efficacy
Control	19	W= .969 p= .29	W= .95 p= .17	W= .97 p= .42	W= .98 p= 5.21
PAD	46	W= .972, p= .33	W= .95, p= .07	W=0.97, p= .51	W=0.98, p= .62
PVL	44	W= .976, p= .48	W= .95, p= .73	W= .96 p= .29	W= .97, p= .45

Table 3. Oneway Anova Tests

Group	Sum sq	Mean Sq	F value
Pre-course Theory Knowledge	11.32	5.66	2.33
Post-course Theory Knowledge	85.9	42.95	14.93***
Pre-course Self-Efficacy	.3	.15	.05
Post-course Self-Efficacy	20.92	10.46	5.607**

Degree of freedom df=2, significant at *p<0.05, ** p<0.01,***p<0.001

Table 4. T Tests

Group	t test	Theory knowledge	Self- Efficacy
Control	pre-post	.363	.123
PVL	pre-post	.004**	.000***
PAD	pre-post	.000***	.000***

significant at *p<0.05, ** p<0.01,***p<0.001

3.2 Study Results

For the control group there are no statistically significant differences between pre- and post-course levels of knowledge or self-efficacy ($p = 0.363$ for knowledge, $p=0.123$ for self –efficacy, α err probability=0.05).

Both types of VPs are associated with a statistically significant increase of knowledge about panic disorder diagnostic criteria ($p=0.0043$ for PVL, $p = 0.0006$ for PAD group, err probability $\alpha = 0.05$, $d = 0.5$) and also of self-efficacy level ($p = 0.0008$ for PVL, $p = 0.0001$ for PAD, err probability $\alpha = 0.05$, $d = 0.5$).

The study failed to show that one of the two VPs types is associated with a significantly better outcome for knowledge acquisition or for self-efficacy, although based on a literature review we were expecting better outcomes for students that learned with the branched virtual patient.

4 Discussions

The study reinforced the fact that VPs have an impact on cognitive profile, as well as on self-efficacy (related to procedural knowledge). This is consistent with VPs being placed by literature in a hierarchy of learning sources at the beginning of the transition from theory to practice; they indeed strengthen the knowledge and help in this transition through self-efficacy.

However, data analysis failed to prove that assisted learning with one version is better than the other, in terms of knowledge or self-efficacy. One possible explanation is the fact that both VPs presented the same case, a case without comorbidities and highly standardized, so the branched virtual patient did not have the opportunity to be used at its best for clinical decision learning.

The statistical analysis results are reinforced by the user feedback: 10% of participants offered optional qualitative feedback, particularly a positive one. They appreciated the way information was structured, containing step-by-step guidance, with information about diagnostic criteria, examples of formulated questions based on criteria and hints about developing a therapeutic relationship. They mentioned several times how excited they were to play the clinician's role for the first time.

The study results make a case for using this type of training course, associated with traditional courses, to facilitate the acquisition of knowledge and the transition towards its application.

The VPs we used were developed easily on an open source platform by a psychology MA student after brief training with an experimented user of the platform. This means that developing such VPs is accessible not only to IT specialists, but to teachers and trainers also, and that it is a cost-effective tool.

Presented VPs could be considered low-interactive, or lacking media effects like animation or sound; still, they were associated with a statistically significant effect.

Student's satisfaction and interest, as expressed in the large number of participants who finished the course and in their feedback, also make a case for the use of VPs as a learning tool in the mental health field.

Future research should investigate the effect of branched VPs compared to linear ones for more complexes cases, with co-morbidities and difficult differential diagnostic.

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