Available online **www.ijpras.com**

International Journal of Pharmaceutical Research & Allied Sciences, 2017, 6(4):88-94

Research Article

ISSN : 2277-3657
CODEN(USA) : IJPRPM

Virtual Patient as A Multimedia Learning Tool to Help Students Learn Clinical Reasoning Skills in Medicine

Saad Hamad Al-Dosari[1*], Abdulmajeed Al-Drees[2], Fahad Saeed Al-Qahtani[1], Naif Ali Alajji[1], Abdullah Ali Al-Qahtani[1]

[1] Intern, College of Medicine, King Saud University, Riyadh, KSA.
[2] Ph.D. in medical physiology, Vice- Dean of Graduate Studies and Scientific Research, Prince Sultan bin Abdul Aziz College for Emergency Medical Services, King Saud University, Riyadh, KSA.

ABSTRACT

Background: Numerous instructional methods are used in medical education, including interactive lectures, problem-based learning (PBL), case-based learning, and bedside teaching. Bedside teaching provides students with a real-life experience interacting with patients. Therefore, researchers have been working to create computer programs with virtual patients (VPs) that simulate live patients, which aim to improve medical student clinical reasoning skills without the need of live patients. Aims: To study the perception of medical students at King Saud University (KSU) of the Diagnostic Reasoning program (DxR) as a learning tool in the hybrid curriculum. Study Design: Cross-section study conducted at the College of Medicine, KSU, Riyadh, Saudi Arabia using qualitative and quantitative data collection methods. Methods: The data was collected from third, fourth, and fifth year medical undergraduate students of both genders, from November 2014 until March 2015. Results: The results were divided into ten categories according to five themes: learning, specialty, assessment, authenticity, and implementation. In correlation with our reviewed literature, one of the primary targets of virtual patients is to stimulate relative thinking and problem solving. The students claimed that it was an enjoyable experience that allowed them to practice their skills in history taking, physical examination, ordering investigations and treating accordingly. It was also found that student satisfaction increased relative to the number of cases they attempted ($p < 0.05$). Conclusion: The study evaluates the medical students' perception of DxR in the system-based hybrid curriculum at KSU. Our findings show that DxR leads to positive knowledge and skill outcomes. Students believed that further DxR training workshops should be implemented in order to improve software usage.

Keywords: *virtual patient, medical learning, Clinical Reasoning Skills*

INTRODUCTION

Numerous instructional methods are used in medical education, including interactive lectures, problem-based learning (PBL), case-based learning, and bedside teaching. Bedside teaching provides students with a real-life experience interacting with patients. However, its limitations include inadequate number of patients for the sessions, a limited spectrum of cases, time consumption, and the need for trained instructors [1]. Therefore, researchers have been working to create computer programs with virtual patients (VPs) that simulate live patients, which aim to improve medical student clinical reasoning skills without the need of live patients[1,2].

Richard E. Mayer introduced and promoted the cognitive theory of multimedia learning (CTML). He showed that words and pictures help people learn more deeply than words alone [3]. He also found that learning is more effective when words and pictures are converted into mental representations (schema) by the active learner [3]. CTML is

based on the principles of dual-channel working memory (auditory and visual channels), the limited capacity and duration of working memory, and the active processing of information, including organization and integration with prior knowledge [3,4,5]. Three memories are involved in the CTML model: very short-term sensory memory (visual and auditory), very short-term working memory (selection, processing, and integration of information), and long-term memory (knowledge store) with five different forms of word and picture representation [3]. In addition, leaners become more conscious of information stored in their long-term memory when it has been applied [3]. Furthermore, meaningful learning is demonstrated when the learner can apply what they have learnt to new situations [6].

Clinical reasoning is a complex intellectual activity. It is the ability to gather relevant information from the patient, then integrating it with previous knowledge and experience to reach a diagnosis and decide on management [7]. Both simulated patients and virtual patients have been reported to be beneficial mediums for gaining diagnostic reasoning skills[7].A virtual patient (VP) is defined as interactive computer simulations of a real-life patient used to practice history taking, physical examination, diagnostic skills and management[2]. The learning process with a virtual patient is active, contextual and can provide a more authentic learning experience than classroom-based PBL. In addition, VPs give learners the ability to make choices and experience the consequences in an engaging and realistic environment [8]. High acceptance of virtual patient programs has been documented among both pre-clinical and clinical year medical students [9,10]. In addition, students reported VPs to be realistic and challenging. Student satisfaction was high with the use of VPs in combination with other teaching activities. Furthermore, it has been found that using VPs improved students' knowledge and clinical examinations skills more than traditional methods, such as didactic lectures, case-based learning, bed-side teaching, and interactive OPD teaching clinic [11].

However, students displayed little interest in further assessment and feedback regarding VPs [10]. Students also considered the relatively high technology demands of the program as a disadvantage. Furthermore, the scenarios and program interface complexity were reported to create a cognitive overload [8].

The recommended ten principles of VP design to help students develop clinical reasoning skills: Relevancy, level of difficulty, interactivity, ability to give feedback, optimal use of media, student focus, learning points recapitulation, authenticity, and questions and explanations [2]. The study also highlights the importance of considering VP-based activities integration with other course activities. Various approaches should be used in the early stages of integration, which should also be appropriate to the student's level.

VPs have been used in numerous educational programs, like Diagnostic Reasoning (DxR) and Second Life8, [12]. DxR, first introduced in 1990, is simulated patient software that allows students to practice their clinical reasoning skills by providing tools to gather information in order to diagnose and treat. With DxR, students are required to repeatedly state the patient's problem, generate hypotheses and interrupt information [12]. DxR has been used in many health colleges [8,7].

MATERIAL AND METHODS:

Cross-section study was conducted at (Name of institution) using qualitative and quantitative data collection methods. The data was collected from third, fourth, and fifth year medical undergraduate students of both genders, from November 2014 until March 2015. All participants were informed of the objectives of the study. The study objective was explained to the participants prior to their participation. Participant anonymity was assured by assigning each student with a code number for the analysis. The Research Ethical Committee (name of institution) approved the study.

Questionnaire:

An anonymous, self-administrated questionnaire, validated by [10] with minor modifications, was used. The first part of the questionnaire pertained to gender, age, academic year, and grade point average (GPA). The second part of the questionnaire contained questions about DxR benefits and perceptions using a 5-point Likert scale based on the number of cases the students finished, the time it took to work on them, and the methods of working with cases. The third part of the questionnaire contained questions with answers as strongly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1). At the end of the questionnaire there were open-ended questions. The participants were directed to answer the questions by choosing the appropriate choices and writing the answer to open-ended questions. Incomplete questionnaires were excluded.

Data were coded and entered into Microsoft Excel, then analyzed using SPSS® version 21.0 (IBM Corporation, Armonk, NY, USA). The average score for each student was calculated on a 5-point Likert scale. The 5-point Likert scale responses were combined into three different categorical variables: 'agree' (strongly agree plus agree),

'neutral', and 'disagree' (strongly disagree plus disagree). Chi-Square test was used to measure the associations among the different categorical variables (agree, neutral, and disagree), and gender and year of study.

Focus groups:

The students' perceptions of DxR were explored in a focus group discussion. All students of the third, fourth and fifth academic years were invited to participate in the focus groups, and only 50 students consented. Participants (n=50) were divided into five focus groups, with each group containing students from different academic years. One of the authors, a medical educationist, moderated the sessions, which started with a briefing on the study objective. Then the discussion was initiated using a series of preset directing questions to ensure consistency across the groups. The sessions lasted for 2 hours. During the sessions, students were encouraged to speak freely while a moderator assistant took notes, and the discussion was audio-recorded and transcribed. Three of the authors analyzed the transcript, identifying recurrent themes. The themes were further divided into categories. A summary report of each group was generated and presented to the groups.

RESULTS:

The results have been divided into ten categories, which fall under five general themes. The presentation of the results includes quotations from the students during the focus group session. The most reliable quotation was chosen to avoid redundancy. However, other students expressed similar ideas with fluctuations in agreement. For a synopsis of the results, please consult table 1.

Chi-square test was used for categorical variables, while the association between continuous variables were examined using T-test. Independent T-test was used to analyze the mean difference between the two trial arms. In case an independent variable contained more than two categories, analysis of variance test (ANOVA) was used to measure significant associations with the study outcome. SPSS software, version 23 (SPSS Inc., Chicago, Illinois, USA) was used for data entry and analysis. All analyses were carried out at a 5% two-sided significance level and results were reported with 95% confidence intervals.

Surveys were analyzed for each student, and a mean satisfaction score was awarded for each question. Analysis was theme based, as several questions in the survey were intended to measure student satisfaction towards a predefined theme. Below, statistical analysis is presented for each proposed test and supported by students' quotes gathered from several focus groups meeting.

A total of 321 students completed the surveys, of which 184 were male (56.8%) and 137 were female (42.3%). The mean satisfaction score for male and female students was 1.72 and 1.63. The mean difference between both mean scores was statistically significant ($p < 0.05$) (table 2). This means that male students scored an overall higher satisfaction score than female students. Clinical year distribution was as follows: 137 students from third year, 102 from fourth year, and 80 from fifth year. There were three different student GPA categories: 2.75-3.74 (3.7%), 3.75-4.74 (36.7%) and 4.75-5.0 (50.9%).

Theme 1: Learning

Category 1: Clinical reasoning

ANOVA test was conducted to measure the association between student satisfaction and the average number of times each individual case was attempted. Students who attempted each case more than twice had a significantly higher satisfaction score than students who worked on each case only once ($p < 0.05$). One of the main targets of VPs is to stimulate relative thinking and searching to solve problems. From the focus group questions on clinical reasoning, a student quoted that "if u [sic] are dedicated to solve the case it makes u go and read about it". From the students' point of view, the opportunity to learn about cost efficiency was one of DxR interesting features: "The cost is good point because it will minimize my investigation [sic]". Furthermore, students mentioned that one of the positive aspects of DxR is that it mimics real-life situations: "It is more realistic in terms of doing physical examination, like stethoscope you can hear the heart beats with the abnormalities [sic]".

Category 2: Safe to make mistakes

Since the DxR is web-based software, students were more relaxed concurring cases, as it was safe to make mistakes. As an active learning technique, they preferred DxR over real-life situations, where they sometimes got stressed dealing with live patients. "It is fine for me to make mistakes in DXR rather than real patient [sic]", a student commented, to which the majority of participants agreed.

Theme 2: Specialty

Category 1: Case variety

An ANOVA test was done to investigate the association between the number of DxR cases attempted by each student and their satisfaction score. As the number of cases increased (more than 15 cases), so did the mean students' satisfaction score ($p < 0.05$). Moreover, students were satisfied with the number of cases, topic variation, and relevance of topics to their curriculum themes. "I liked the variety in cases and its [sic] association with what we are studying at the moment," was a common comment by many students during the focus group. On the other hand, a few students felt that the cases were novel to them and had not been covered in the theoretical part of their studies. As they quoted, "the cases sometimes are not common cases seen in clinic nor taken in the theoretical part [sic]".

Theme 3: Assessment

Category 1: DxR assessment-qualitatively different in manner of student year:

Third year students were more satisfied with DxR than both fourth and fifth year students, as the mean satisfaction score for third, fourth and fifth year students were 1.84, 1.60, 1.51 (p-value < 0.05). Student feedback showed that DxR did not differentiate between third, fourth, and fifth year in terms of information presented. "As third year students, we know how to take history but investigation and treatment is [sic] beyond our knowledge," noted a third-year focus group student. Another student in the same meeting also commented "it does not differentiate between the student's clinical year, for third year it should access history and physical exam parts and continue for fifth year students, with investigation and management [sic]". In addition, students were required to list differential diagnosis for each case, which was considered one of the difficult aspects. They commented "differential diagnosis is beyond our level since, some of the differential we did not take or have any knowledge about it [sic]".

Category 2: Motivation and limitations

According to the students' feedback, the DxR experience was enjoyable: "In somehow [sic], it was interesting in the beginning". They enjoyed the role assigned to them while working cases, doing physical examinations, requesting medical tests and treating accordingly. As a student commented, it was "enjoyable in terms of ordering investigation and planning a management protocol [sic]". However, stress while attempting cases was mentioned during the focus group and the students quoted different reasons for that, such as: "it makes me stress because I want to score all mark [sic]", and "DxR puts me on pressure because of the dead line [sic]". The amount of time spent on average by each student was measured, which was statistically correlated with student satisfaction. It was noticed that if students spend more than one hour on a case, their satisfaction score will decrease significantly ($p < 0.05$). During the focus group, students complained from a heavy workload during the academic year and minimal time to work on the DxR: "very long cases which take a lot of time to solve and sometimes it's too much for a student to handle [sic]". Another student complained "it is time consuming (a lot of writing)" and that "SOAP is time consuming". This can be noticed from Table 1, as many of the students selected SOAP as the most difficult question.

Category 3: Feedback

The students appreciated DxR feedback given at the end of each completed case. As most of the students agreed during the focus groups, "it gives you feedback about the things you missed". They also endorsed a software feature which allows them to consult a specialist: "in examination and investigation after your interpretation it gives you consultation form a specialist [sic]".

Theme 4: Authenticity

Category 1: Design and content

The participants believed that the DxR interface was outdated, misleading and complex: "DxR layout is very old"; "user interface is complicated". The students also complained about the quality of the radiological images: "some images in the DxR were not clear, especially the radiological imaging". This feedback was mostly from students who did not attempt as many cases on DxR as other students with higher satisfaction scores, which has been linked as aforementioned. However, the students admired how the case histories were presented: "the question presented in DxR history is good, clear, and covering the subject of the case [sic]".

Theme 5: Implementation

Category 1: Access and availability

Students were asked about the locations where they worked on DxR from. Answers included home, college and coffee shops. An independent t-test showed that there was no statistically significant difference between the mean satisfaction score for students working from these different places. This implies that location of work does not affect the satisfaction score of students. During the focus group, students agreed that the flexibility of access to DxR was

one of the features they admired, and mentioned that "because it is a web based you can do it in college home or anywhere and at any time [sic]".

Category 2: Topics and number of cases

Students were satisfied with the number of cases that were presented per theme. "I believe that the number of cases is acceptable", as a student commented. "Most of the cases are common", mentioned another student, to which the rest agreed to.

Category 3: Suggested improvements

The students suggested several methods to improve DxR. These include improving the rigid grading system. "The DxR is too ideally, you should answer everything to get the full mark. I think they should lower their standard and make it if you reach a certain degree you get the full mark for the section like if you should ask 10 question in history if you asked 7-8 question it's enough [sic]". Another student added, "fail or pass will be better in evaluation". Furthermore, students believed more workshops on DxR should be implemented in order for them to improve and adapt to the software: "the orientation was beneficial to us but we need more workshops". Another issue that participants believe need improvement is that spelling and misspelt words were considered a problem: "I always have problem with spelling [sic]". Moreover, different names for one disease were considered an issue: "in differential diagnosis some diseases have more than one name but the DxR recognizes only one and count the other as mistake [sic]"; "Because it is web based if you change one letter in a word it counts as mistake and the whole mark is lost [sic]".

DISCUSSION:

Learning:

Clinical reasoning: Students reported that DxR helped test their existing knowledge[12] and it allowed them to actively apply their newly gained insights in clinical reasoning during the corresponding teaching events[13,14]. Our study adds that DxR motivated them to read more about the cases they attempted in order to solve them. Moreover, students mentioned numerous positive features of DxR software, including how it mimics real-life situations.

Safe to make mistakes: Students claimed that computer cases were not stressful as opposed to real patient interactions, which could be highly stressful. If a mistake was made on a VP, they did not feel embarrassed or intimidated z[2,9,12,14]. Additionally, they could try things on a computer patient that they could not do on a real patient[12]. In our study, students also preferred DxR over real-life situations where they sometimes got stressed dealing with real patients.

Specialty:

More cases were linked to more knowledge. It is sometimes necessary that students attempt more than one case per topic for common diseases, which are often complicated with co-morbidities at presentation [14]. Case variety is a beneficial feature of DxR, and students were satisfied with the number of cases, their variation, and their relevance to the topics in their curriculum.

Assessment:

Qualitatively different: The degree of difficulty of DxR cases should be appropriate for students' knowledge and academic levels (no number). Students indicated that DxR did not differentiate between third, fourth, and fifth year in terms of information presented.

Motivation and limitation: Students said the program was interesting, fun, non-stressful, yet engaged them to think. They enjoyed the opportunity to practice gathering information and working through a patient's problem from beginning to end. They also appreciated the feedback on their performance [12]. (no number just on the feedback point). In our experience, students also felt DxR was enjoyable and interesting in terms of ordering investigations and planning management. They also commended the DxR feedback given at the end of each case, as well as the specialist consultation feature, which allowed them to ask for a second opinion when they felt doubtful about a finding. However, our students believed that DxR was time consuming and required a lot of effort to score a full mark.

Authenticity:

Students had difficulty sometimes searching in the DxR database. This was complicated by differences in terminology[12]. In our study, students also found the DxR layout to be outdated and the user interface to be misleading and complex. However, they liked how the case history was presented and felt they would use the software to practice their history-taking skills [13].

Implementation:

Access and availability: Our study showed that students appreciated the flexibility of access to DxR. VPs were always accessible, unlike real patients [2,12,13]. The number of cases available was acceptable and topics of cases were commonly seen in the clinic, as the students claimed.

Suggested improvement: The students suggested several improvements to DxR. According to them, DxR is rigid and will not accept any spelling mistakes. Furthermore, DxR will recognize only one name for a disease, even if it has more than one. Moreover, they felt they needed further seminars and workshops on how to use DxR. Lastly, they believed it would be better to use a pass or fail system, as a grading system is not flexible.

CONCLUSION:

The study evaluates the perception of students toward DxR in a system-based hybrid curriculum. It shows that DxR has no positive effect on knowledge and skill outcome in a system-based hybrid curriculum at (name of institution) Therefore, students need more guidance and training concerning working with the web cases presented on DxR. Moreover, the DxR website needs to be updated in terms of layout and features. Lastly, students require further seminar discussions of the DxR web cases.

REFERENCES:

1. Oliven, A., Nave, R., Gilad, D., Barch, A. Implementation of a Web-Based Interactive Virtual Patient Case Simulation as a Training and Assessment Tool for Medical Students. European Federation for Medical Informatics, 2011: 233–237. http://doi.org/10.3233/978-1-60750-806-9-233
2. Reichert, F., Bosse, H., Leng, B., De Vleuten, C., Haag, M., Hoffmann, G.F. Virtual patients Design principles for virtual patients: a focus group study among students. Medical Teacher, 2009; 43: 580–588. http://doi.org/10.1111/j.1365-2923.2009.03369.
3. Mayer, R.E. Cognitive Theory of Multimedia Learning. In R.E. Mayer (Ed.). The Cambridge Handbook of Multimedia Learning, Cambridge University Press: New York; 2005.
4. Mayer, R.E., Moreno, R. A split-attention effect in multimedia learning: Evidence for dual processing systems in working memory. Journal of Educational Psychology, 1998; 90: 312-320.
5. Mayer, R.E. Elements of a science of e-learning. Journal of Educational Computing Research, 2003; 29(3): 297-313.
6. Mayer, R.E. What neurosurgeons should discover about the science of learning. Clinical Neurosurgery, 2009; 56: 57-65.
7. Wilson, R.D., Klein, J.D., Hagler, D. Computer-Based or Human Patient Simulation-Based Case Analysis: Which Works Better for Teaching Diagnostic Reasoning Skills. Nursing Education Perspectives, 2004; 35: 14–19. http://doi.org/10.5480/11-515.
8. Conradi, E., Kavia, S., Burden, D., Rice, A., Woodham, L., Beaumont, C., et al. Virtual patients in a virtual world: Training paramedic students for practice. Medical Teacher, 2009; 31: 713–720. http://doi.org/10.1080/01421590903134160
9. Gesundheit, N., Brutlag, P., Youngblood, P., Gunning, W.T., Zary, N. The use of virtual patients to assess the clinical skills and reasoning of medical students: initial insights on student acceptance. Medical Teacher, 2009; 31: 739–742. http://doi.org/10.1080/01421590903126489
10. Edelbring, S., Brostro, O., Henriksson, P., Vassiliou, D., Spaak, J. Technology enhanced learning Integrating virtual patients into courses: follow-up seminars and perceived benefit. Medical education, 2012; 46: 417–425. http://doi.org/10.1111/j.1365-2923.2012.04219.x
11. Huang, G., Reynolds, R., Candler, C. Virtual patient simulation at US and Canadian medical schools. Acad Med J Assoc Am Med Coll, 2007; 82(5):446–51.
12. Bryce, D.A., King, N.J.C., Graebner, C.F., Myers, J.H. Evaluation of a Diagnostic Reasoning Program (DxR): Exploring Student Perceptions and Addressing Faculty Concerns Demonstrations. Journal of Interactive Media in Education, 1998; 98 (1): 196–198.
13. Andrzej, A., Kononowicz, Paweł, Krawczyk, Grzegor,z Cebula, Marta, Dembkowska, Edyta, Drab, Bartosz, Frączek, et al. Effects of introducing a voluntary virtual patient module to a basic life support with an automated external defibrillator course: a randomised trial. BMC Medical Education, 2012; 12:41.

14. Mihaela, Botezatu, Håkan, Hult, Uno, G. Fors. Virtual patient simulation: what do students make of it? A focus group study. BMC Medical Education, 2010; 10:91.

Tables:

Table 1

Diagnosis	97	29.6
Physical Examination	66	20.1
Laboratory Tests	156	47.5
SOAP	221	67.6
Management	189	57.7

The table above illustrates the number of counts calculated for each section given by the students. The SOAP and Management sections scored the highest counts, which were mostly given by third year students.

Table 2

Independent Samples Test				
	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
Gender	0.005	0.27962	0.08612	0.47311

Table (3) Result themes and Category

Theme	**Category**
Learning	Clinical reasoning Safe environment
Specialty	Case variety
Assessment	Qualitatively different Motivation and limitation Feedback
Authenticity	Design and content
Implementation	Access and availability Number of cases Improvement