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Use of virtual patients in orthopedic teaching as an adjuvant tool to clinical training for medical students

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ABSTRACT

Background: Virtual patients are a valuable tool that can be used besides clinical teaching for medical students' education. The purpose of this study was to assess the educational benefit of using virtual patients in the orthopedic field for the clinical teaching of medical students. *Methods:* One hundred eighty-seven undergraduate medical students, 99 male, and 88 female from the college of medicine in Al-Qunfudhah, university of Umm Al-Qura, from level 3 till level 6, who finished the orthopedic course, were recruited in this cross-sectional study after their acceptance to participate. Each student had the same validated virtual patient questionnaire to assess their learning and clinical reasoning experiences with virtual patients. *Results:* Regarding the items of the questionnaire regarding the virtual case teaching: in the 1st item, 80% of students agree with the "Authenticity of the patient encounters and the consultation" while 5.8% of students disagree. In the 2nd item, 79.1% of students agree with the "Professional approach in the consultation" and 5.8% disagree. In the 3rd item, 83.9% of students agree with the "Coaching during the consultation" and 2.1% disagree. In the 4th item, 54.5% agree with the "Learning effect of consultation" while 5.8% disagree and 36.8% are neutral. Finally, there is no significance between the different student levels in their response. *Conclusions:* Virtual patients had a favorable effect on medical students and can be carried out as a supportive tool in clinical teaching to achieve maximum educational benefit.

Keywords: Virtual patient, clinical education, patient safety, medical students

1. INTRODUCTION

Clinical education is a paramount part of medical education. However, it faces many difficulties as a small number of clinical physicians, bounded number of variations in the clinical cases, and high standard of patient safety that limit the classic way the training of medical students through direct contact with a patient as in coronavirus disease (Cairney-Hill et al., 2021; Kononowicz et al., 2019). Furthermore, early clinical exposure is a new paradigm in medical curricula of the medical school that requires a various number of clinical cases patients either actual patients or simulated patients for medical students

(Tayade et al., 2021). A virtual patient is one of the digital education modalities that can be applied to enhance the medical clinical education, assessment, and training of the medical students (Car et al., 2019). It is a simulation system founded on artificial intelligence where the students perform the position of the doctor who faces a virtual clinical patient. The student response in the calculated standard time for the resolution by the medical student immediately impacts on the responses of the patient, merely like in real life (Kononowicz et al., 2019).

Virtual patients can be used to improve knowledge and skills in clinical education like problem-solving and clinical reasoning that decrease the number of medical errors and consequently enhance patient safety. Also, they can be applied in learning history taking, clinical examination, medical communication, and practical skills (Mıdık and Kartal, 2015). The goal of this study is to speculate on the educational benefit of using virtual clinical patients teaching in the orthopedic field for the clinical teaching of medical students.

2. MATERIAL & METHODS

This is a cross-sectional study carried out between students of the college of medicine in Al-Qunfudhah, the university of Umm Al-Qura for assessment of students' feedback on a virtual patient teaching after the course of orthopedic teaching as an adjuvant to clinical training, the study done between January 2021 to May 2021 the time of the course, 187 students share in this study 99 male and 88 female resembling different levels from level 3 which start the orthopedic clinical course to the students of level 6 who finish the course, the study formed of the well-prepared self-controlled questionnaire, delivered to students across WhatsApp, the questionnaire in reference towww.virtualpatients.eu, the questionnaire formed of 4 points the first one measures “the patient meeting and consultation” by two questions. The second point measures “professional approach to counseling”, it is formed of 4 questions, the third point measures “the training during the consultation” by 3 questions. The fourth point measures “the effect of learning from counseling” by 2 questions. The students were informed about the procedure and the target of the study. This study was approved by the medical education department in the faculty with high acceptance from the vice dean of academic affairs of the faculty, our data was tabled in an excel sheet to be easily handled for statistical analysis by GraphPad prism 9.1.3 software California USA, all the data expressed in frequency with percentage, for comparison between the response of students at different levels we will use one-way ANOVA test followed by hoc test When the $p < 0.05$ is significant.

3. RESULTS

According to demographic distribution discussed in (table 1) 187 students share in our study 99 male, 88 female, according to the first item “the patient meeting and consultation” we founded that (Table 2 and Figure 1) 84.6% of the students of the third level agree that the virtual patient helping them to take a decision like a doctor in real patient, while 10% of level 6 students disagree, 18,8% of students at the level 5 neutral, and all levels share the same percent in non-applicable option, also in 85.2% of the students of the level 4 feel as doctor care to patient, 6.3% of students of level 5 disagree, 13.8% of students of level 3 neutral, 10% of students of level 6 thinking it's not applicable, the second item “professional approach to counseling” (Table 3 and Figure 2), 79.6% of students of level 4 agree to participates in the discussion of the clinical history and examination of the patient, 15% of students at level 6 disagree, 13.8% of students of level 3 neutral, 10% of students of level 6 thinking it's not applicable, 76.7% of students of level 3 agree to actively participates in reviewing the primary investigations of the patients, 10% of students at level 6 disagree, 26.5 % of students of level 4 neutral, 10% of students of level 6 thinking it's not applicable, 63% of students of level 3 agree to be actively participates in making a review of the clinical condition of the patient we notice marked decrease in the agreements of the students at different levels to this question, 17.6% of students at level 4 disagree, 31.3% of students of level 5 neutral, 10% of students of level 6 thinking it's not applicable, 87.6% of students of level 3 agree to be actively share in putting the evidences helping in diagnosis of the patients, 10.5% of students at level 5 disagree, 16.7 % of students of level 5 neutral, all the students of different levels share the same percent of not applicability, the third item, “Coaching during consultation” (Table 4, figure 3), 73.9% of students of level 3 agree that the virtual case difficulty fit to his level of training, 15% of students at level 6 disagree, 20 % of students of level 6 neutral, all the students of different levels share the same percent of not applicability, 94.1% of students of level 4 agree that the virtual case enhancing their diagnostic reasoning, 5% of students at level 6 disagree, 22.9 % of students of level 5 neutral, all the students of different levels share the same percent of not applicability, 94.1% of students of level 4 agree that the comments I received were helpful in furthering my diagnostic skills in this case, 2.9% of students at level 4 disagree, 20 % of students of level 6 neutral, 10% of students of level 6 thinking it's not applicable. the fourth item “Learning effect of consultation” item (Table 5, figure 4), 79.6% of students of level 4 agree that felt I am better in the diagnosis and exclude the differential diagnosis of the clinical case of real patient 15.3% of students at level 3 disagree, 27.1% of students of level 5 neutral, all the students of different levels share the same percent

of not applicability, 67.6% of students of level 4 agree that after this case I felt qualified to take care of the patient, 10.4% of students at level 5 disagree, 60%% of students of level 6 neutral, all the students of different levels share the same percent of not applicability. While we compare the different responses of the different levels we found no significance between the levels in its response (table 6, figure 5 A, B, C, D).

Table 1 Demographic distribution of the students

Parameter	Frequency		Percentage
	N	187	%
Gender			
Male	99		52.9
Female	88		47.1
Academic level			
Leve 3			
Male	25		38.5
Female	40		61.5
Level 4			
Male	17		50
Female	17		50
Level 5			
Male	29		60.4
Female	19		39.6
Level 6			
Male	28		70
Female	12		30

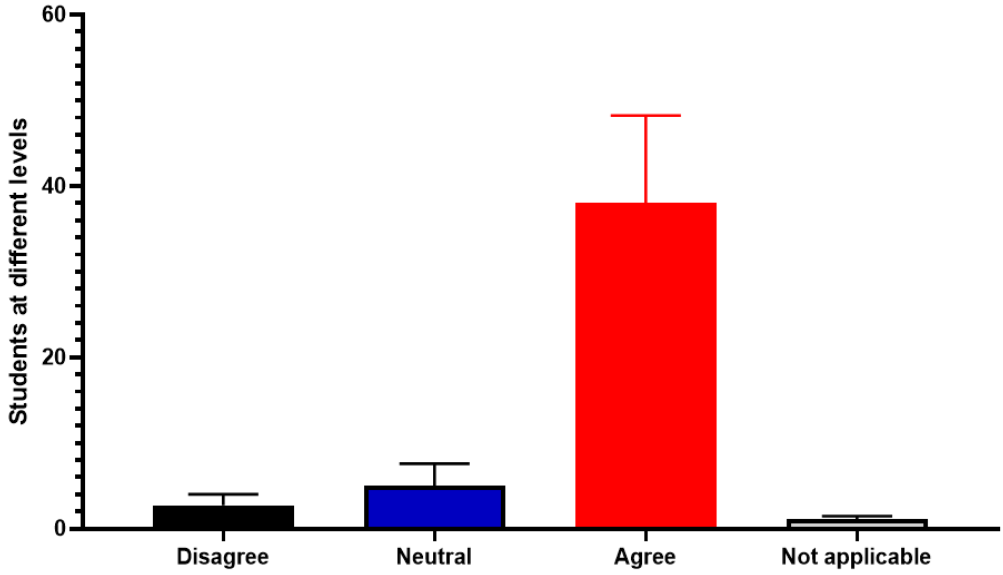

Figure 1 the patient meeting and consultation (N189)

Table 2 the patient meeting and consultation (N189)

1st point		Disagree	Neutral	Agree	Not applicable
Q1. Working on this case helping me to take a decision like a doctor in	Level 3 (65) n	4 (6.2%)	5 (7.7%)	55(84.6%)	1(1.6%)
	Level 4 (34) n	1(2.9%)	2 (5.9%)	30(88.3%)	1(2.9%)
	Level 5 (48)	2 (4.2%)	9 (18.8%)	36(75%)	1(2.1%)

real patient	Level 6 (40)	4 (10%)	4(10%)	31(77.5%)	1(2.5%)
Total	189 n	11(5.8%)	20(10.5)	152(80.4%)	4(2.11%)
Q2. Discussing this case gave me the impression as doctor care to patient	Level 3 (65) n	3(4.6%)	9(13.8%)	52 (80%)	1(1.6%)
	Level 4 (34)n	1(2.9%)	3(8.8%)	29(85.2%)	1(2.9%)
	Level 5 (48)	3(6.3%)	4(8.3%)	40(83.4%)	1(2.1%)
	Level 6 (40)	4(10%)	4(10%)	30(75%)	2(5%)
Total	187 n	11(5.8%)	20(10.6)	151(80.7)	5(2.6)
1stItem score		2.75±1.28	5±2.61	38±10.24	1.12±0.35

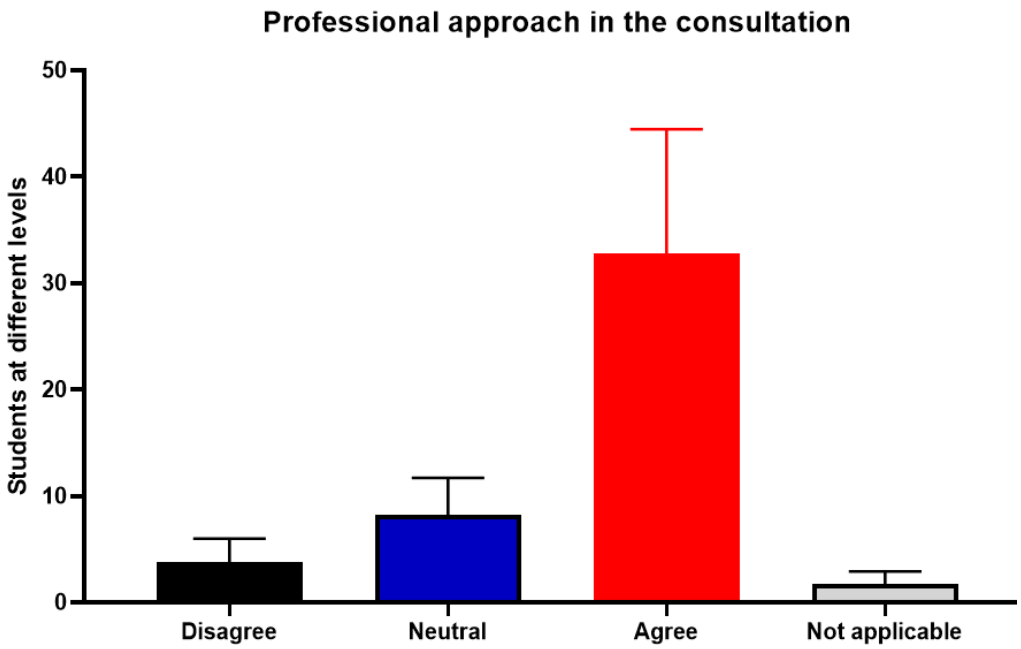

Figure 2 professional approaches in the consultation

Table 3 Professional approach in the consultation

2nd point		Disagree	Neutral	Agree	Not applicable
Q3. During working on this case I share in the discussion of the clinical history and examination of the patient	Level 3 (65) n	2(3.1%)	11(16.9%)	51(78.4%)	1(1.6%)
	Level 4 (34)n	1(2.9%)	4(11.8%)	27(79.5%)	2(5.9%)
	Level 5 (48)	6(12.5%)	4(8.3%)	37 (77.1%)	1(2.1%)
	Level 6 (40)	6(15%)	6(15%)	24 (60%)	4(10%)
Total	189 n	15 (8%)	25 (13.3%)	139(74.3%)	8(4.2%)
Q4. During working in this case I actively participates in reviewing the primary investigations of the patients	Level 3 (65) n	5(7.7%)	9(13.8%)	50(76.9%)	1(1.6%)
	Level 4 (34)n	1(2.9%)	9(26.5%)	22(54.7%)	2(5.9%)
	Level 5 (48)	3(6.3%)	11(22.9%)	32(66.7%)	2(4.2%)
	Level 6 (40)	4(10%)	6(15%)	26(65%)	4(10%)
Total	189 n	13 (6.9%)	35 (18.7%)	130(69.5%)	9(4.8%)
Q5. At working on this case I share in the preparation of short review about the clinical case	Level 3 (65) n	8(12.3%)	14(21.5%)	41(63%)	1(1.6%)
	Level 4 (34)n	6(17.6)	10(29.4%)	17(50%)	1(2.9%)
	Level 5 (48)	2 (4.2%)	15(31.3%)	30(62.5%)	1(2.1%)
	Level 6 (40)	6 (15%)	10(25%)	20(50%)	4(10%)
Total	189 n	22 (11.7%)	49 (26.2%)	108(57.7%)	7(3.7%)
Q6. During working at this case I actively share in putting the	Level 3 (65) n	2(3.1%)	5 (7.7%)	57(87.6%)	1(2.9%)
	Level 4 (34)n	2(5.9)%	4(11.8%)	26(79.5%)	1(2.9%)

evidences helping in the diagnosis of the patients	Level 5 (48)	5(10.5)%	8(16.7%)	34(70.8%)	1(2.5%)
	Level 6 (40)	2(5%)	6 (15%)	31(77.5%)	1(2.5 %)
Total	189 n	11(5.8%)	23(12.2%)	148(79.1%)	4(2.1%)
2nd Item		3.81±2.19	8.25±3.47	32.8±11.6	1.75±1.18

Table 4 Coaching during consultation

3rd point		Disagree	Neutral	Agree	Not applicable
Q7. the virtual case difficulty fit to my level of training	Level 3 (65) n	8(12.3%)	8(12.3%)	48(73.9%)	1(1.5%)
	Level 4 (34)n	4(11.7)%	5(14.7%)	25(70.6)%	1(2.9)%
	Level 5 (48)	5(10.5%)	8(16.7%)	34(70.8%)	1(2.1)%
	Level 6 (40)	6(15)%	8(20%)	25(62.5%)	1(2.5%)
Total	189 n	23 (12.2%)	29 (15.5%)	132(70.5%)	8(4.2%)
Q8.the virtual case enhancing my diagnostic reasoning	Level 3 (65) n	1(1.6%)	5(7.7%)	58(89.2%)	1(1.6%)
	Level 4 (34)n	1(2.9%)	1(2.9%)	33(94.1%)	1(2.9%)
	Level 5 (48)	2(4.2)%	11(22.9)	34(70.8%)	1(2.1)%
	Level 6 (40)	2 (5)%	6(15%)	31(77.5%)	1(2.5%)
Total	189 n	6(6.9%)	23(12.2%)	156(83.4%)	4(2.1%)
Q9. The comments I received were helpful in furthering my diagnostic skills	Level 3 (65) n	1(1.6%)	5(7.7%)	58(89.2%)%	1(1.6%)
	Level 4 (34)n	1(2.9%)	1(2.9%)	33(94.1%)	1(2.9%)
	Level 5 (48)	1(2.1)%	7(14.6)	39(81.2%)	1(2.1)%
	Level 6 (40)	1 (2.5%)	8(20%)	27(67.5%)	4(10%)
Total	189 n	4(2.1)%)	21(11.2%)	157(83.9%)	7(3.7%)
3rd item		2.75±2.41	6.08±2.93	37.08±11.6	1.25±0.86

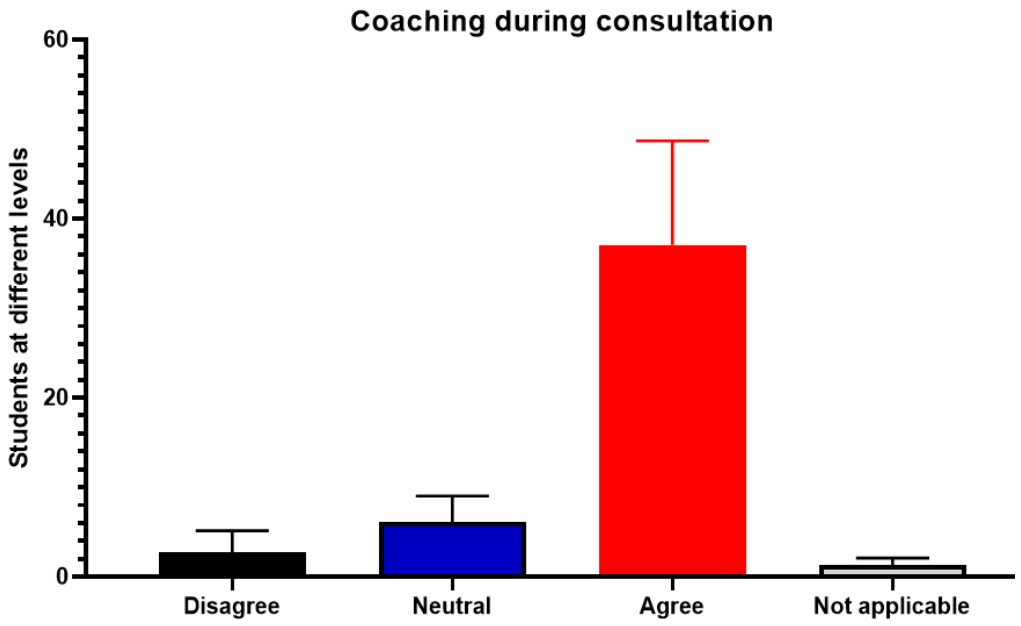

Figure 3 Coaching during consultation

Table 5 Learning effect of consultation.

4th point		Disagree	Neutral	Agree	Not applicable
Q10.After discussing the case I felt better in the diagnosis and	Level 3 (65) n	10(15.3%)	13(20.3%)	41(63%)	1(1.6%)
	Level 4 (34)n	1(2.9)%	5(14.7%)	27(79.6)%	1(2.9)%

exclude the differential diagnosis of the clinical case of real patient	Level 5 (48)	3(6.2%)	13(27.1%)	31(64.6%)	1(2.1)%
	Level 6 (40)	2(5)%	22(20%)	15(37.5%)	1(2.5%)
Total	189 n	16 (8.5%)	53(28.3%)	114(60.9%)	4(2.1%)
Q11. After this case I felt qualified to take care of the patient	Level 3 (65) n	3(4.6%)	23(35.9%)	37(56.8%)	1(1.6%)
	Level 4 (34)n	2(5.9%)	8(23.5%)	23(67.6%)	1(2.9%)
	Level 5 (48)	5(10.4)%	14(29.2)	28(56.2%)	1(2.1)%
	Level 6 (40)	1(2.5)%	24(60%)	14(35%)	1(2.5%)
Total	189 n	11(5.8%)	69(36.8%)	102(54.5%)	4(2.1%)
4thitem		3.37±2.97	15.25±7.06	27±9.5	1

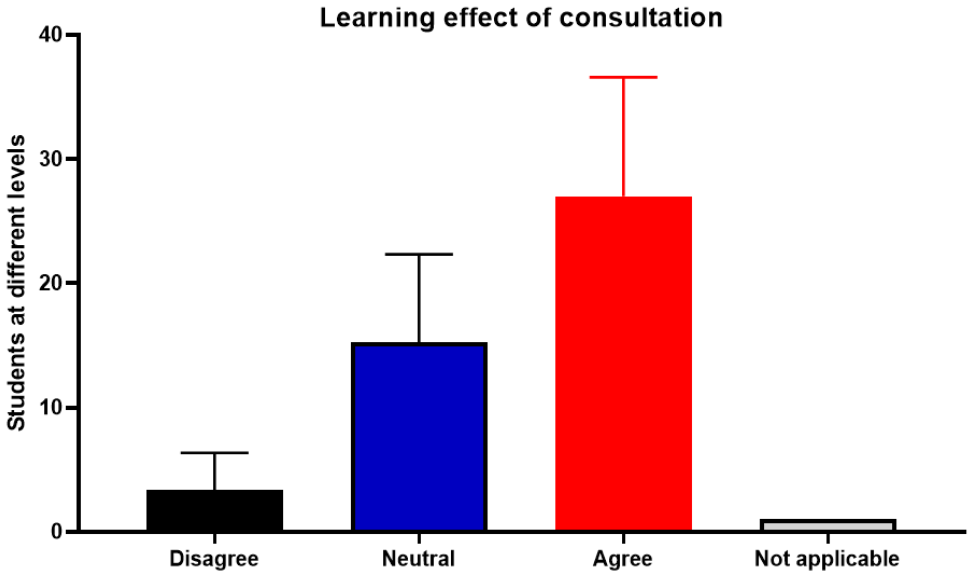

Figure 4 Learning effect of consultation.

Table 6 comparison between different levels of response using one-way ANOVA followed by post hoc test

	Years of students	N	Mean+SD	P-value
Point 1: Authenticity Item	3rd year	65	16.25±23.14	0.817
	4th year	34	8.62±13.21	
	5th year	48	12±16.28	
	6th year	40	10 ±12.71	
Point 2: Professional approach Item	3rd year	65	16.19±20.6	0.924
	4th year	34	8.43±9.32	
	5th year	48	12±13.3	
	6th year	40	10±9.52	
Point 3: Coaching during consultation item	3rd year	65	16.25±23.44	0.689
	4th year	34	8.75±12.81	
	5th year	48	12±14.68	
	6th year	40	10±11.3	
Point 4: Learning effect of consultation item	3rd year	65	16.13±15.94	0.634
	4th year	34	8.50±10.53	
	5th year	48	12±11.92	
	6th year	40	10±9.94	

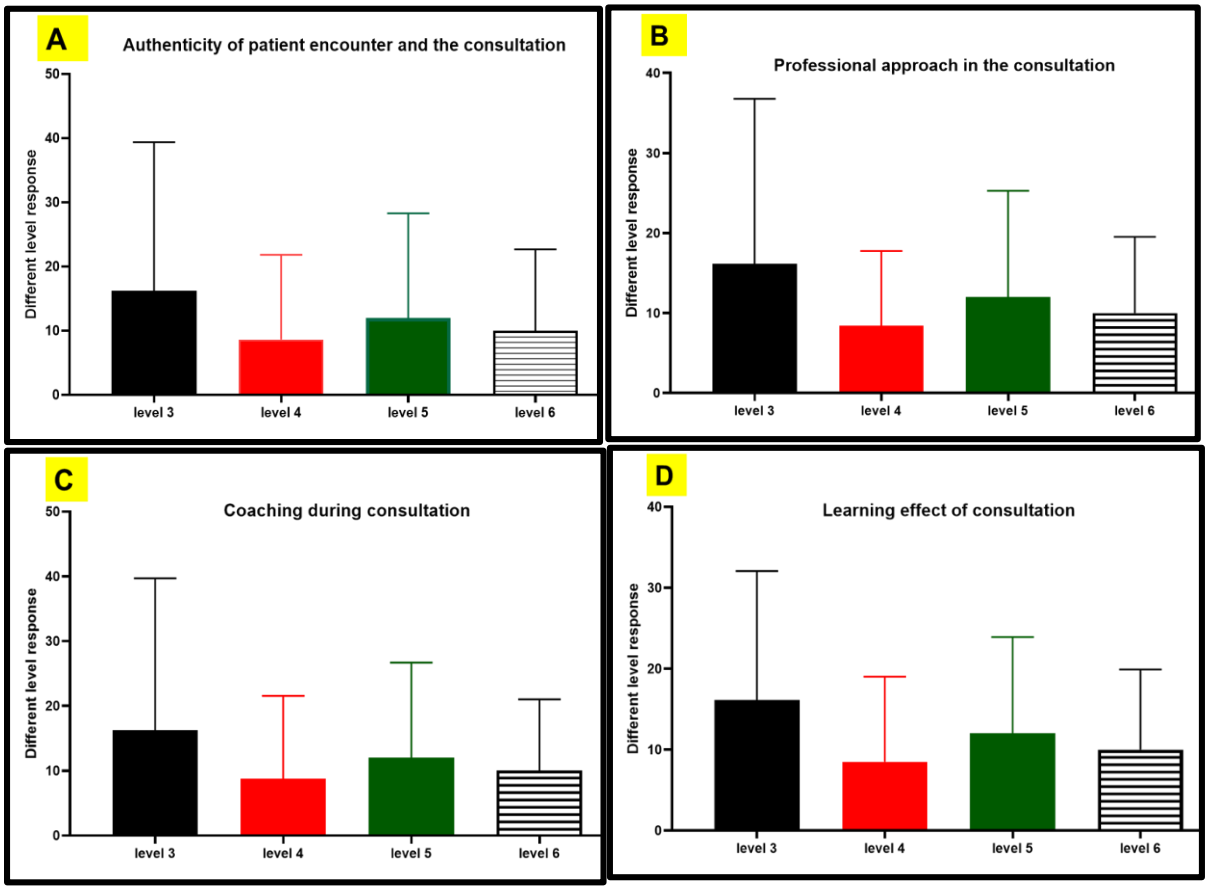

Figure 5 A, B, C, D Comparison between different levels response.

4. DISCUSSION

In this study, the main outcome of interest was to assess the satisfaction of medical students with the application of virtual teaching supplementary to clinical teaching. In recent years, using virtual patients has been suggested in medical education. However, their use is still not introduced as an essential part of the medical school curricula (Oliven et al., 2021). But it considers an excellent educational tool for augmenting clinical reasoning and skills and building-up clinical competency for medical students (Martini and Datt, 2022). The findings in this study showed that the students illustrated educational benefits and improved learning experience because the virtual patient cases made them actively participate in thinking as a physician and motivated them to be more approachable to other options and more vigilant as real-life patients. Similar estimations have been seen in prior studies.

One study where done by Yang et al., (2013) showed that simulated patients can be used in undergraduate surgical teaching and that students showed an affirmative experience in their clinical decision-making skills after utilizing it. Another study was done by Jeimy et al., (2018) documented that virtual patient teaching is satisfactory to most medical students as an efficient tool for clinical education and training. Virtual patient teaching accommodates the space between academic knowledge and medical clinical training. Thus, this can fill the gap of time between the basic academic sciences and the clinical sciences as focused by Edelbring et al., (2019). In addition, one of the benefits of the virtual clinical patient teaching is the student can repeat the training on the clinical cases several times, receive feedback about their performance, and learn from their errors besides improving their clinical skills that ought to reflect later on patient safety and when they interact with real patients (Edelbring et al., 2019; Aper et al., 2014).

Important notice in this study is that students with different levels showed positive responses to using virtual patient cases with no significance in student response between all the questions of our survey, giving a positive impression about the virtual clinical patient training in teaching the orthopedic course. On the flip side, there are some issues with the use of virtual patients in education. It should not replace real-patient contact, may lead to less empathic trainees, and may show ineffective when objectives drive teaching rather than being prompted by education needs or may cause a barrier to learning by using uncouth technology (Kononowicz et al., 2019; Berman et al., 2016).

One of the limitations of our study is the small size group of the students. Nevertheless, this was indemnified by comparing male and female students at all levels, and by choosing a validated questionnaire from the University of Heidelberg. Future study

work intended to examine the impact of the long-term training for the virtual clinical patient training for medical students' practice after graduation as well as continuing education and determine whether learned skills translate into real life.

5. CONCLUSION

The challenge faced in clinical education of undergraduate medical students leads to looking for ways to improve its quality. One way is to use a virtual patient that showed a favorable effect on medical students and can be carried out in clinical teaching to achieve maximum educational benefit.

Acknowledgments

The authors declare no external financial assistance with the project.

Ethical Approval

This study was approved by the medical education department in the faculty with high acceptance from the vice dean of academic affairs of the faculty (Ethical approval code: 4301122157).

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This study has not received any external funding.

Conflicts of interest

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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