

# The Characterisation of a Virtual Reality System to Improve the Quality and to Reduce the Gap between Information Technology and Medical Education

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**Abstract.** Contemporary medical training is hindered by an excessive amount of information provided to students through mainly traditional teaching methods yet the younger generations are accustomed to digital data and information on-demand. As such they have developed a fully customised manner of learning, which in turn requires a new, innovative and equally customised teaching method. This inherited customisation and accelerated manner of learning stems from contemporary lifestyle trends. As such, a reduced learning curve requires innovative and efficient teaching methods, which comply with existing curriculums, yet facilitate the contemporary learning mantra. In particular medical education requires a plethora of information related to the understanding of spatial relations and the three-dimensionality of the human body. Previous studies successfully employed Virtual Reality (VR) and high fidelity patient simulation in order to improve and enhance the medical education and clinical training. The benefits of this technological adoption in the teaching field offered safer experimentation environments, reduced time and cost. Furthermore the Virtual Reality facilities and systems can be extensively customised with relatively low cost and be re-used for various applications. The purpose of this paper is to identify the differences between current education methods and the proposed technology. This research will exploit current teaching trends and attempt to provide recommendations based on a University of Jordan case study. Overall the paper describes the design process of the survey questionnaire that was used for this evaluation and provides valuable insights to both academics and practitioners regarding the potential benefits and drawbacks of adopting such a system.

**Keywords:** Applications: Education, Virtual Reality, system characterisation, medical education, Middle East.

## 1 Introduction

Virtual Reality is gradually spreading as a teaching aid due to a plethora of benefits (Onyesolu, 2009). In medicine this technology facilitates several teaching and

diagnostic activities. In turn, VR teaching methods enable the students to investigate the human body and create a three-dimensional mental picture of the human body structures and relationships. Real-time VR applications offer a rich, interactive, and highly engaging educational context, thus supporting experimental learning-by-doing. Notably, it can contribute to increasing interest and inspiration in students and to effectively support skills (Mantovani et al, 2003).

The study presented, took place in the medical school of the University of Jordan and involved interaction and consultation with staff and students in the form of questionnaires and interviews. The obtained data were subsequently analysed according to standard tools. The findings of this study will inform the decision making process that will determine the efficiency of applying the idea of a new service in the particular University environment. The recommendations derived by this work will define the framework for the development of an exclusive facility, namely the Virtual Reality and Simulation laboratory, which will aim to enhance the traditional ways of learning in the medical field. The study develops a conceptual model that integrates the SERVQUAL Gap model (Parasuraman et al, 1988), to help the University to discover the shortfalls and evaluate student satisfaction. This will guide their improvement efforts by highlighting the weaker attributes that must be strengthened. The first stage of the empirical work has been to design, administer and analyse a questionnaire that is based on the SERVQUAL framework adapted to the University of Jordan.

## **2 Background**

Through extensive review of existing teaching areas that require technological enhancement it was deemed ideal to engage with the medical disciplines as they involve direct and critical interaction with human beings, which requires a high level of knowledge and dexterities. This can only be acquired through practical training, and is not without potential risk to the patient as with traditional teaching methods (see one, do one, and teach one). One of the basics of the medical profession is to do no harm, and human error is unacceptable. For this reason providing a virtual environment that simulates an identical situation to what the doctor or student may encounter as part of their duties towards patients, allows them to gain confidence in dealing with these situations skillfully before proceeding to the stage of real doctor-patient interaction.

### **2.1 Simulation in Medical Education and Training**

Medical education throughout the past decade has observed a major growth in the use of simulation technology (Scalese et al, 2007), Simulation basically reconstructs the “experience” of patient care, the participants can have the opportunity to practice variety of skills in a safe environment, and this kind of practice will reflect on their

performance (Bond et al, 2007). Medical simulation techniques have shown great ability in other areas especially in medical disciplines.

## **2.2 Virtual Reality and Medical Education**

Over the past few years Virtual Reality has been used in many areas and has proven to be a powerful teaching tool in several fields; one of the most important fields is medical education and there are many applications which have been designed for various fields within medicine (Vozenilk et al, 2004).

There are multiple benefits of using VR technology in medicine such as having an opportunity for repeating a training task (Riener, 2012), in addition to the chance of practice without taking a risk for the patient. Furthermore VR aims to enhance the quality of the education, raise safety, and allow extensive and effective training.

## **2.3 Education in Jordan**

Jordan places huge emphasis on education and it is one of the most educated Arab countries. Out of a population of 6,249,000 million (Department of statistics, 2011), higher education in Jordan has a major role in the procedure of comprehensive development at numerous levels and areas. Throughout the last ten years, higher education in Jordan has observed a vast growth in terms of the diversity of study programs, techniques of teaching and learning that control both the quality and quantity and growth of higher education institutions (Higher education in Jordan, 2012).

Despite the limited human and financial resources in Jordan, higher education is within the priorities of the state, for the important role it plays on the structure of a knowledge based society.

## **2.4 Service Quality (SERVQUAL)**

The SERVQUAL model was developed by Parasurman et al (1988) with a 22 item instrument. The instrument items perform five dimensions; Reliability, Responsiveness, Tangibles, Assurance, Empathy (Jabnoun and Al Rasasi, 2005).

The particular model offers primarily a tool for measuring and managing services. In addition, many organizations have adopted the SERVQUAL model to improve their quality. As an example the Midland and Abbey National banks used this model (Buttle, 1995). SERVQUAL is a vastly used model to rate and evaluate the service quality provided to the end users (Pawitra and Tan, 2003). Furthermore this model is used to measure the satisfaction of the customers, students, end-users for any system or for any service. As such it has been employed as the main evaluation method in a diverse set of fields across different industries, including dental services, hotels, higher education, business schools, hospitals and banking (Buttle, 1995).

The aim of this study is to measure the student experience and needs. One of the advantages of the model is measuring students experience rather than just measuring the experience of teaching (Cuthbert, 1996b). Furthermore, focusing on the learning process is much more important than focusing on the end results for the students. Cuthbert (1996a) pointed out that SERVQUAL gives attention to the service delivery against the final result and for this reason is appropriate for measuring the learning process.

### 3 Methodology

The objective of this research is to identify and comprehend the lecturing needs of the students within the University of Jordan and to determine ways to improve the current medical training within the University.

The first part of the research involved designing a questionnaire to explore differences between the perceived training and the student expectations. The survey instrument was adapted from the SERVQUAL model. Focus groups of friends and family medical doctors were used to pilot the questionnaire. The final questionnaire, as shown in Appendix section, contains 22 statements that reflected the five different SERVQUAL dimensions. Each dimension contains four to six questions, as shown in Table 1. Students were first asked to supply some demographic information, such as gender and age. They were then asked to rate their general expectations from the medical school on a 5-point Likert scale ranging from not expected (1) to essential (5). On the reverse side of the questionnaire students were then asked to rate their perceived qualities in the medical school using 5-point Likert scale ranging from strongly disagree(1) to strongly agree(5). Final year medical students were asked to answer a total 44 questions (22 expectations against 22 experiences), within each of five categories, as shown in Table 1.

**Table 1.** Definition of SERVQUAL Dimensions

<b>Categories</b>	<b>Definition</b>	<b>Number of items in questionnaire</b>
<b>Tangibles</b>	The appearance of physical facilities in the university, laboratories, physical models.	4 items
<b>Reliability</b>	Ability to perform the promised knowledge regularly and truthfully	6 items
<b>Responsiveness</b>	Willingness to help students	4 items
<b>Assurance</b>	Knowledge and Courtesy of doctors and their ability to convey trust and confidence to the students	4 items
<b>Empathy</b>	Caring, respect, attention, and friendliness	4 items

The questionnaire was distributed to 30 medical students of the University of Jordan Hospital in their last taught year, consisted of 17 males and 13 females. This group was of particular interest as its members typically have more experience in the clinical training environment than the earlier years. The feedback was collected by hard copy in order to improve the response rate. The aim of the questionnaire is to measure students' expectations in contrast to university's provision, in order to highlight the potential gaps between knowledge offering and demand.

#### 4 Data Analysis

The analysis of the SERVQUAL questionnaire was conducted by using the SPSS software program that calculated the frequencies and the gaps (differences), within the data. The T-Test conducted was used to calculate the frequencies and the gaps (differences between perceived and expectation) Parasurman et al (1988), within the data. Preliminary results of the data analysis showed the demographics for the final year medical students including gender.

A Paired-Sample T-test of all 22 statements T-test results using the SPSS program was used to compute and compare the means scores for students' expectation and experience statements presenting satisfying results (Appendix 1). In term of expectation, the mean ranged between 3.90 (the university training is available when required) and 4.80 (school doctors are knowledgeable about their training materials) except one question, which scored 1.30 (the school doctors are often too busy to respond to the student needs). Experiences ranged between 2.83 (the physical models are flexible enough for training) and 4.30 (the school doctors give patient centered communication skills to the students) except one question that scored 1.93. This result indicates that there are gaps and the students are not satisfied in some statements, as shown in Table 2.

**Table 2.** SERVQUAL Scores

	<b>Maximum</b>	<b>Minimum</b>	<b>Likert Scale Ranging</b>
<b>Expectation Mean</b>	Mean 4.80: (The school doctors are knowledgeable about their training materials).	Mean 3.90: (The university training is available when required).	3.9 Range: Between No feelings and Preferred 4.8: Between Preferred and Essential.
<b>Experience Mean</b>	Mean 4.30: (The school doctors give patient centred communication skills to the students).	Mean 2.83: (The physical models are flexible enough for training).	2.83 Range: Between Disagree and Moderated 4.30: Between Agree and Strongly Agree.

The SERVQUAL statements were grouped into five dimensions (in both the expectations and experience sections) each with its range of relevant statements:

- Tangibility (Statements 1-4).
- Reliability (Statements 5-10).
- Responsiveness (Statements 11-14).
- Assurance (Statements 15-18).
- Empathy (Statements 19-22).

The results presented in Appendix, show the differences between the ratings, which students assigned to expectation statements, and experience statements for the 30 questionnaire responses. For each pair of statements, the SERVQUAL score was computed as follows; Service quality = Experience - Expectation. Figure 4 shows the differences between expectations and experiences for all 22 statements. The statement number 13 was a positive gap (0.633): The School Doctors are often too busy to respond to the student’s needs so that means a good thing because the students pointed out that the doctors do respond to their needs.

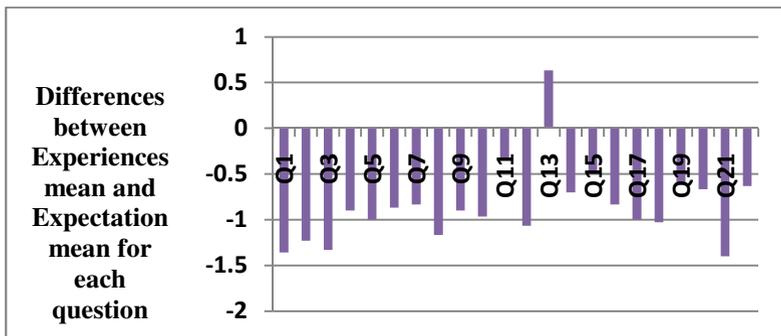


Fig. 1. SERVQUAL 22 differences

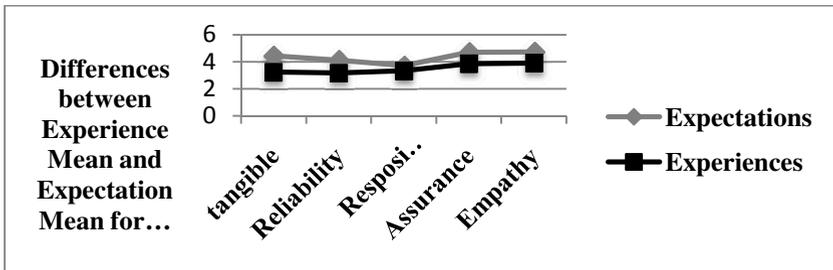
SPSS was used as an analysis tool, to calculate the differences or gaps between the student expectations and experiences over the SERVQUAL 5 dimensions. As shown in Table 2, there is a gap between expectations and experience in all dimensions, but the biggest gap was tangible and reliability which is (-1.208) (-0.955), and the smallest gap was in responsiveness which is (-0.366).

Paired-Sample T-test of the 5 dimensions the descriptive, correlation and paired-sample t-test using the SPSS program was done in order to compare the 5 mean dimension scores for expectations and experiences and their differences. The t-test was carried out to compare the mean to show the significant differences (Gaps) between the expectations and experiences of the SERVQUAL 5 dimensions.

**Table 3.** SERVQUAL Dimension Gaps

Dimensions	Expectations (Mean)	Experiences (Mean)	Differences (Mean)
Tangible	4.44	3.23	-1.208
Reliability	4.12	3.17	-0.955
Responsiveness	3.70	3.33	-0.366
Assurance	4.69	3.85	-0.841
Empathy	4.72	3.90	-0.825

As shown in Figure 2 there is a gap between expectations and experiences in all dimensions, but the biggest gap was in tangible, and the smallest gap was in responsiveness.

**Fig. 2.** SERVQUAL Dimension Gaps between Expectations and Experience

## 5 Conclusion

Initial Analysis of the survey of 30 respondents, who are final year medical students at University of Jordan, shows that there is a gap between student expectations and experiences in all dimensions of the SERVQUAL model, with the biggest gap in tangible attributes and the smallest gap in responsiveness. It was clear from the SERVQUAL results that there is a gap between what students expect and what the university provides. The SERVQUAL instrument identified weaknesses in the university services and the gap for all the dimensions were negative value indicators that the current methods of clinical training provided by the university do not satisfy the student expectation. The findings from this research show that there are gaps in all SERVQUAL dimensions, with the largest gap in 'Tangibles' and smallest gap in 'Responsiveness'. Adhering to the above, our future plan of work will focus further in the development of a bespoke research and teaching facility which will utilize extensively Virtual Reality and synthetic environment interaction methods. In particular the next stage for this work will have three experiments in order to make comparisons between Virtual Reality (using 3D models) vs traditional methods (using

physical models). Consequently, depending on the result, the best solution will be applied to improve the clinical training within the University of Jordan.

## References

1. Vozenilk, J., Huff, J.S., Reznek, M., Gordon, J.A.: See One, Do One, Teach One: Advanced Technology in Medical Education. *Academic Emergency Medicine* 11(11) (2004)
2. Onyesolu, M.: Virtual Reality Laboratories: An Ideal solution to the Problems Facing Laboratory Setup and Management. In: *Proceedings of the World Congress on Engineering and Computer Science, San Francisco, USA, vol. 1* (2009)
3. Mantovani, F., Castelnuovo, G., Gaggioli, A., Riva, G.: *Virtual Reality Training for Health-Care Professional* 6(4) (2003)
4. Parasuraman, A., Zeithaml, V.A., Berry, L.L.: SERVQUAL: A Multiple Item Scale for Measuring Consumer Perception of Service Quality. *Journal of Retailing* 64(1), 12–40 (1988)
5. Jabnoun, N.A., AL Rasasi, A.J.: Transformational leadership and service quality in UAE hospitals. *Managing Service Quality* 15(1), 70–81 (2005)
6. Buttle, F.: SERVQUAL: review, critique, research agenda. *European Journal of Marketing* 30(1), 8–32 (1996)
7. Pawitra, T.A., Tan, K.C.: Tourist satisfaction in Singapore - a perspective from Indonesian tourists. *Managing Service Quality* 13(5), 399–411 (2003)
8. Cuthbert, P.F.: Managing service quality in HE: is SERVQUAL the answer? Part 1. *Managing Service Quality* 6(2), 11–16 (1996a)
9. Cuthbert, P.F.: Managing service quality in HE: is SERVQUAL the answer? Part 2. *Managing Service Quality* 6(3), 31–35 (1996b)
10. Kim, G.: *Designing Virtual Reality Systems*, p. 3. Springer (2005) ISBN-13: 987-1-85233-958-6
11. Stone, J.R.: The reality of virtual reality, *World Class Design to Manufacture* 2(4), 11–17 (1995)
12. Riener, R.: *Virtual reality in medicine*, p. 1. Springer, London (2012) ISBN: 978-1-4471-4011-5
13. Department of statistics (2011): Department of statistics, [http://www.dos.gov.jo/dos\\_home\\_e/main/ehsaat/alsokan/1.pdf.pdf](http://www.dos.gov.jo/dos_home_e/main/ehsaat/alsokan/1.pdf.pdf) (last accessed October 2012)
14. Higher education in Jordan (2012): Hashemite Kingdom of Jordan Ministry of Higher education and Scientific Research (last accessed December 2012)
15. <http://www.mohe.gov.jo/brief/briefmohe1/tabid/558/language/enus/default.aspx>
16. Scalese, R., Obeso, V., Issenberg, S.: Simulation Technology for Skills Training and Competency Assessment in Medical Education 23(1), 46–49 (2008)
17. Bond, W.F., Lammers, R.L., Spillane, L.L., Coggins, R.S., Fernandez, R., Reznek, M.A., Vozenilek, J.A., Gordon, J.A.: *The Use of Simulation in Emergency Medicine* (2007)
18. A Research Agenda, on Behalf of the Society for Academic Emergency Medicine Simulation Task Force 14(4), 354–362 ISSN: 1069-6563

## Appendix

Appendix shows 30 questionnaire responses grouped into five categories. Expectation means and actual experience means were compared.

<i>Tangible</i>	<b>Expectations (Mean)</b>	<b>Experience (Mean)</b>	<b>Difference (Mean)</b>
Q1. 2D virtual models are enough to learn and understand.	4.27	2.90	-1.36
Q2. Having an opportunity for repeating a training task.	4.63	3.40	-1.23
Q3. The University provides an appropriate range of physical models for each student.	4.53	3.20	-1.33
Q4. The scenarios that are used in the lecture are relevant.	4.33	3.43	-0.90
<i>Reliability</i>	<b>Expectations (Mean)</b>	<b>Experience (Mean)</b>	<b>Difference (Mean)</b>
Q5. The University provides training within a controlled environment.	3.97	2.97	-1
Q6. The University training is available when required.	3.90	3.03	-0.86
Q7. The way of training in the anatomy laboratory sufficient when using the physical 3D models.	3.90	3.07	-0.83
Q8. The physical models flexible enough for training.	4.0	2.83	-1.16
Q9. The essential material is covered by the training.	4.73	3.83	-0.90
Q10. Quality of cadaver is important to avoid decay.	4.27	3.30	-0.97
<i>Responsiveness</i>	<b>Expectations (Mean)</b>	<b>Experience (Mean)</b>	<b>Difference (Mean)</b>
Q11. The School Doctors give each student the opportunity to practice.	4.03	3.70	-0.33
Q12. The School Doctors give patient centred communication skills to the students.	4.70	3.63	-1.06
Q13. The School Doctors are often too busy to respond to the student needs.	1.30	1.93	-0.633
Q14. The School Doctors are always willing to help with any student problems.	4.77	4.07	-0.70
<i>Assurance</i>	<b>Expectations (Mean)</b>	<b>Experience (Mean)</b>	<b>Difference (Mean)</b>
Q15. School Doctors are knowledgeable about their training materials.	4.80	4.30	-0.50
Q16. School Doctors are generally able to solve any problems at the training class.	4.73	3.90	-0.833
Q17. The period of training time matches the time in the syllabus.	4.57	3.57	-1.0
Q18. The knowledge given by the School Doctors gives confidence to the students.	4.67	3.63	-1.03

<i>Empathy</i>	<b>Expectations (Mean)</b>	<b>Experience (Mean)</b>	<b>Difference (Mean)</b>
Q19. The Faculty of Medicine listens carefully to student requirements.	4.83	4.23	-0.60
Q20. The Faculty of Medicine gives each student individual attention.	4.67	4.0	-0.667
Q21. The style of training is appropriate for all students.	4.67	3.27	-1.40
Q22. The Faculty of Medicine understands a student's specific needs.	4.73	4.1	-0.633