



Taibah University  
**Journal of Taibah University Medical Sciences**

[www.sciencedirect.com](http://www.sciencedirect.com)



## Educational Study

# ‘Blended learning’ as an effective teaching and learning strategy in clinical medicine: a comparative cross-sectional university-based study

Naeem Makhdoom, FACHARZT <sup>a,\*</sup>, Khalid I. Khoshhal, ABOS <sup>b</sup>,  
 Sami Algaidi, Ph.D <sup>c</sup>, Khaled Heissam, MD <sup>d,1</sup> and Mohammed A. Zolaly, SB-Ped <sup>e</sup>

<sup>a</sup> Department of Otorhinolaryngology, Taibah University, Almadinah Almunawwarah, Kingdom of Saudi Arabia

<sup>b</sup> Department of Orthopaedic Surgery, Taibah University, Almadinah Almunawwarah, Kingdom of Saudi Arabia

<sup>c</sup> Department of Anatomy, College of Medicine, Taibah University, Almadinah Almunawwarah, Kingdom of Saudi Arabia

<sup>d</sup> Department of Family Medicine, Faculty of Medicine, Suez Canal University, Egypt

<sup>e</sup> Department of Pediatrics, Taibah University, Almadinah Almunawwarah, Kingdom of Saudi Arabia

Received 14 October 2012; revised 10 November 2012; accepted 4 January 2013

### KEYWORDS

Blended learning;  
 E-learning;  
 Family medicine;  
 Learning strategy;  
 On-line learning;  
 Traditional learning

**Abstract Objective:** Blended learning is a relatively new technology-based teaching approach. Few attempts have been made to use this approach in medical education. The aim of this study was to assess the effectiveness of blended learning in studying family medicine as an example of a clinical medical science.

**Methods:** This comparative cross-sectional study involved 121 fourth-year medical students, at the clinical phase of a family medicine course at the College of Medicine, Taibah University, Almadinah Almunawwarah, Kingdom of Saudi Arabia. The students were randomly divided into two groups: 61 taught by the traditional approach (face-to-face) and 60 taught by blended learning (both electronic and face-to-face). The effect of blended learning was evaluated from responses to the Dundee ‘ready education environment measure’ questionnaire. Clinical skills were assessed with the ‘objective structured clinical examination’; knowledge gain was assessed from a written multiple-choice examination; and problem-solving, critical thinking, decision-making skills and attitude were assessed in written and oral examinations based on clinical scenarios.

**Results:** Blended learning was statistically significantly better than traditional learning in all domains of the educational environment, except for social perception, and in all types of examination: written, objective structured clinical and case scenarios.

**Conclusion:** The findings suggest that medical students, as adult learners, are open to new methods of learning. The blended learning approach is an effective method for teaching family medicine and may be applicable to other clinical medical sciences.

© 2013 Taibah University. Production and hosting by Elsevier Ltd. All rights reserved.

\* Corresponding address: Associate Professor, Department of Otorhinolaryngology, College of Medicine, Taibah University, P.O. Box 30001, Almadinah Almunawwarah, Kingdom of Saudi Arabia. Tel.: +966 4 8460008; fax: +966 4 8461407.

E-mail: [dr.naeem.m@hotmail.com](mailto:dr.naeem.m@hotmail.com) (N. Makhdoom)

<sup>1</sup> Formerly, Department of Family Medicine, College of Medicine, Taibah University, Almadinah Almunawwarah, Kingdom of Saudi Arabia.

Peer review under responsibility of Taibah University.



Production and hosting by Elsevier

## Introduction

Medical education is facing various challenges in teaching tomorrow's physicians. Technological advances have become integral parts of our lives and changed them forever, increasingly with each new generation. Such changes mean that medical schools must adopt new teaching methods, while maintaining excellence in medical education. The new methods include electronic (e-learning), on-line or web-based and problem-solving-based learning. These methods shift teaching from a largely teacher-centred, product-based activity to a more student-centred, process-based activity. This strategy encourages students to be active in the experience of learning rather than being passive learners.<sup>1</sup> Ford et al.<sup>2</sup> stated that "integrating teaching, learning and technology is a mandate, not an option, and doing any less would border on professional irresponsibility." While cost is a significant barrier, such innovations can have a large impact on self-directed learning, especially when human resources are scarce.

The method of combining electronic and face-to-face learning, known as 'blended learning', is gaining popularity as increasing numbers of medical colleges use the Internet as the digital repository of teaching and learning forums.<sup>3</sup> E-learning provides possibilities for devising new educational tools, for learning by interactivity, self-paced study and easy access. To overcome the lack of a teacher in a real classroom, face-to-face teaching should be included in the course. Blended learning translates this theory into practice.<sup>4</sup> The term describes models of learning that combine several instructional methods, such as use of digital resources (or e-learning) alongside traditional teaching.<sup>5</sup> Blended learning allows adaptive, collaborative learning and transforms the role of the teacher from a disseminator of knowledge to a facilitator. Therefore, a combination of traditional and on-line learning in particular or e-learning in general creates a more integrated approach for both instructors and learners. It is well suited for practice-based disciplines like the medical sciences.<sup>6</sup> Studies reported in both the medical and non-medical literature have consistently shown that students are satisfied with e-learning,<sup>7,8</sup> however, they do not see e-learning as replacing traditional instructor-led training but as a complement, forming part of a blended learning strategy. Another benefit of e-learning for teaching family medicine and other clinical sciences is that it can be delivered at any time and any place and can be tailored to individual learning needs. Although blended learning was originally promoted to save costs and increase efficiency, it was found to enhance learning, information dissemination, creation of learners' communities and networking and to support learners in choosing the ideal content.<sup>9</sup>

The traditional approach in medical education is the well-established didactic method, whereas blended learning is a relatively new, promising, technology-enhanced trend.<sup>5</sup> There has been limited research on the appropriate use of blended learning for clinical medicine studies.<sup>10-15</sup> The purpose of this study was to determine the effectiveness of a blended learning approach in teaching family medicine as an example of clinical medicine, by comparing it with delivery of the same course face-to-face by the same teachers.

## Materials and Methods

### *Study design*

This comparative cross-sectional study was carried out at the College of Medicine, Taibah University, Almadinah Almunawarah, Kingdom of Saudi Arabia, in the year 2009-2010. The study was approved by the local research ethics committee, and all participating students gave informed consent.

### *Participants*

During the 10-week family medicine course, a traditional didactic course, 121 fourth-year medical students (in a 5-year BSc-BMed programme) participated in the study. Students were randomly divided into two groups: 61 students (31 males and 30 females) who followed the traditional (face-to-face) course and 60 students (30 males and 30 females) who followed the course with a blended learning strategy (e-learning plus face-to-face learning). The intended learning outcomes of the course and detailed study guides were relayed to both groups.

### *Teaching methods*

Students following the traditional course received lectures, participated in clinical rounds, kept a logbook and attended seminars. The objective of the clinical rounds was to help students to achieve clinical skills, such as collecting patient data, communication, clinical examination and problem-solving on the basis of evidence. All the clinical training was done at family health care centres. During their training in clinical settings, the students worked in groups of five to eight. The logbook contained case studies and preventive activities such as vaccination, health education and participation in community surveys. A seminar was given at the end of each week to address students' concerns about their cases. The students could interact with their tutors outside the classroom during staff office hours, which were 6 h per week divided into three sessions.

The students who received blended learning were taught by the traditional methods and also by use of an electronic course management system. Both students and teaching staff were trained in use of this system. Unique, person-specific log-in details were generated for each student and participating staff, with an option for interaction among the group members. The tutors had access to all groups in order to monitor their pace and directions. The system was supported with options for video conferencing, a discussion board and e-mail. The tutors uploaded all their lectures and video demonstrations of basic clinical skills, such as clinical examination of various body systems, measuring blood pressure and examination of a mass. The students uploaded their logbooks and received feedback electronically. The blended learning group also had the option of chatting or discussing learning issues through a discussion board, student forum or video conferencing, individually or in groups. The students worked in groups of five to eight, both during their training in clinical settings and for e-learning. Each tutor was assigned time to log in to the system and to spend an average of 6 h/week divided into three to six

sessions. Specific questions were directed to the tutor who had lectured on the topic; other questions were directed to the pool of teaching staff. The closing time for interaction with the tutors was 3 days before the final examination.

### Evaluation

The effect of blended learning was evaluated by measuring the following outcomes: the students' perception of the educational environment; clinical skills, assessed by the 'objective structured clinical examination'; knowledge, assessed from a written examination with multiple-choice questions; and problem-solving, critical thinking, decision-making skills and attitude, assessed from analysis of case scenarios.

The Dundee 'ready educational environment measure' was used to measure students' perception.<sup>16</sup> This is a reliable, valid tool developed to assess the educational environment, consisting of a 50-item questionnaire. It is scored on a 0–4 Likert scale, where 4 is the maximum ('strongly agree') and 0 is the minimum ('strongly disagree'). As nine negative items were reversed for scoring, the maximum score was 200, indicating the ideal educational environment. The items were grouped into five categories to measure perception of a specific component of the educational environment: perception of learning, perception of course organizers, academic self-perception, perceptions of atmosphere and social self-perceptions.

The interpretation of the total score was: 0–50, very poor; 51–100, many problems; 101–150, more positive than negative; 151–200, excellent. The following guide was used to interpret the results of each domain:

Perception of learning: 0–12, very poor; 13–24, teaching is viewed negatively; 25–36, a more positive perception; 34–78, teaching is highly thought of.

Perception of course organizers: 0–11, abysmal; 12–22, in need of retraining; 23–33, moving in the right direction; 34–44, model course organizers.

Academic self-perceptions: 0–8, feeling of total failure; 9–16, many negative aspects; 17–24, feeling more on the positive side; 25–32, confident.

Perception of atmosphere: 0–11, a terrible environment; 13–24, many issues need changing; 25–36, a more positive attitude; 37–48, a good feeling overall.

Social self-perceptions: 0–7, miserable; 8–14, not a nice place; 15–21, not too bad; 22–28, very good socially.

We used an Arabic–English questionnaire so that students would fully understand the questions. The questionnaire was given to students immediately after their examination, with instructions on how to answer it.

### Statistical analysis

Data were analysed with SPSS version 13. The mean scores of the Dundee ready educational environment measure and the examinations scores for the two groups were analysed with Student *t* test. The significance of differences in different educational environment domains were tested with an ANOVA, with significance at  $p \leq 0.05$ .

## Results

### *Blended learning enhanced students' perception of the educational environment*

Blended learning was statistically significantly better in all domains of the educational environment, except for social perception (Table 1). The domain in which the greatest improvement was seen was students' perception of learning ( $p = 0.000$ ), followed by the perception of course organizers ( $p = 0.006$ ; Table 2). The least affected domain was academic self-perception ( $p = 0.036$ ).

### *Blended learning had a positive effect on students' performance in examinations*

The group taught by blended learning showed statistically significant better performance in written examinations ( $p = 0.011$ ), objective structured clinical examinations ( $p = 0.000$ ) and clinical scenarios examinations ( $p = 0.022$ ) (Table 3). Thus, students taught by blended learning gained more knowledge and clinical skills and had better problem-solving, critical thinking and decision-making skills and attitude.

## Discussion

The results of our study showed a significant effect of blended learning on many domains of students' perception of the educational environment and their performance in examinations. Blended learning results in a beneficial interaction between students, teachers and resources<sup>17</sup> and permits greater flexibility and responsiveness in teaching and learning.<sup>4</sup> In addition, integration of on-line teaching has been shown to overcome the restrictions of time and place, support teaching methods that are hard to achieve with textbooks and reach a larger number of students without increasing resources.<sup>18</sup> The amalgamation of web-based technology into pedagogy has substantial potential to facilitate flexible, learner-centred teaching, enhance interaction among students and staff and allow them to collaborate and communicate asynchronously.<sup>19</sup> Although blended learning can be done in many different ways, the emphasis is not on the tools: once the learning outcomes of the course have been selected, the tools that best facilitate achievement of those outcomes should be chosen.

Our results are in agreement with those of other studies on the effectiveness of e-learning as part of blended learning,<sup>8,11,12,15,20,21</sup> which showed that students' engagement was increased<sup>4</sup> and their perception of the educational environment was improved.<sup>22,23</sup> The only domain that was affected negatively by blended learning in our study was the social perception. Thus, although the use of technology in teaching is effective and is perceived as such, it requires a cultural change in learning practice that might not be easy for everyone.

Blended learning is used in many areas of health education.<sup>24,25</sup> Hsu and Hsieh<sup>25</sup> reported that blended learning contributed to the learning outcome by facilitating self-development and meta-cognitive development. Students have more responsibility in blended learning than in traditional face-to-face learning environments. Those researchers attrib-

**Table 1: Sample mean scores for students' perception among those who were taught traditionally and those taught by blended learning.**

Perception	Type of learning	N	Mean	Standard deviation	Standard error	df	p
Total educational environment	Traditional	61	106.148	18.545	2.374	119	0.024
	Blended	60	113.117	14.85	1.917		
Learning	Traditional	61	22.738	6.673	0.854	119	0.000
	Blended	60	28.083	5.12	0.661		
Educational atmosphere	Traditional	61	23.557	6.114	0.783	119	0.006
	Blended	60	26.383	4.847	0.626		
Course organizers	Traditional	61	23.098	4.6	0.589	119	0.004
	Blended	60	25.717	5.116	0.66		
Self-academic	Traditional	61	19.131	3.814	0.488	119	0.005
	Blended	60	21.5	5.29	0.683		
Social	Traditional	61	17.624	3.514	0.348	119	0.006
	Blended	60	11.434	2.823	0.148		

Significance at  $p \leq 0.05$ ; df, degrees of freedom.

**Table 2: Scores on Dundee 'ready education environment measure' for educational environment domains among students taught traditionally and those taught by blended learning.**

	Response	Traditional learning	Blended learning	Total	p
		No. (%)	No. (%)		
Total educational environment	Excellent	1 (1.64)	0 (0.00)	1	0.054
	More positive than negative	38 (62.30)	49 (81.67)	87	
	Plenty of problems	22 (36.07)	11 (18.33)	33	
Perception of learning	Very poor	2 (3.28)	0 (0.00)	2	0.000
	Teaching is viewed negatively	35 (57.38)	15 (25.00)	50	
	A more positive perception	22 (36.07)	45 (75.00)	67	
	Teaching highly thought of	2 (3.28)	0 (0.00)	2	
Perception of educational atmosphere	A terrible environment	1 (1.64)	0 (0.00)	1	0.012
	Many issues need changing	34 (55.74)	23 (38.33)	57	
	A more positive attitude	24 (39.34)	30 (50.00)	54	
	A good feeling overall	2 (3.28)	7 (11.67)	9	
Perception of course organizers	In need of some retraining	33 (54.10)	18 (30.00)	51	0.006
	Moving in the right direction	26 (42.62)	37 (61.67)	63	
	Model course organizers	2 (3.28)	5 (8.33)	7	
Academic self-perception	Excellent	1 (1.64)	0 (0.00)	1	0.036
	More positive than negative	37 (60.7)	49 (81.67)	86	
	Plenty of problems	23 (37.7)	11 (18.33)	34	
Social perception	Miserable	0 (0.00)	1 (1.67)	1	0.008
	Not a nice place	1 (1.64)	3 (5.00)	4	
	Not too bad	22 (36.07)	32 (53.33)	54	
	Very good socially	38 (62.30)	24 (40.00)	62	

Significance at  $p \leq 0.05$ ; df, degrees of freedom.

uted the success to creative use of computer technology and the practical nature of the material and concluded that medical educators should consider the blended learning approach in standardizing clinical learning. Gormley et al.<sup>21</sup> reported that undergraduate medical students considered that e-learning had a positive effect on their achievement of clinical skills and was comparable to traditional forms of teaching. Students who appeared to learn well with e-learning performed better in objective structured clinical examinations.

All educational formats have strengths and limitations, and blended learning is no exception. We demonstrated the ability

of blended learning to enhance perceptions of the educational environment, problem-solving, critical thinking, decision-making skills and clinical skills, as well as knowledge gain by standardizing student experiences in a flexible manner without a specific place or time. Several students commented verbally that a major advantage of blended learning for average and below-average students was that they could use the electronic material several times until they were satisfied and could move at their own pace, without the embarrassment of asking a teacher to repeat information or a procedure in front of the class. Another advantage of e-learning as part of blended learning is

**Table 3: Sample mean scores in the objective structure clinical examination, the written examination and the case scenario examination among students taught traditionally and those taught by blended learning.**

Examination	Type of learning	N	Mean	Standard deviation	Standard error	df	p
Objective structured clinical examination (score out of 50)	Traditional	61	38.028	3.235	0.434	119	0.000
	Blended	60	43.13	5.158	0.645		
Written examination (score out of 50)	Traditional	61	33.01	5.911	0.757	119	0.011
	Blended	60	35.845	6.156	0.794		
Clinical scenario examination (score out of 30)	Traditional	61	23.962	5.562	0.554	119	0.022
	Blended	60	26.025	4.29	0.712		

Significance at  $p \leq 0.05$ ; df, degrees of freedom.

the permanency of discussions with colleagues and with teaching staff, as students can refer back to them at any time. The time allocated to teaching courses in medical schools is usually limited; blended learning can be used in medical education to increase students' exposure to courses. Research has shown that an associated on-line course or an on-line component of a course can improve the learning of medical students.<sup>26</sup>

One obvious weakness of the e-learning part of blended learning is the lack of personal interaction between students and teachers. This was, however, overcome by face-to-face interactions during weekly lectures and clinical rounds. Although e-learning is an established and effective approach in many medical schools, it should not replace traditional learning, which is why blended learning is probably a better approach than purely web-based teaching. Course organizers and educators may have to change the way in which they use computers to design curricula to take advantage of technology-enhanced teaching and learning.<sup>10</sup> In constructing a working blended learning model, course organizers must decide beforehand which parts of the curriculum are to be delivered face-to-face and which can be delivered on-line or by another modality of e-learning. The balance between face-to-face education and e-learning is delicate, depending on factors such as the learning outcome, the level of the students, the electronic resources and the trainer's experience. Another issue to be kept in mind in constructing blended learning courses is the range of the students' computer skills: measures should be taken to prevent students who lack computer skills from becoming disadvantaged or frustrated and develop computer-hostile attitudes.<sup>27</sup> Continuous feedback from students about electronically delivered material is thus important.

In conclusion, the findings of our study suggest that medical students, as adult learners, are open to new methods of learning. The study shows that blended learning is an effective method for teaching family medicine and may be applicable to other clinical sciences. The results of this study have encouraged the authors to apply blended learning in the teaching of other clinical medical disciplines.

#### Author contributions

All the authors contributed equally in this study.

#### Conflict of interest

The authors declare no conflict of interest

#### Acknowledgements

The authors thank the Deanship of Scientific Research, Taibah University, Almadinah Almunawwarah, Kingdom of Saudi Arabia, for funding this project (Grant Number 420/430). The authors gratefully thank Dr. Abdulqader Allam (Dean of the College of Medicine, Taibah University) for encouraging the students to participate in this study.

#### References

- Mellor C. Experiential learning through integrated project work: an example from soil science. *J Geogr Higher Educ* **1991**; 15(2): 135–149.
- Ford PJ, Foxlee N, Green W. Developing information literacy with first year oral health students. *Eur J Dent Educ* **2009**; 13(1): 46–51.
- Thakore H, McMahon T. Virtually there; e-learning in medical education. *Clin Teach* **2006**; 3: 225–228.
- Lewin LO, Singh M. Blended learning B. Improving education in primary care: development of an online curriculum using the blended learning model. *BMC Med Educ* **2009**; 9: 33.
- Voos R. Blended learning – what is it and where might it take us? *Sloan-C View* **2003**; 2(1): 2–5.
- Karimzadegan D, Mojtahedzadeh R, Mohammadi A. E-learning in medical education in the world and Iran. *J Med Educ* **2007**; 11: 37–39.
- Gibbons A, Fairweather P. Computer-based instruction. In: Tobias S, Fletcher JD, editors. *Training and retraining: a handbook for business, industry, government and military*. New York: McMillan Reference; 2000. p. 410–442.
- Chumley-Jones HS, Dobbie A, Alford CL. Web-based learning: sound educational method or hype? A review of the evaluation literature. *Acad Med* **2002**; 77(Suppl. 10): S86–S93.
- Wood BP. Blended learning in medicine: trouble in paradise? *Am J Roentgenol* **2011**; 197: 529.
- Rowe M, Frantz J, Bozalek V. The role of blended learning in the clinical education of healthcare students: a systematic review. *Med Teach* **2012**; 34: 216–221.
- Shaffer K, Small JE. Blended learning in medical education: use of an integrated approach with web-based small group modules and didactic instruction for teaching radiologic anatomy. *Acad Radiol* **2004**; 11(9): 1059–1070.
- Gordon DL, Issenberg SB, Gordon MS, LaCombe D, McGaghie ER, Petrusa ER. Stroke training of prehospital providers: an example of simulation-enhanced blended learning and evaluation. *Med Teach* **2005**; 27(2): 114–121.
- Taradi SK, Taradi M, Radic K, Pokrajac N. Blending problem-based learning with web technology positively impacts student learning outcomes in acid-base physiology. *Adv Physiol Educ* **2005**; 29(1): 35–39.
- de Leng BA, Dolmans DH, Muijtjens AM, van der Vleuten CP. Student perceptions of a virtual learning environment for a

- problem-based learning undergraduate medical curriculum. **Med Educ** 2006; 40(6): 568–575.
15. Ruiz JG, Mintzer MJ, Leipzig RM. The impact of e-learning in medical education. **Acad Med** 2006; 81(3): 207–212.
  16. Roff S. The Dundee Ready Educational Environment Measure (DREEM) – a generic instrument for measuring students' perceptions of undergraduate health professions curricula. **Med Teach** 2005; 27(4): 322–325.
  17. Garrison DR, Kanuta H. Blended learning: uncovering its transformative potential in higher education. **Internet Higher Educ** 2004; 7(2): 95–105.
  18. Gray K, Tobin J. Introducing an online community into a clinical education setting: a pilot study of student and staff engagement and outcomes using blended learning. **BMC Med Educ** 2010; 10: 6.
  19. Ellaway R, Masters K. AMEE guide 32: e-learning in medical education Part 1: learning, teaching and assessment. **Med Teach** 2008; 20: 455–473.
  20. Fordis M et al. Comparison of the instructional efficacy of Internet-based CME with live interactive CME workshops: a randomized controlled trial. **JAMA** 2005; 294(9): 1043–1051.
  21. Gormley GJ, Collins K, Boohan M, Bickle IC, Stevenson M. Is there a place for e-learning in clinical skills? A survey of undergraduate medical students' experiences and attitudes. **Med Teach** 2009; 31(1): e6–e12.
  22. Choules AP. The use of elearning in medical education: a review of the current situation. **Postgrad Med J** 2007; 83: 212–216.
  23. Carbonaro M, King S, Taylor E, Satzinger F, Snart F, Drummond J. Integration of e-learning technologies in an interprofessional health science course. **Med Teach** 2008; 30(1): 25–33.
  24. Hsu LL. Blended learning in ethics education: a survey of nursing students. **Nurs Ethics** 2011; 18(3): 418–430.
  25. Hsu LL, Hsieh SI. Factors associated with learning outcome of BSN in a blended learning environment. **Contemp Nurse** 2011; 38(1–2): 24–34.
  26. Silva CS, Souza MB, Silva Filho RS, Medeiros LM, Criado PR. E-learning program for medical students in dermatology. **Clinics** 2011; 66(4): 619–622.
  27. Link TM, Marz R. Computer literacy and attitudes towards e-learning among first year medical students. **BMC Med Educ** 2006; 6: 34.