

Distance learning in academic health education

A literature review

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Distance learning is an apparent alternative to traditional methods in education of health care professionals. Non-interactive distance learning, interactive courses and virtual learning environments exist as three different generations in distance learning, each with unique methodologies, strengths and potential. Different methodologies have been recommended for distance learning, varying from a didactic approach to a problem-based learning procedure. Accreditation, teamwork and personal contact between the tutors and the students during a course provided by distance learning are recommended as motivating factors in order to enhance the effectiveness of the learning. Numerous assessment methods for distance learning courses have been proposed. However, few studies report adequate tests for the effectiveness of the distance-learning environment. Available information indicates that distance learning may significantly decrease the cost of academic health education at all levels. Furthermore, such courses can provide education to students and

professionals not accessible by traditional methods. Distance learning applications still lack the support of a solid theoretical framework and are only evaluated to a limited extent. Cases reported so far tend to present enthusiastic results, while more carefully-controlled studies suggest a cautious attitude towards distance learning. There is a vital need for research evidence to identify the factors of importance and variables involved in distance learning. The effectiveness of distance learning courses, especially in relation to traditional teaching methods, must therefore be further investigated.

Key words: distance learning; health education; methodology; effectiveness; interactive learning.

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DISTANCE LEARNING (DL) is not a new phenomenon. Correspondence courses are reported to have existed in England as early as the 1840s. The University of Chicago established a correspondence division in the 1890s (1). Applications of distance learning have closely reflected the evolution of communications technology (2). The explosive progress of communications experienced during the last 20 years, has greatly enhanced the possibilities of DL, boosting the number and the potential of applications. Already in 1995, a third of higher institutions in USA were offering DL courses, while another 25% had plans to introduce DL within the coming three years (3).

Distance learning was introduced long ago, evaluated and accepted in many disciplines such as liberal arts, humanities, social and political sciences, mathematics etc. (4). The introduction of DL to health-care students occurred much later and experience in the field of medical and dental education is still compara-

tively limited. There is continuing debate regarding which academic disciplines are suitable for distance learning (4). It seems that the special character and objectives of medical and dental education have caused the introduction of distance learning to be delayed for a number of years. However, due to the remarkable achievements in technology and the increasing need for continuing updated knowledge, DL today has become an important alternative to traditional methods of education in the health care professions.

A survey among 35 FDI association members (5), concluded that there will be a strong interest for distance learning in the near future amongst dentists, while Hinman (2) sees DL as the only feasible way to help the USA's 500,000 public health workers to meet new challenges. DL is also reported to be the most appropriate way to serve the growing demand for postgraduate and specialist education, a demand that cannot be accommodated by existing university structures (6). In that sense, DL will be especially attractive to certain categories of professionals who are practi-

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cally excluded from access to traditional continuing and postgraduate education due to a variety of social, professional, geographical and economic factors (7). With the first formal DL medical curriculum already under development (2, 8), geographical barriers are fading and professionals or students seeking competence and skills development will have access to a global market. In this way, DL could be a field of major competition between universities in the years to come and the first indications of this are already visible (9).

The purpose of this review is to summarise the present experience in the field of distance learning in health education and to report the current state of the art, as well as the future trends and tendencies that can be identified. The review will focus on undergraduate and postgraduate education of medical and dental professionals, as we believe both are directed by the same needs and principles. Current literature and resources will be examined, mostly focusing on publications made during the last decade, as technology has dramatically changed the potential of DL during the last 10 years. In this review, factors that relate to learning methodology, acceptance and overall effectiveness of DL are investigated, leaving aside the detailed technological aspects, which are reviewed in a separate article (10).

Evolution of distance learning applications in health education

Two main categories of distance learning applications can be currently identified in dental and medical education: the undergraduate applications and those that aim at health-care professionals. In the group of undergraduate applications, we can distinguish DL that was introduced in the traditional curriculum or replaced part of it, and extra-curriculum applications, where DL was carried out parallel to traditional teaching.

At a postgraduate level, there are continuing education applications, credited or not, that aim to maintain and update the professional competence of the practitioners. We can then identify DL courses that

aim to present the practitioner with advanced competence, as reflected in a higher diploma or MSc degree. A third category could be DL courses that aim at the development of specialist skills and competence (Table 1). It becomes increasingly important to identify the unique social and professional characteristics and learning needs of each group, as these will direct the appropriate methodology and technology for a successful distant course.

The evolution of technology has dominated the learning methodologies of distance learning to the extent that a similar evolution can be observed in distance learning courses. Correspondence or home-study courses in the form of printed material and mail were the first distance learning applications to be reported (2). From a methodological point of view, we can refer to these kinds of applications as “non-interactive distance learning”. This term describes courses run at a distance in which the learning objectives are achieved through one-way communication, with no student-tutor or student-student interaction employed at any stage. At this point, it is important to distinguish student-tutor interaction from that of user-content or human-computer interaction, which can be observed in many recent applications. Recent non-interactive DL courses are facilitated by a large variety of media such as videotapes, television programmes, Web pages, CD-ROM and more. Non-interactive distance learning appears to be the simplest and oldest type of health distance education, yet it is still preferred by many institutions, as it is possibly the least demanding in student and tutor resources. The method is widely applied in the continuing education of health professionals, but very few applications can be found for undergraduate students.

The student-tutor live interaction possibility at a distance, starting in the late 1950s, added a whole new dimension to distance learning. Interactive distance learning allows us to speak of “second generation” applications. Teleconference, two-way audio and video applications, interactive television and radio shaped a whole new kind of distance learning, introducing new methodological and structural aspects. However, due to the complexity and cost of the em-

TABLE 1. Categories of distance learning applications in academic health education

undergraduate distance learning	1. in- curriculum distance learning 2. extracurricular distance learning
postgraduate distance learning	1. structured advanced education (MSc, Diploma, etc.) 2. specialist education 3. continuing education
	credited non-credited

ployed technologies, this kind of distance learning was unattractive for the individual professional. On the contrary, these methods benefited collective formations such as associations, hospitals, universities, ministries, etc., which could bring together large numbers of professionals, thus greatly reducing the cost per person.

A third generation of distance learning is now visible, characterised by “virtual learning environments” or “integrated distributed learning environments” (3). Although still in its infancy, the “virtual classroom” represents a promising new potential in distance learning (3). The former term is rather new and not yet absolutely defined. However, for the purposes of this study we could refer to a virtual classroom as the learning environment created on the internet, which resembles, in terms of interaction, method and function, an on-campus academic classroom (10). At this point, it is important to note that according to this definition, not every educational application on the internet is a virtual learning environment. Indeed, what we commonly see on the internet are variations of non-interactive distance education, sophisticated textbooks or course-related archives of information (11). Rather than being a new medium, a virtual classroom is the powerful combination of a variety of media and resources, with the internet as a backbone. Audio-visual interaction, synchronous and asynchronous text discussions, on-line libraries and search engines, on-line sharing of working files and documents are some of the basic communication elements of virtual classrooms (12). These environments are indi-

cated to preserve or even enhance interactivity and teamwork (13). Another strength reported is that all interactions can be recorded and serve as a basis for assessment purposes or the planning of learning strategies (3). We are in the very beginning of this phase in academic learning, and research in the field is needed before we are able to draw conclusions. However it appears that virtual classrooms, standardising the technology, will allow researchers to focus on the learning method rather than the media used for distance learning (Table 2).

Analysis of the factors of importance in distance learning

Theoretical framework and learning methodology

After close examination of the DL experiences presented so far, one can see that they lack the support of a solid theoretical framework. Such a theoretical background would allow the research outcome of individual studies to be replicated and generalised in other contexts. In a recent review on DL research by the Institute for Higher Education Policy (April 1999) (4), this fact was reported as a missing link in research, which requires further investigation. This review emphasised the need to develop a more integrated programme of research in distance learning based on theory. Theory allows researchers to build on the work of others and thereby increase the probability of addressing the more significant questions regarding distance learning. A similar remark was

TABLE 2. Main characteristics of distance learning applications according to the level of interaction provided

	1st generation	2nd generation	3rd generation
	correspondence courses	interactive courses	virtual classrooms
interaction	no interaction evaluation questionnaires	audio (early) audiovisual (late)	audiovisual synchronous-asynchronous text discussions sharing of working files and resources on-line libraries
technical demands	less demanding	both server and client demanding	mostly server demanding
technology	mail, workbooks, tapes, slides, videos radio, TV broadcast, CD-ROM, web applications	teleconference two-way video microwave TV fibre optics, satellite	internet multimedia HTML
methods	self-teaching	didactic courses study groups	problem-based learning dynamic knowledge networks
mostly applicable to	individual professionals	professionals or undergraduates larger groups	professionals or undergraduates individuals or groups

Data from Mattheos et al. (10).

made by Gianni et al. (13) with regard to web-based applications.

In early DL projects and correspondence classes, the method followed was basically an imitation of the didactic teaching model. Correspondence courses are usually of a modular structure, with some self-assessment questions or tests upon completion of each module. In some cases, recommendations and links for studying could be included, to allow a more self-directed form of learning. This structure allowed professionals to follow their own pathway, especially with regard to time, to fit better the continuing education needs of busy practitioners. This kind of distance learning is indicated to provide continuing education to dentists otherwise not reached by more traditional methods (14).

As DL courses were becoming more and more structured, more complicated methods were attempted. Although the initial approach of the correspondence courses was didactic, the later introduction of interactivity enabled teamwork and even problem-based learning (PBL), which many educators considered appropriate for the DL environment (13, 15).

The Welcome Tropical Institute, in a study conducted in Africa and Pakistan (16), concluded that a PBL approach is no less acceptable or effective than a more conventional method of distance learning. However the need for a very thorough briefing on the use of PBL modules was emphasised. That is in agreement with Kamien et al. (17) who rejected the use of PBL in their distance course, due to the students' need of previous experience with this educational method in order to comprehend the content of the course. Other aspects that were highlighted were the value of consistent, active support by a doctor appointed as a mentor to the isolated learner and the need to ensure that the learning material was adapted to local conditions faced by the student (16). The level of human interaction during a PBL course is reported to be successfully preserved or even enhanced (3) within a virtual classroom by the fact that the electronic media allow real-time communication between group members, as well as with the tutor. In fact, the addition of asynchronous instruments for knowledge sharing, adds a new dimension to the interaction between the resources and the learner (13).

The role of individual participation versus teamwork in distance learning

The introduction of interaction in DL gradually brought up many aspects in methodology that demanded special study. With courses based on tutor-student interaction, teamwork was now available and

the formation of small study groups was in many cases favoured. Smith et al. (18) noted that participation in distance learning groups has a better completion rate than home-study instructional methods. Indeed, it appears that most of the authors strongly recommended the option of teamwork, although it could possibly limit self-paced learning (19). This is especially true for the undergraduate applications, where small groups of students were essential components in most published cases. The question raised, however, is how much active guidance should the distant groups receive from mentors/tutors, especially regarding undergraduate applications. In the case described by Kamien et al. (17), a third of the students disliked the student-run case discussions, describing the process as "the blind leading the blind". The same criticism is not found in undergraduate DL courses with more actively guided groups (13).

In postgraduate applications, authors seem to favour teamwork as well. Smith et al. (18) rated student-student interaction as a very important element of the success of their DL course, referring to it as "community development". In another case, Houston (20) reported that a group of doctoral students taught with two-way compressed video, emphasised that the support they received from their group at remote sites was important in causing them to persist in finishing the program (20). This is consistent with 15 DL instructors surveyed in Ohio, who stressed strongly that instructors should develop classroom interaction in an interactive television course (21).

In general, formation of small, self-organised study groups seems to be popular amongst designers and participants of distant courses. However, it must be noted that a minority of DL postgraduate students propose private study as the preferable method (22). In an attempt to match the two methods, Ndeki et al. (23) concluded that a regional core team should support the efforts of individuals throughout the program, establishing a balance between individual work and group work. However, it appears that teamwork and individual work can contribute in different ways to the effectiveness of a DL course. A detailed consideration of the social, economical and cultural background of the users, as well as their individual learning needs, might indicate the best method or combination (14).

Personal interaction in distance learning

The discussion about remote interaction soon brought up questions about face-to-face contact. It is accepted by definition that DL refers to situations in which the tutor and the student are physically remote. However

personal contact between tutors and participants has been employed at various stages of many DL courses with positive results. What is the role of in-person contact in distance learning and how important can it be?

Personal contact appears in the form of introductory meetings (15), workshops (24), group-study sessions (17), local visits of tutors (23, 25) or even chair-side supervision (15). The duration of these meetings can vary from 1-day workshops to 2 weeks in campus training (15), depending on the overall duration of the DL course. Most of these meetings aimed to introduce participants to the methodology or the technology of the course (3, 26), or were focused on the development of communication skills, activities that according to Holborow et al. (15) are not easily performed through distance teaching. Personal contact during DL courses is reported to have a strongly motivating effect upon students and was strongly recommended by all authors. In addition, preparatory meetings reportedly save much course time and trouble, especially during technology dependent courses.

It appears therefore that DL does not exclude person-to-person contact. On the contrary, personal contact at some stage is believed to accelerate the progress of the course and enhance the potential of DL.

Assessment methods in distance learning

As DL courses moved to ever higher and more complicated learning objectives, assessment of the students' participation became a necessity. Self-paced correspondence courses relied almost completely on self-assessment tests or questions (27). As courses were structured leading to credits, skills or even higher degrees, a kind of peer assessment had to be introduced. However, little can be found in relevant publications regarding assessment. In-campus examinations after the completion of the DL course, appeared to be a quite safe way for student assessment in some cases (28).

Van Putten et al. (29) reported the use of internet for the assessment of undergraduate students to be beneficial. The most recent trends, however, tend to assess students' competence by means of more holistic approaches such as case presentations and assignments. Radford (30) noted that tutor-marked assignments enable acquired knowledge to be applied in real situations. Successful completion of the distance course included completion of 3 tutor-marked assignments by the students, and a final written paper.

In the same way, Smith et al. (18) assessing a web-based DL course, concluded that case presentations

are an important method for assessing competency in clinical dental procedures in DL methods. Case presentations were reported by the authors to evaluate performance in contexts that resembled those to be encountered following the educational program. Lang (31) added that students' peer evaluation of one another's activity should be part of the evaluation scheme of a distance-learning course.

Another trend introduced by the on-line courses and virtual learning environments suggests the assessment of the total student participation during the course (11). As these environments have the ability to record all the interactions and contributions during a course, the total participation of a student is available for either self, tutor or group assessment in terms of both quality and quantity. However, it remains yet to be investigated in what ways the recorded interactions relate to the competence developed.

In conclusion, although many methods of assessment have been proposed so far, none of them is yet adequately tested in the environment of DL applications. There is an indication that future DL assessment methods will be based more on students' total activity than on the occasional filling in of questionnaires or exams. Assessment in DL must become a major research field as applications become more demanding. One of the key points for designing high quality distance education should be to ensure that the students receive the education they are exposed to (2).

Student motivation

Motivation amongst students participating in DL courses is another topic of interest. It is commonly reported that distance learning in general is plagued by high drop-out rates (4, 18). That is especially true if DL courses are not a compulsory part of an accreditation system, curriculum or degree (32). On the contrary, dentists appeared more motivated when the distant course was leading to accreditation points (14) and undergraduate students when they were told that part of their final exams would be based on the computer-instructed material (32). Bonazzi et al. (33), in a research analysis, concluded that evaluation results are related to the student's degree of self motivation in DL. This suggests the importance of self-motivation for successful participation in a DL course.

Tutor-student personal contact (3, 23), work in study groups and student-student interaction (18) are suggested as strong motivating factors. Smith et al. (18) during a DL program, reported no drop-outs at all, and Holborow et al. (15) also reported a very high completion rate. In both cases, however, participants

were charged a tuition fee in advance, which possibly filtered out less motivated students.

Overall effectiveness of distance learning

Many methods and technologies have been developed and proposed for DL of health-care students. The major question that is raised, however, has to do with the effectiveness of the method. Can we defend the effectiveness of this form of health education, especially in comparison with traditional teaching methods? Can medical and dental students be educated at a distance and what is the level of competence developed in comparison to traditional teaching?

In order to answer these questions, we undertook a literature review, with the intention of identifying the current state of research in medical and dental DL. After reviewing more than 50 published cases, our conclusion was that there is a lack of original research investigating the effectiveness of such courses, and therefore a lack of valid recommendations. An overview of some of the most characteristic published cases can be found in Table 3.

The majority of studies so far consist of descriptions and case reports, in which the authors usually present their experiences of a certain DL model, including descriptions of the technology and the learning material. Although evaluation of the results is presented in many cases, it usually focuses on student and faculty attitudes about the DL education, overall satisfaction with the course and problems experienced throughout the program. Most studies conclude with an increased appreciation of distance learning by the participants and faculty (Table 3), the achievement of learning objectives (22, 34) and that DL has a positive impact upon the participants' skills and competence (18, 35). The most commonly employed means of evaluation is completion of questionnaires after the course (Table 3). However, strong indication exists that participants' opinions are often subject to different kinds of bias factors and therefore cannot be a satisfactory way of evaluating distance learning (4, 36). In some cases, authors have tried to point out the effectiveness of their courses by means of more measurable entities, such as measuring the amount of interaction during the course (31, 37), presenting the comparative pass rates in state exams (24), or the increasing number of applicants for their course (15). The change in the participants' skills and knowledge was also studied, but in most cases where it occurred, it was carried out by means of self-assessment questionnaires rather than any external judgement (18, 27, 35).

The results from the few original research papers available in academic health education, recommend a more critical approach. Authors of comparative research studies tend to find similar levels of achievement between distance and classroom students, as indicated by exam and test scores (32, 38–40). In addition, Lyon et al. in a very carefully controlled study, found that students using computer instruction reached the learning objectives in 43% less time than the control group without any loss in the competence developed (32). In another study, Rogers et al. (39) compared computer instruction to lecture feedback seminars for the purpose of teaching a basic surgical skill. Although both groups were found equally effective in conveying the cognitive information associated with the skill, the computer-instructed group presented significantly lower performance scores. A weakness in the above study, however, could be that computer-instructed students had not had the benefit of the feedback available to the in-classroom teaching group.

Regarding interactive distance learning, a very interesting study was designed by Lewis et al. (38), aimed at comparing two-way video with in-classroom teaching. Again, the authors found no significant difference in the exam scores of the distance and the in-classroom group. However, the attitude that interactive video instruction was an effective medium of teaching declined significantly among the students of the distance group, as they found the video conferences to be more boring than expected. In addition, interaction amongst participants in the experimental group was rated as poorer than anticipated and classroom residents asked more questions than their colleagues attending at a distance. This finding is in agreement with another controlled comparative study by Gould et al. (41). The experimental group in this study attended an internet based course on periodontology. Although the study is still undergoing evaluation, the authors found that the contribution of most participants to the asynchronous discussions was poor (41).

With regard to cost-effectiveness, many authors agree that costs are minimised with distance learning. In support of this, Hibbard et al. (37) describing a DL program, claimed that the National Health Service saved more than £3000 per participating group, in comparison to the cost of the traditional methods of education. Kudryk et al. (42) mentioned that thanks to the use of the examined teleconference system, the US Army saved much money in terms of travel expenses, experts' compensation and lost duty hours. Ndeki et al. (23), dividing the cost of a single doctor's

TABLE 3. Overview of the most characteristic studies published since 1985 regarding DL applications in health education

	Author	Year	Method	Type	Subject	Evaluation	Results, conclusions
1	Williams (45)	1985	interactive television	UG	medicine	not present	increased acceptance
2	Marshall et al. (19)	1985	telephone conference	UG	medicine	not present	increased acceptance
3	Hibbard et al. (37)	1986	telephone conference	Ex	medicine	questionnaire	increased acceptance
4	Kamien et al. (17)	1991	audiovisual material, study groups	UG	general medicine	questionnaire	increased acceptance
5	Patterson et al. (27)	1991	printed material	CEP	fissure carries	questionnaire	changes in diagnostic procedures of users
6	Holborow et al. (15)	1991	telephone conference, site visits, audiovisual material	HD	dentistry	not present	increasing number of students, high completion rate
7	Lyon et al. (32)	1992	interactive software	UG	medical	controlled group study	similar test scores in both groups computer group needed 43% less time
8	Lang WP (31)	1992	computer conference	UG	dentistry	questionnaire, recording of interaction	positive acceptance, problematic evaluation, students developed information access and retrieval skills.
9	Marshall et al. (48)	1993	printed material, telephone conference	ST	medical photography	not present	not present
10	Dockning S (28)	1993	printed material	CEP	nurse education	not present	not present
11	Dirksen et al. (43)	1993	microwave television	UG	nurse education	questionnaire	similar achievements and attitude between distance and in classroom students, complex and expensive technology
12	Ndeki et al. (23)	1995	printed material, site visits	CEP	medicine	questionnaire, pre-post test	enthusiastic acceptance, increased motivation
13	Hayes et al. (49)	1996	web-based patient hypertext	CEP	medical	user comments	enthusiastic acceptance
14	Macfarlane et al. (46)	1996	hypertext	CEP	epidemiology	not present	not present
15	Hinmman AR (2)	1996	satellite transmission	CEP	epidemiology	not present	increased cost – effectiveness
16	Van Puten (29)	1996	web based	UG	prosthodontics	not present	internet environment suitable for examinations
17	Tanenbaum et al. (1)	1996	not present	UG	dental hygiene	not present	not present
18	Gould et al. (41)	1997	asynchronous conference	CEP	dentistry	controlled group study	low participation from most users study undergoing evaluation
19	Cochrane et al. (24)	1997	workbooks, teamwork	Ex	medicine	not present	better pass rate of course users increased acceptance
20	Kudryk et al. (42)	1997	two-way video	CEP	dentistry	cost-effectiveness study	in 38 of 40 cases, diagnosis was possible at distance
21	Bailey J (44)	1997	two-way int. video	UG	paediatric dentistry	not present	increased faculty/student acceptance
22	Kuramoto et al. (25)	1997	audiographics teleconference	CEP	nurse education	questionnaire	positive acceptance, technical difficulties
23	Lewis et al. (38)	1998	two-way video	CEP	family medicine	controlled group study	similar achievements in both groups, decreasing acceptance and low level of interaction in distance group
24	Smith et al. (18)	1998	two-way video	HD	general dentistry	questionnaire	increased acceptance, high completion rate, improvement in skills of users
25	Gianni (13)	1998	virtual classroom	UG	medicine	recording of interaction	high level of interaction, theoretical background development
26	Agius et al. (34)	1998	web based	UG	occupational medicine, env. health	questionnaire group reports	gains in technological expertise, achievement of learning objectives
27	Rogers et al. (39)	1998	computer based	UG	surgical skills	controlled group study	similar achievement of learning content, lower proficiency level in the computer instructed group
28	Hobbs et al. (40)	1998	in classroom, computer network, satellite network	UG	emergency medicine	controlled group study	similar achievements in distance and control groups.
29	Dugas et al. (47)	1999	web based	CEP	medicine	not present	not present
30	Fox et al. (35)	1999	virtual class	CEP	medical informatics	questionnaire (pre-post)	improvement in 8 skills of users

Figures in parenthesis refer to the numbered reference list. UG: undergraduate education, Ex: preparation for state examinations, CEP: continuous education of professionals, HD: leading to higher degree, ST: specialist training.

participation fee in a distance course by the number of people living in the area in which the doctor practiced, estimated the cost per affected person to be \$0.38. However, a number of studies of DL courses report increased costs and complexity (43), while a widely-adopted finding is that distant and especially on-line courses are more time consuming and labour intensive for educators than in-classroom teaching (3). This indicates an increased cost of educational and teaching resources.

Amongst presently available studies, there are many indications that DL can be an effective way to educate health professionals. However, no solid evidence seems to have been produced. In addition, only weak indication exists towards identifying the methodological factors that would make the difference between a successful and a not successful distance course. Case studies are not based on comparative research protocols that could test the effectiveness in a controlled environment, with a random sample, excluding all the extraneous variables. These conclusions are in agreement with the findings of the American Institute for Higher Education review, which concluded that there is a relative paucity of true, original research dedicated to explaining or predicting phenomena related to DL (4). Among the key shortcomings of the research is lack of control over extraneous variables and therefore inability to prove cause-effect relations. The selection of the student sample, as well as the lack of control over reactive effects such as the novelty effect, are also reported as shortcomings (4). However, it can be argued that educational research cannot be as flexible as research in the laboratory and therefore the same strict rules cannot be applied.

Distance learning appears to be a promising answer to many of the current problems and challenges faced by medical and dental education. However, before moving on to new revolutionary ways of training doctors, much work is still to be undertaken. The real potential of distance learning in health education, especially in comparison with traditional teaching methods, remains to be proven.

Conclusions

Distance learning is becoming increasingly apparent as a promising method in dental and medical education. It appears that DL is able to cover the educational needs of certain categories of professionals and students not otherwise attainable by traditional methods for social, professional, economic and geographical reasons. There is also sufficient indication

that DL is able to cut down the cost of dental and medical education at all levels.

Correspondence courses, interactive courses and virtual learning environments seem to represent three main generations of distance learning in health education. The evolution of the technology between these three generations has allowed major changes in the DL methodology as well. The existing technology has the potential to facilitate complicated distance learning environments and highly structured learning methods.

Designers of more recent applications tend to appreciate team-work and the formation of small groups more than individual study, although the latter appears still to be more applicable to many categories of professionals. Also, accreditation, team-work and personal contact in DL, are stressed by most authors as important factors for increasing motivation and minimising drop-out rates.

The learning methodology employed in DL has changed during recent years. Early applications as well as self-study courses have mostly relied upon didactic teaching models. The interactive applications, especially the virtual learning environments, tend to employ more complicated methods such as PBL and dynamic knowledge networks (13) with encouraging results. Just as in traditional teaching, the learning method rather than the medium seems to be a significant factor for the effectiveness of a DL course and the attitude and achievements of its participants.

At the same time, assessment methods have passed several stages, from no assessment, self-assessment questions or on-campus examinations, to evaluation of actual cases, presentations and tutor-marked assignments. The trend of virtual learning environments is that student activity throughout the course can be recorded and assessed. It is also proposed that students could assess the activity of their colleagues within the course.

There is a lack of a theoretical framework to support distance learning applications. Cases reported so far seem to focus rather on the effectiveness of a certain technology than on the design and evidence of effectiveness of a learning method. Encouraging and sometimes enthusiastic results are widely presented in case studies. However, more carefully controlled studies seem to suggest a cautious approach, although they tend to agree that students educated through DL courses present similar achievements with their in-classroom controls.

Trying to characterise DL as "effective" or "not effective" as a medium for health education, appears to be the wrong approach. The term "distance learning"

covers a wide variety of courses, technologies and often contradicting methods. It will be much more accurate to acknowledge that certain DL techniques and environments can be effective when applied to the appropriate audience. Research is needed to investigate all the variables involved and identify the factors that contribute to or jeopardise the success of a DL course. The weaknesses and strengths of the traditional teaching methods in comparison to the appropriate DL alternatives have to be further investigated. In time, this could lead to the development of the necessary theoretical framework.

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