Review Article

Blended learning in postgraduate oral medical and surgical training - An overall concept and way forward for teaching in LMICs

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ARTICLE INFO

Keywords:

Blended learning

e-learning

Postgraduate dental programs

Digital postgraduate oral medical college

ABSTRACT

E-learning programmes have become established in postgraduate oral medical education and training. Internet and literature researches show a variety of good concepts that provide an attractive alternative to face-to-face training.

What is missing is an overall concept in which continuing education and training are offered in bundled form in various teaching and learning formats. We discuss the blended learning concept which offers the best options, which has been proven by scientific studies. Using the example of the International Medical College (IMC) at the University of Duisburg-Essen, a blended learning overall concept for postgraduate continuing education is presented.

1. Introduction

Digital teaching and learning permeates all areas of education and employment as digitalisation progresses in our society. From kindergarten to senior citizens, knowledge is now imparted digitally. Via the internet, access to it is available worldwide, independent of time and place. The new field of artificial intelligence opens up even more options for intelligent knowledge transfer. Technical development is rapid and new research results in this field are rapidly presented. (see Figs. 1–5)

In the meantime, there are also numerous e-learning offers in medical and dental education and training. Traditionally, continuing education in medicine and dentistry takes place in the form of attendance at congresses or workshops. Since this requires a considerable amount of time as well as difficulties due to the current pandemic, these new media offer excellent opportunities for optimizing postgraduate continuing education for doctors and dentists. The use of these new concepts in dentistry was recommended by the Science Council of the Federal German Government in 2005.¹

Especially in higher education, different concepts are offered for different dental specialties in student teaching, but also in postgraduate education. During the current Covid pandemic crisis, development has accelerated and many new formats have proven to be effective.

Companies and publishers have also discovered the market of digital learning and teaching. The offerings range from provision of lectures and further training scripts, PowerPoint and PDF files, which are offered

in a content management system, to interactive learning programmes and structured, complex blended learning concepts.

All these individual projects or programmes support the transfer of knowledge more or less effectively.

With all the options and offerings, the following questions arise:

- Which factors characterize the acceptance and successful establishment of e-learning?
- Which concepts are necessary for long-term application and establishment?
- How can the exploitation of e-learning products be optimized?
- Which measures are necessary to ensure widespread access and application?

This article initially provides an overview of various e-learning systems and platforms and explains different didactic models by giving examples. This is followed by a presentation of an overall blended learning concept for postgraduate training and continuing education using the example of the International Medical College (IMC) at the University of Duisburg-Essen.

2. E-learning systems

The term e-learning initially refers to all forms of teaching and learning that are based on working on and with a PC. E-learning is

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<https://doi.org/10.1016/j.jobcr.2021.09.015>

Received 23 August 2021; Accepted 16 September 2021

Available online 20 September 2021

2212-4268/© 2021 Published by Elsevier B.V. on behalf of Craniofacial Research Foundation.

defined as “the learning supported by digital electronic tools and media”. Using the Internet in the field of education, learning via mobile devices or wireless networks or transmission is referred to as “mobile learning” or “m-learning”.^{2,3} Different kinds of software systems are available for realization of e-learning programs. A distinction is made between different technologies which include Computer-Based Training (CBT), Web-Based Training (WBT), Video Teaching, Content Management Systems (CMS), Learning Management Systems (LMS) or Learning Content Management Systems (LCMS).⁴ E-learning is subject to constant development of technical options and didactic use. Current topics in this context are Cloud Computing, Web 2.0, Sematic Web and Artificial Intelligence.

A brief description of different relevant types of e-learning follows.

3. Computer-Based-Training (CBT)

Computer-Based-Training (CBT) refers to computer-supported multimedia learning programmes that contain extensive, hypermedia-structured learning materials. A CBT covers a self-contained topic, and access to it is usually Internet-independent.³ CBT is a methodology for providing systematic, structured learning; a useful tool when properly designed⁵

The conventional learning CD-ROM or DVD is the most common example of Computer-Based-Training. Here, the teaching and learning subjects are conveyed by means of images, sounds computer-generated image sequences, video recordings and interactive models.^{3–5}

This type of e-learning is used a lot by publishers who equip their textbooks with additional CD-ROMs or DVDs. Examples of this are the textbooks “Digital Volume Tomography in Dentistry, Oral and Maxillofacial Surgery” by Zöllner and Neugebauer. and “Computed tomography: fundamentals, system technology, image quality, applications” by Kalender. With an accompanying DVD, the reader can analyse DVT data sets themselves using software.^{6,7}

4. Web-based-training (WBT)

In Web-Based-Training, the Internet enables the learner to work flexibly and to have access to the most up-to-date information, regardless of time and place. Both CBT and WBT provide the user with the opportunity to deal with topics and questions self-determined, autonomously. In addition to the Internet, WBT can also include e-mail, newsgroups or conferences. Furthermore, WBT can be continuously adapted and updated.⁸

Examples of this are the online CME continuing education courses provided by many journals and publishers. Current CME continuing education courses are available, for example, at:

<https://cme.thieme.de/cme-webapp/#> (July 2021)

<https://www.cmelist.com/dentistry-cme/> (July 2021)

<https://www.dental-online-college.com/en/> (July 2021)

www.imc-orec.de (July 2021)

This platform provides interactive case-based learning which represents an application for WBT.

5. Content Management System (CMS)/ Learning Management Systems (LMS)/ Learning Platforms/ Learning Content Management System (LCMS)

The website e-teaching.org describes learning management systems as follows: “A learning management system (LMS) usually forms the technical core of a complex, web-based e-learning infrastructure. It is software installed on a web server that supports the provision and use of learning content and provides tools for cooperative work and user administration”.²

Moreover, LMS is defined as an online system that allows users to share information and collaborate online.⁹ The following table shows a clear representation of the functions that an LMS or LCMS should contain:

However, the difference between a Content Management System (CMS), a Learning Management System (LMS) and a Learning Content Management System (LCMS) is not really evident.²

LMS refers to comprehensive software programmes for managing processes in the field of e-learning. In this context, an LMS includes complex management tools such as user and course administration, user management, etc.⁹

LMS or LCMS are also summarized under the term “learning platforms”. Especially in the university environment, these are used to realize complex e-learning applications. Here, the open source systems ILIAS “Integrated Learning, Information and Work Cooperation System”¹⁰ and MOODLE “Modular Object Oriented Dynamic Learning Environment”¹¹ are frequently used. In contrast to commercial products these source codes are open and freely available.

Moreover, numerous LMS products exist, sometimes proprietary developments of certain institutions, which have been able to establish them due to their flexibility.

One example of an LMS is the Dentalteach website. This web-based learning programme is addressed to dental students and dentists for the achievement of caries diagnostic competence [<http://www.dentalteach.de/home>, July 2021].

6. Wiki Systems (Interactive CMS)

The most well known WIKI-System, WIKIPEDIA, defines a WIKI as “a hypertext publication collaboratively edited and managed by its audience directly using a [web browser](http://www.wikipedia.org). A typical wiki contains multiple pages for the subjects or scope of the project and could be either open to the public or limited to use within an organization for maintaining its

Master courses (M.Sc.)	Part-time 60 ECTS 3 semester	Part-time 90 ECTS 4 semester
Implantology and Dental Surgery	✓	✓
Restorative and Aesthetic Dentistry	✓	✓
Periodontology	✓	✓
Specialized Orthodontics	✓	✓
Advanced General Dental Practice		✓

Fig. 1. Accredited master programmes of the IMC at the University of Duisburg-Essen.

internal knowledge base". [wikipedia: <https://en.wikipedia.org/wiki/Wiki>; (July 2021)

Examples of real wikis in dentistry offered as an open authoring system are rare. Online encyclopaedias are more likely to be found, for example:

https://psychology.wikia.org/wiki/Pediatric_dentistry (July 2021)

<https://dentalmammoth.com/en-us/> (July 2021)

IMC-OREC: OREC-Library (July 2021)

7. Video conferencing/conference systems

Any number of learners at different locations can participate in a video conference or virtual seminar conducted by a lecturer in a room equipped with a WebCam. In real time, instructors and learners can communicate with each other via audio and video. During the pandemic, this kind of e-learning has become established in very many educational institutes. Over time, research results will show if knowledge transfer will be effective using only this format.

8. Massive Open Online Courses (MOOC)

Massive Open Online Courses, or MOOCs, represent a new area in university teaching. MOOCs can be characterized as follows:

- online courses
- no formal entry requirement
- no participation limit
- free of charge
- do not earn credits.¹²

The "Gabler Wirtschaftslexikon" provides a definition: "A MOOC, a Massive Open Online Course, is an Internet-based course that is addressed to many participants ("massive": "huge, enormous"), open to all ("open") and usually free of charge. A distinction is made between xMOOCs ("x" for "extension"; Harvard University used this letter in its directories to draw attention to virtual courses) and cMOOCs ("c" for "connectivism"). MOOCs are attractive to people with different educational backgrounds. Some courses have enrolled tens of thousands of participants.¹³

9. Siemens and Downes distinguish two different models of MOOCs

- cMOOC model (c for connectivity), which "emphasises creation, creativity, autonomy and social networking learning" and "focus on

knowledge creation and generation". The cMOOCs stand in the tradition of Connectivist philosophy, and refer to the work of Ivan Illich. As a sharp critic of institutionalised education, Illich proposed in 1970, to establish "learning webs" by using new technology.

- xMOOC model – which is more or less the approach described so far – which "emphasises a more traditional learning approach through video presentations and short quizzes and testing" and "focus on knowledge duplication".¹⁴

In the U.S., xMOOCs were intended to be used in higher education institutions to deliver knowledge to a larger audience at no cost. This project could not be established because, among other reasons, xMOOCs do not take into account important face-to-face learning and are associated with high costs. Furthermore, an integration of xMOOCs into university teaching proved to be problematic. In the area of didactic design, there are different findings. Often, there is a lack of necessary supervision or exchange during the courses both by the teachers and among the students.

Therefore, blended learning concepts are proposed.^{15,16}

10. Blended learning (hybrid learning)

Experience shows that the effectiveness of pure e-learning is limited. Therefore, blended learning combines web-based learning with face-to-face sessions.

On e-teaching.org, blended learning or hybrid learning is described as a combination of virtual and non-virtual learning settings and methods. This defines a teaching/learning concept that provides for a didactically meaningful combination of face-to-face events with classical forms of learning and virtual learning on the basis of new information and communication media.^{2,8} On the one hand, this makes it possible to learn largely independently of spatial and temporal limitations and, on the other hand, to realize a personal exchange of experiences among learners in conventional training events.¹⁷

In contrast to the term "e-learning", which is associated with a predominantly technical approach, the term "blended learning" is intended to emphasize the teaching and learning environments determined by technology and people.¹⁸ Kerres also speaks of hybrid learning arrangements as a combination of computer-based learning and classical face-to-face learning. In principle, neither of these two forms of learning is more effective than the other, but rather it is a question of a useful didactic combination of the two parts.¹⁹

A special form is the Internet-based blended learning system.⁴ Here, e-learning units are combined with so-called online live lectures or seminars. The online live events are conducted by means of a conference

Fig. 2. The IMC LMS platform E-med: complex university information and management system.

system to which the students log on. Due to the direct contact with the lecturer and the communication between the participants, this represents a special kind of “face-to-face event”. During the pandemic, this kind of internet-based-blended-learning seems to be the most effective, whereby the online-live-events must be implemented as direct

communication exchange lectures.

11. Current offers

An internet search on the current availability of e-learning

Fig. 3. Countries of origin of the graduates from 2004 to 2020.

programmes showed that further training opportunities exist for specific parts of the different disciplines.

The different programmes are very informative in terms of content, often very user-friendly in terms of technology and didactics, and certainly provide interested parties with an attractive alternative to face-to-face training.

In addition, there are a large number of e-learning research projects at university dental clinics. Literature researches in Pubmed or Web of Science confirm this. For example, an e-learning program for the diagnosis and therapy planning of an orthodontic treatment case was developed at the University of Ulm.²⁰ A similar programme was developed at the University of Münster in 2007. This describes an orthodontic digital case documentation as a problem-based eLearning system in student education (ePBL).²¹

At the University of Frankfurt a.M., an online-based teaching programme with dental case vignettes and learning elements on EbM has been established for dental students in their first clinical semester.²²

But will these often excellent projects also be able to be established in practice?

As early as 2006, Boeker and Klar pointed out that for the long-term success of e-learning and blended learning offerings, their integration into the medical curriculum and continuing education is important. Successful establishment and further development is characterized less by technical than by didactic and organizational aspects.²³

The demand for institutions that offer e-learning continuing education for all dental disciplines is therefore very high. Some have already been established in this field. The portal www.e-wise.de (July 2021) as a video portal, or <https://www.dental-online-college.com/zahnmedizin-oralchirurgie-zahnarzt-fortbildung/> (July 2021) of the German Ärzteverband can be mentioned here. These are platforms which are intended for the most part for pure self-study. Occasionally, interactive webinars are also offered. In addition to the examples mentioned, there are many other complex offerings on the web. Many company-related institutions offer complex case databases such as the ITI-Online Academy <https://academy.iti.org/academy> (July 2021) or the FOR website <https://www.for.org/> (July 2021).

However, it has been shown that many products are often not evaluated in a structured way and are usually only provided as a single offer or for a specific discipline, and often the e-learning training sessions are difficult to find in the internet. Helpful are websites such as the German website <https://www.univiva.de/> (July 2021), on which targeted searches can be made for continuing education courses that are

previously registered there by providers.

What is missing is an overall concept in which continuing education and training courses are offered in bundled form in the various teaching and learning formats, whereby the Internet-based blended learning concept certainly offers the most diverse possibilities. Here, of course, the organisations responsible for postgraduate continuing education, are much in demand. The Science Council of Germany also calls for the involvement of universities in this regard.¹

The International Medical College at the University of Duisburg-Essen, whose concept is now presented here as an example, is taking a path towards a digital postgraduate college for oral medicine.

12. Brief description/history

The International Medical College (IMC) was founded in 2003 at the Westfälische Wilhelms - University, and since 2018 has been part of the University of Duisburg – Essen.

The main focus is on providing postgraduate master courses in the field of oral medicine according to the blended learning concept. Another field is continuing education, which is also performed according to the blended learning concept.

The IMC is internationally oriented and offers its courses in German and English. There exist national and international university co-operations with the universities of Hamburg, Dresden, Saarland, Budapest/Hungary, Szeged/Hungary, Mahidol University Bangkok/Thailand and Jiaotong University Shanghai/China.

Through the use of telematics and cloud computing, IMC also provides support and consulting services after completion of an advanced training course.

13. Technical and didactic concept

For the realization of the offers, an own complex e-learning platform was developed. This learning platform was developed on the basis of a commercial Content Management System and continuously enhanced to a complex university information and management system through technology adaptations and the latest developments and findings in media pedagogy and virtual university administration. The platform is based on the latest technological standards and is characterized by stability, flexibility, open structures, integration possibilities of external systems, use of standardized interfaces, permanent availability, fail-safety, guarantee of being up-to-date, a comprehensive security

Fig. 4. Age distribution of the graduates from 2004 to 2020.

concept, a standardized user interface and differentiated rights and user management. The servers are hosted in data centres, fail-safes for both hardware and software are guaranteed.

The e-med platform consists of the following components:

- Teaching and learning management including knowledge management
- Management system for master theses
- Examination management
- Editorial management
- Communication management
- Study organization
- University administration and organization
- Student administration
- Study programme coordination
- Alumni administration

It thus encompasses the criteria and functional areas for an LMS described in Table 1. The learning environment is characterized by the use of IT standards and by ensuring availability and stability. It includes all e-learning functionalities and has a high flexibility. The user functionalities are permanently extended with regard to internet functions and social media, which are tested and established in the field of multimedia and e-learning didactics.

The learning platform has already been established since 2003 and is used internationally.

The study courses, as well as the continuing education courses, are based on the concept of Internet-based blended learning. For the theoretical self-study in the study courses, as well as in the online training courses, the teaching contents are presented in a didactically prepared form on the e-learning platform e-med. Both asynchronous (e-learning) and synchronous (online live lectures) forms of communication are used. Communication also takes place in asynchronous (e-mail, discussion fora) and synchronous (online live lectures) forms. In contrast to platforms that focus purely on downloading materials, this is an e-learning offering based on scientific findings. The e-med platform was realized with these aspects in mind. During the web-based studies, tutors (medical specialists) and lecturers are available via a hotline. Technical support is guaranteed. The platform and the presentation of the teaching and learning content were already highlighted as very positive during the reaccreditation of the study programmes [Accredited study programmes and higher education institutions | Stiftung Akkreditierungsrat/(July 2021)].

The practical courses are held in conventional teaching formats. For

Table 1

Functions of learning management Systems

(Source: <http://www.e-teaching.org/technik/distribution/learnmanagementsysteme/funktionen/>).

Function	Supported activities
Authors tools	Preparation of learning content for the internet, also by enriching it with different media (image, audio, animation, etc.) and in the form of exams/tests; usually no programming knowledge required.
Course administration	Compilation of the prepared content into larger units; definition of time windows in which the content can be accessed; definition of filters for adaptive course/test structure.
User management	Registrations; accounting; automatic invitation to specific events; compilation of teams; evaluation of examination/test results.
Roles and rights assignment	Determination of roles, content access
Communication functions	synchronous communication like chats, audio and/or video conferences; asynchronous communication like panels, e-mail etc.
Co-Working functions	Support for group working via whiteboard, group calendar, annotation function, joint editing of files etc.
Personalization	Support for individual work via bookmarks, individual calendar, individual note and annotation function

example, participants will find realistic conditions appropriate for surgery in the anatomical-surgical practical course. Classes are held in a tutor-student ratio of 4:1 or 2:1, ensuring an optimal supervision ratio. During the clinical internships, participants are given the opportunity to perform surgical procedures under supervision. Here, too, there is a tutor-student ratio of 1:1 for practical tasks. In addition, lectures are offered and web seminars are held that are equivalent to classroom seminars. This form of teaching is increasingly being used in the Specialized Orthodontics course, for example, to teach participants how to use telerradiographic analysis programmes. The format of case-based learning as a cloud application has been proven here. During the internships, the participants receive constant feedback on their skills from the tutors.

In the context of the accreditation of the study programmes, the concept was particularly convincing due to the support provided both during the internships and during the theoretical study portion.

The IMC's learning and teaching concept includes student-centred learning and teaching. In practice, this means.

Fig. 5. Gender distribution of graduates from 2004 to 2020.

- flexible learning paths, self-determined learning independent of place and time are offered and made possible.
- a variety of different teaching methods are offered and made possible by the e-learning platform and by the special blended learning concept.
- different didactic methods are used flexibly.
- regular evaluations and adaptations of the teaching methods and didactic methods have already been implemented.
- students are encouraged to learn independently, as part of the learning and teaching concept.
- lecturers provide adequate orientation and support.
- an appropriate procedure for dealing with student complaints is in place.

During the practical courses, what has been learned is then put into practice. There is the possibility to discuss and clarify not understood or complicated issues directly with the experts on site.

Examinations can be conducted as software-supported examinations (e-examinations) or as face-to-face examinations. Multiple choice exams are used specifically to test the knowledge of individual lessons. Competency-based knowledge examinations are conducted during face-to-face sessions and clinical internships.

All communication is carried out via the e-med platform. Thus, a chat, a forum and an online conference system are available to the students. These communication media are provided via a virtual seminar room.

In the module “Scientific work” the students are specifically prepared for the master thesis. They have to analyse, evaluate and present scientific work in term papers, and also have to write smaller scientific texts.

In summary, the following additional functions are provided by the e-med platform:

1. tutorial support via a web application developed and provided for this purpose during the preparation of the master’s thesis
2. group and team work via a developed and provided Own-Cloud
3. moderated work via the virtual conference system
4. case based learning via the virtual conference system
5. regular webinars with discussion and question sessions
6. e-mail contact through contact persons
7. support by the lecturers is guaranteed via a hotline. Technical support is also provided.
8. in the theoretical part of the course, participants have access to a pool of online exams for self-testing. A traffic light system is implemented within the platform, which then shows the participant their level of knowledge. The exams that conclude the basic and advanced courses inform the participant about his or her level of performance through the evaluation.

The IMC also offers support to participants after they have completed a training course through the use of telematics applications. This is done through online live consultations as well as online video support during surgeries for complicated treatment cases by the qualified training team.

14. Data, facts, evaluations

From 2004 to 2020, 1143 participants have successfully completed courses of study. Of these, 848 were male, 295 female. The graduates came from 55 countries.

The IMC programs are aimed at licensed dentists who want to specialize in dentistry or expand their existing treatment spectrum. This is a clientele in the age group of mid-20s and older. The age statistics of the graduates since 2003 show an accumulation of the middle age between 25 and 45 years, with the highest age group among the German participants in the interval between 31 and 35 years, and among the international participants in the interval between 25 and 30 years.

The age distribution of participants for the Implantology and Dental Surgery programme is as follows:

It can be concluded that, on the one hand, participants often start further qualification directly after undergraduate dental education, which usually includes clinical training, and, on the other hand, many participants often first gain experience in practices or even set up their own practice before they specialize further. In both cases, it is important to consider the compatibility of further training, career and family.

A decisive factor for the feasibility of the study courses is the fact that the web-based modules can be integrated into the everyday working life of a dentist/physician, i.e. they can be carried out during practice/clinic time. Since the participants are practicing dentists, they are very familiar with the knowledge and can individually recognize which areas they need to focus their study.

The dentists deal with patients who require implantological, periodontological, endosurgical or orthodontic treatment during their daily work in the practices. The contents of the web-based modules are thus illustrated in their everyday practice work. In this way, they can visualize the theory once again through their practical work and incorporate this workload into their daily practice.

The IMC has taken gender mainstreaming aspects into account since 2003 and offers women and men equal development opportunities, especially when returning to work.

The concept of blended learning is particularly suitable for taking gender mainstreaming into account. The free time management, the reduction of attendance through integrated online seminars as well as the independence of time and space are only a few aspects that facilitate the compatibility of career and family. Especially in the field of dentistry, there is an increased proportion of women (about 80% of students are female). A logical consequence is therefore to take this fact into account in continuing education and training. Unlike programmes at other institutions that offer only weekend seminars on an in-service basis - which are unfriendly for families and partnerships - the IMC has a unique advantage with its in-service offerings with regard to gender mainstreaming.

The IMC is increasingly trying to appeal to women. Considering that traditionally men are more interested in surgery and oral surgery and that the master programme “Implantology and Dental Surgery” has the most graduates since 2004, the proportion of women is 19% among German participants. Internationally, the proportion of female participants is 31%. In total women are represented with 25.8%. The reason that more international women graduated is that initially only the master programme “Implantology and Dental Surgery” and, only since 2019, the master programme “Specialized Orthodontics” were offered in German language. The study programmes Restorative and Aesthetic Dentistry and Periodontology are only offered in English language and the programme “Specialized Orthodontics” since 2012 in English. These master courses are traditionally chosen more by women. An increased proportion of women is expected in the fields of Orthodontics and Aesthetic dentistry. In order to attract more women also in the field of Implantology and Dental Surgery, the IMC offers e.g. further support for dental students after graduation. For more complex cases, graduates can treat their patients under the supervision of the IMC team and present cases in the IMC virtual conference system. To better highlight these unique points, special information sessions are offered online.

15. Summary/conclusion

It is undisputed that e-learning is indispensable in the field of postgraduate oral medical training and continuing education. As MacDonald et al. showed, during the Covid-19 pandemic, the teaching component was significantly improved compared to face-to-face learning before the pandemic. The authors therefore encourage the development of a blended learning approach in the delivery of postgraduate education.²⁴

Many offerings have become established and have also proven their worth. The advantages are obvious. Face-to-face courses are time-

consuming and costly, whereas online training is convenient because it can be conducted at any time and from any location. This makes it easy to meet the training requirements.

Do these courses meet the quality requirements and do they fulfill the criteria for evidence-based knowledge transfer? It is often difficult for dentists interested in continuing education to recognize the quality of a continuing education course. A major problem in learning practical skills, especially in surgical disciplines, is the insufficient practical training during the study and also afterwards. A recent study published in the Bulletin of the Royal College of Surgeons of England (2021) shows that the practical training time for trainees in trauma and orthopaedics is significantly reduced and that therefore all training opportunities must be used optimally. To ensure the continued production of the highest-quality future surgeons within a reduced time frame for training, it is crucial that all training opportunities are maximised.²⁵

A review of mastering learning outside medicine shows that 'doing' is universal in achieving expertise. In chess and in music, the universal requirement to gain mastery is deemed to be 10,000 h of deliberate practice. On virtually every measurable indicator of surgical performance (including number of complications and even mortality), greater experience 'doing' leads to better results. But, just 'doing' alone is not enough. It therefore appears that both 'doing' and 'thinking' are inextricably linked, and are both mutual and symbiotic. Surgery could therefore best be described as a combination of 'doing, thinking and interacting with others'.²⁶

Another challenge in e-learning continuing education is the social integration of students through technical and didactic measures. It has been shown that collegial exchange among learners has a positive effect on learning success. Likewise, to ensure learning success, a supervisor is necessary in an e-learning training course to support the direct learning process.²⁷

Here, the concept of blended learning is suitable as almost unanimously confirmed in the literature.²⁸ In addition to supplementing e-learning with face-to-face events, blended learning is characterized by the possibility of expanding the variety of methods. For example, group assignments are conceivable, which can be carried out not only in face-to-face phases, but also by integrating cloud applications. Case-based learning with online live discussions in terms of problem-based learning offer another aspect of the use of blended learning concepts.

Internet-based blended learning studies, as implemented at IMC, provide a combination of self-study, direct supervision by the instructor, and communication exchange with fellow students. This combined form of internet-based learning and online live lectures represents a way of imparting knowledge that promotes independent learning.

The effectiveness and relevance of the use of blended learning, learning and teaching concepts in biotechnology, dentistry and medicine has been proven in scientific studies, including many international studies. For example, a study at the Public Health School, Tehran University of Medical Science, showed that blended learning methods increase the learning rate of students and increase their knowledge, satisfaction and attention.²⁹ In a randomized controlled trial in an undergraduate biochemistry programme at Columbia University, New York, it was shown that the use of blended learning methods improved exam performance and student satisfaction.¹⁶

The IMC builds on blended learning as academic knowledge transfer in its overall concept. Since 2003, the concept has proven its worth. It is open to all new developments in digitization. After testing, the new possibilities are integrated and made available to interested medical and dental professionals.

Through its many years of experience in setting up and further developing the e-med platform, the IMC has built up a bundled competence that, unlike isolated e-learning projects that focus on a specific integrated technology, includes all available technologies. Thus, at the technical level, a platform has emerged that has proven to be the basis for a digital postgraduate oral medical school and could be applied

universally and internationally with ease.

According to Boeker and Klar successful establishment and further development is characterized less by technical aspects than by didactic and organizational aspects.²³ The concept of IMC confirms this. The didactic preparation and processing of the content to be conveyed represents a core element of digital knowledge transfer. The IMC has been dedicated to this since 2003. Here, too, further developments are taking place using the latest findings in teaching and learning theories and didactics. Due to new possibilities of technology (cloud computing, streaming, etc.) the contents are adapted accordingly by specially trained dentists, doctors and scientists.

The organization of the entire teaching operation is also realized via the e-med platform. The IMC has a complete university administration system.

To return to the questions from the beginning, the experiences of the International Medical College as an overall concept for blended learning allow us to state the following:

- The acceptance and successful establishment of e-learning depend on a convincing concept of technology, didactics, support, personal contact and exchange, as well as on the qualification of the instructors.
 - In order to establish high-quality postgraduate training as a blended learning concept, e.g. in the form of a digital postgraduate university, which then also benefits patients, the participation of universities, professional governing bodies and politics is necessary in order to jointly define guidelines and bundle the offers.
 - This would then also answer the questions of optimized use and broad access and use of e-learning offerings
- The main statements of the article can be summarized as follows:
- E-learning has been established in postgraduate oral medical training and continuing education.
 - Online continuing education is convenient because it can be conducted independent of time and place.
 - The challenge of e-learning training is the social integration of students through technical and didactic measures. The concept of blended learning is suitable for this.
 - In addition to supplementing e-learning with face-to-face events, blended learning is characterized by the possibility of expanding the variety of methods.
 - The acceptance and successful establishment of e-learning offerings depend on a convincing concept of technology, didactics, support, personal contact and exchange as well as on the qualification of the teachers.
 - In order to establish high-quality postgraduate training as a blended learning concept, e.g. in the form of a digital postgraduate university, which then also benefits patients, the participation of universities, professional governing bodies and politics is necessary.
 - Given all of the aforementioned, this approach to teaching in medicine and dentistry can be applied on a global scale and be adopted as a method of further training for all.

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