REVIEW ARTICLE

Core Competencies needed for performing effective digital teaching by medical teachers

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Background: The digital teaching is quite different from the traditional in-person classroom teaching. The purpose of the thematic review was to identify the development and future prospects of digital teaching with reference to medical and dental teachers as well as to identify any published competency frameworks in this regard.

Method: The authors conducted a thematic review of the relevant literature published between1994-2022. The databases searched included PubMed, Education Resources Information Center (ERIC), and Google Scholar. Manual search was also carried out so as not to miss any relevant published literature.

Results: The initial search yielded 31,389 publications. At the search phase, the identification of publications was based on the titles of the publications. At the screening phase, 31,322 records were excluded because of their being irrelevant or duplicated. The remaining 67 articles were further screened by reading the abstracts. Out of these 67 publications, 24 were excluded because of being non-relevant. At the appraisal phase, 43 publications were assessed for eligibility. At final synthesis phase of the literature review, 26 publications were included.

Conclusion: The available published literature on digital teaching was focused predominantly on primary and secondary school students. The digital competency frameworks were designed for the transfer of the knowledge component and dealt mostly with children. These frameworks did not meet the specific requirements of medical teachers. The latter have to transfer not only the knowledge domain, but also teach clinical skills and professional attitudes to their adult learners. Hence, they need a framework which should provide for these added competencies and real-life, patient-oriented clinical scenarios.

Keywords: Digital Teaching, Online Teaching, e-learning, Digital Teaching Competency Frameworks, Medical Teachers

الكفاءات الأساسية اللازمة لأداء التدريس الرقمي الفعال من قبل معلمي الطب

الخلفية: يختلف التدريس الرقمي تمامًا عن التدريس التقليدي في الفصول الدراسية الشخصية. كان الغرض من المراجعة المواضيعية هو تحديد تطور التدريس الرقمي وآفاقه المستقبلية مع الإشارة إلى معلمي الطب وطب الأسنان بالإضافة إلى تحديد أي أطر كفاءة منشورة في هذا الصدد.

الطريقة: أجرى المؤلفون مراجعة موضوعية للأدبيات ذات الصلة المنشورة بين عامي ١٩٩٤ و٢٠٢٢. وشملت قواعد البيانات التي تم البحث فيها PubMed، ومركز معلومات الموارد التعليمية (ERIC)، والباحث العلمي من Google. تم إجراء البحث اليدوي أيضًا حتى لا تفوت أي مؤلفات منشورة ذات صلة.

النتائج: أسفر البحث الأولي عن ٣١٣٨٩ منشورا. في مرحلة البحث، تم تحديد المنشورات بناء على عناوين المنشورات. في مرحلة الفحص، تم استبعاد ٣١,٣٢٢ سجلاً لأنها غير ذات صلة أو مكررة. تم فحص المقالات الـ ٦٧ المتبقية من خلال قراءة الملخصات. ومن بين هذه المنشورات الـ ٦٧، تم استبعاد ٢٤ منها لأنها غير ذات صلة. في مرحلة التقييم، تم تقييم ٤٣ منشورا للتأكد من أهليتها. في مرحلة التوليف النهائية لمراجعة الأدبيات، تم تضمين ٢٦ منشورا.

الاستنتاج: تركز الأدبيات المنشورة المتاحة حول التدريس الرقمي في الغالب على طلاب المدارس الابتدائية والثانوية. تم تصميم أطر الكفاءة الرقمية لنقل المكون المعرفي وتعاملت في الغالب مع الأطفال. هذه الأطر لم تلبي المتطلبات المحددة لمعلمي الطب. ولا يتعين على هؤلاء نقل مجال المعرفة فحسب، بل يتعين عليهم أيضًا تعليم المهارات السريرية والمواقف المهنية للمتعلمين البالغين. ومن ثم، فهم بحاجة إلى إطار عمل يوفر هذه الكفاءات الإضافية والسيناريوهات السريرية الموجهة نحو المريض من واقع الحياة.

الكلمات المفتاحية: التدريس الرقمي، التدريس عبر الإنترنت، التعلم الإلكتروني، أطر كفاءة التدريس الرقمي، معلمي الطب

طبی اساتذہ کے ذریعہ موثر ڈیجیٹل تدریس کو انجام دینے کے لئے بنیادی قابلیت کی ضرورت ہے

پس منظر: ڈیجیٹل تدریس روایتی ذاتی طور پر کلاس روم کی تدریس سے بالکل مختلف ہے۔ موضوعاتی جائزے کا مقصد میڈیکل اور ڈینٹل اساتذہ کے حوالے سے ڈیجیٹل تدریس کی ترقی اور مستقبل کے امکانات کی نشاندہی کرنا تھا اور ساتھ ہی اس سلسلے میں کسی بھی شائع شدہ اہلیت کے فریم ورک کی نشاندہی کرنا تھا۔

طریقہ: مصنفین نے ۱۹۹۴-۲۰۲۲ کے درمیان شائع ہونے والے متعلقہ لٹریچر کا موضوعی جائزہ لیا۔ تلاش کیے گئے ڈیٹا بیسز میں پب میڈ، ایجوکیشن ریسورسز انفارمیشن سینٹر (ERIC) اور گوگل اسکالر شامل تھے۔ دستی تلاش بھی کی گئی تاکہ کوئی متعلقہ شائع شدہ لٹریچر چھوٹ نہ جائے۔

نتائج: ابتدائی تلاش سے ۳۱٬۳۸۹ اشاعتیں برآمد ہوئیں۔ تلاش کے مرحلے میں، اشاعتوں کی شناخت اشاعتوں کے عنوانات پر مبنی تھی۔ اسکریننگ کے مرحلے میں، ۳۱٬۳۲۲ ریکارڈز کو ان کے غیر متعلقہ یا نقل ہونے کی وجہ سے خارج کر دیا گیا تھا۔ باقی ٦٧ مضامین کو خلاصہ پڑھ کر مزید اسکریننگ کیا گیا۔ ان ٦٧ اشاعتوں میں سے ٢٤ کو غیر متعلقہ ہونے کی وجہ سے خارج کر دیا گیا۔ تشخیص کے مرحلے میں، اہلیت کے لیے ٤٣ اشاعتوں کا جائزہ لیا گیا۔ ادب کے جائزے کے حتمی ترکیب کے مرحلے میں، ٢٦ اشاعتیں شامل کی گئیں۔

نتیجہ: ڈیجیٹل تدریس پر دستیاب شائع شدہ لٹریچر بنیادی طور پر پرائمری اور سیکنڈری اسکول کے طلباء پر مرکوز تھا۔ ڈیجیٹل قابلیت کے فریم ورک کو علم کے جزو کی منتقلی کے لیے ڈیزائن کیا گیا تھا اور زیادہ تر بچوں کے ساتھ نمٹا گیا تھا۔ یہ فریم ورک طبی اساتذہ کی مخصوص ضروریات کو پورا نہیں کرتے تھے۔ مؤخر الذکر کو نہ صرف علم کا دائرہ منتقل کرنا ہوگا بلکہ اپنے بالغ سیکھنے والوں کو طبی مہارت اور پیشہ ورانہ رویہ بھی سکھانا ہوگا۔ لہذا، انہیں ایک فریم ورک کی ضرورت ہے جو ان اضافی قابلیتوں اور حقیقی زندگی، مریض پر مبنی طبی منظرنامے فراہم کرے۔

مطلوبہ الفاظ: ڈیجیٹل ٹیچنگ، آن لائن ٹیچنگ، ای لرننگ، ڈیجیٹل ٹیچنگ کمپیٹینسی فریم ورکس، میڈیکل ٹیچرز

شایستگی های اصلی مورد نیاز برای اجرای آموزش دیجیتال مؤثر توسط اساتید پزشکی

زمینه و هدف: آموزش دیجیتال با آموزش حضوری سنتی کاملاً متفاوت است. هدف از این مطالعه مروری، شناسایی توسعه و چشم انداز آینده آموزش دیجیتال با ارجاع به اساتید پزشکی و دندانپزشکی و شناسایی هر گونه چارچوب شایستگی منتشر شده در این زمینه بود.

روش: نویسندگان یک بررسی موضوعی از متون مربوطه منتشر شده بین سال‌های ۱۹۹۴-۲۰۲۲ انجام دادند. پایگاه‌های اطلاعاتی جستجو شده شاملPubMed ، مرکز اطلاعات منابع آموزشی (ERIC) و Google Scholar بود. جستجوی دستی نیز انجام شد تا متون منتشر شده مرتبط از قلم نیفتد.

یافته ها: جستجوی اولیه به ۳۱۳۸۹ منبع منتشر شده دست یافت. در مرحله جستجو، شناسایی نشریات بر اساس عناوین نشریات انجام شد. در مرحله غربالگری، ۳۱۳۲۲ رکورد به دلیل نامربوط یا تکراری بودن حذف شدند. ۶۷ مقاله باقی مانده با خواندن چکیده ها بیشتر مورد بررسی قرار گرفتند که ۲۴ مقاله به دلیل غیر مرتبط بودن حذف شدند. در نهایت در مرحله سنتز نهایی مرور متون، ۲۶ مقاله گنجانده شد.

نتیجه‌گیری: متون منتشر شده موجود در مورد آموزش دیجیتال عمدتاً بر دانشجویان سال اول و دوم متمرکز بود. چارچوب‌های شایستگی دیجیتال برای انتقال مؤلفه دانش طراحی شده‌اند و بیشتر با کودکان سروکار دارند. این چارچوب ها نیازمندی های خاص اساتید پزشکی را پوشش نمی داد. درحالیکه باید نه تنها حوزه دانش را انتقال دهد، بلکه مهارت های بالینی و نگرش های حرفه ای را نیز به یادگیرندگان بزرگسال خود آموزش دهد. لذا چارچوبی نیاز است که این صلاحیت های افزوده و سناریوهای بالینی واقعی و بیمار محور را فراهم کند.

واژه‌های کلیدی: آموزش دیجیتال، آموزش آنلاین، آموزش الکترونیکی، چارچوب‌های شایستگی تدریس دیجیتال، معلمان پزشکی

INTRODUCTION

Digital teaching, online teaching, or e-learning are often used interchangeably. These terms are employed to refer to the various means in which digital media are used or networked information technologies are employed for educational purposes (1). At the turn of the 21st century, the information technology (IT) revolution resulted in rapid digitalization in every walk of life. This also triggered a transformation in the dynamics of medical teaching and learning (2). In this process of change, the teachers and IT employees of medical and dental teaching institutions have been faced with challenges of digital improvements and pedagogical innovations. The digital teaching and e-learning have now become established realities. The primary focus has been on effective integration of technology and internet for enhanced learning. Institutions have developed their virtual learning environments (VLEs), learning management systems (LMSs), course management systems (CMSs), and massive open online courses (MOOCs) (3, 4).

Lack of digital skills or lack of awareness about the dynamics of digital learning environments hinders the teachers from effectively performing their emergent professional role as digital teachers. Since March 2020, the looming threat of COVID-19 pandemic has posed unprecedented challenges in medical education. There has been a compelling need to adapt the digital teaching formats (1, 5).

Considering the complex dynamics of virtual learning environments, digital teaching competencies are not easy to define exactly particularly for medical teachers. This literature review was undertaken to identify the development and future prospects of digital teaching and e-learning. The literature relevant to the evolution of digital teaching competency frameworks or models was also reviewed in detail.

METHODS

It was a thematic review of the published literature. According to the standard protocols, the databases of PubMed/ MEDLINE, Education Resources Information Center (ERIC), and Google Scholar were searched for literature review using the relevant phrases and keywords. Manual search was also carried out so as not to miss any relevant published literature.

The review question was: What are the core competencies required for efficient digital teaching of the e-learners especially the medical and dental students?

The Key words and Medical Subject Headings (MeSH) Words employed for the search were:

- Medical teacher
- Digital competence
- Digital competence framework
- Digital competence profile
- Information and communication technology (ICT) standards.

The Synonyms used for the search included:

- Medical educator,
- Teacher,
- Educator.

The Boolean Operators employed for the search were as follows:

Boolean Operators, asterisks and MeSH words were used to refine and focus the search on PubMed. The search string employed for PubMed was as follows:

(Medical teacher* OR medical educator* OR teacher* OR educator*) AND (digital competence* OR digital competence framework* OR digital competence profile* OR ICT standards)

Inclusion criteria: All publications relevant to the research questions and objectives published from 1994 and onwards were included.

Exclusion criteria: Abstracts only, conference proceedings, citations only, thesis and dissertations and non-relevant data were excluded.

RESULTS

The results of the literature search are summarized in the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow chart (Figure 1).

At the final synthesis phase of the literature review, 26 publications were included. Table 1 summarizes the critical appraisal of the most relevant publications regarding digital teaching competency frameworks (3-14).

DISCUSSION

In this literature review, exploration of the topic of digital teaching or e-learning identified the following major themes: 1) Digital teaching; 2) the digital revolution; 3) importance of the digital competency of the teachers; 4) new challenges posed by the digital teaching; 5) strategies to age the challenges posed by digital teaching, and 6) published competency frameworks regarding digital teaching.

Digital teaching and digital connectivity have now emerged as big avenues for communication and exchange of knowledge. These communications could be fashioned in synchronous or asynchronous ways (4, 15, 16). There are several ways to share digital content with other individuals, for instance, sharing them through the virtual classrooms or their uploading on digital repositories of the educational institutions. This could be accessed by the teachers and students with disregard to their geographic locales or time zones (17).

At the turn of the current century, we witnessed a powerful digital revolution. It revolutionized all aspects of human life with digital transformation (1). The dynamics of medical education also changed remarkably. For medical teachers, institutions and IT professionals, this revolution offered both challenges as well opportunities (17). The medical teachers have to enhance their digital skills and pedagogical approaches (18). The medical institutions are developing their digital infrastructures with VLEs, LMSs and MOOCs (19-21).

The digital revolution has been challenging the traditional roles of the teachers. They are no more sages on the stage, but guides on the side. Instead of being mere information providers, they have to serve as innovative managers of student's learning needs (4). They have to be flexible enough to employ all emerging useful technologies in their teaching

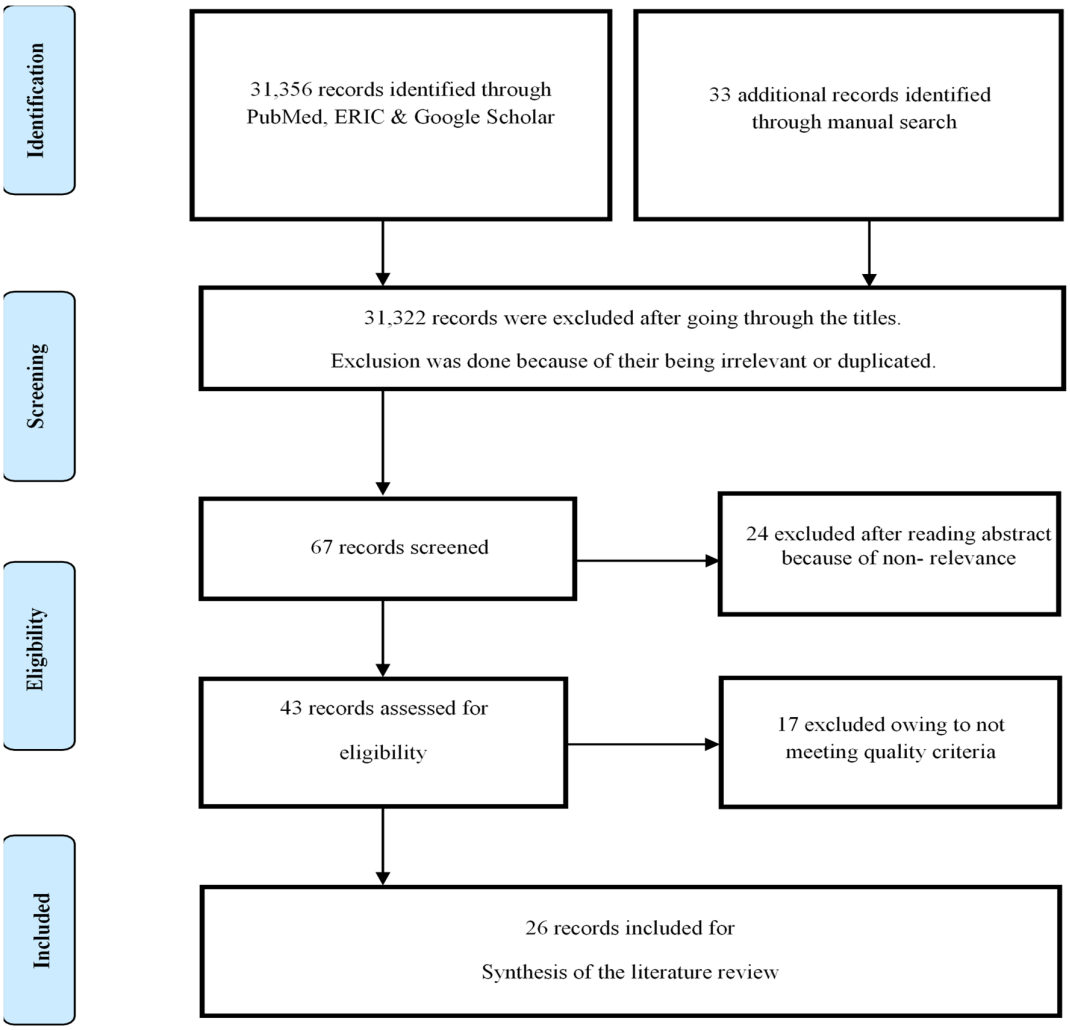

Figure 1. PRISMA Flow Chart: Search results based on PRISMA 2009 categorization

Table 1. Critical appraisal of the digital competency frameworks published in the reviewed articles.

	Author/ Year of Publication	Study design, Research Questions (RQs)	Participants/ Sample, and Data collection	Key findings/ Emergent themes
1	Ally M. /2019 (3)	Qualitative study. **RQs:** 1-What are the forces shaping the future of education? 2-What competencies (in terms of knowledge and skills) are required by digital teachers of the future?	Data were collected from 34 experts through focus groups and interviews. They belonged to six different countries (i.e., Austria, Canada, China, Greece, Malaysia, and Sweden). The experts had experience in using the emerging technologies and innovative pedagogies such as the MOOCs, artificial intelligence (AI), augmented reality (AR), virtual reality (VR), online learning, and mobile learning.	**A**-Nine major themes emerged for the digital teacher of the future. These themes covered 105 competencies. The themes included the following: 1-General competencies. 2-Digital technology usage. 3-Development of digital learning resources. 4-Re-mixing the learning resources. 5-Communication with learners. 6-Facilitation of learning. 7-Pedagogical strategies. 8-Assessment. 9-Personal traits. **B**-The experts narrated a variety of forces that they thought were shaping the future of education. e.g., the emerging technologies, the new generations of learners and the phenomenon of globalization.

Table 1. Continued

	Author/ Year of Publication	Study design, Research Questions (RQs)	Participants/ Sample, and Data collection	Key findings/ Emergent themes
2	Philipsen B et al/ 2019. (4)	Systematic review. **RQ:** What are the important components of teacher professional development (TPD) for online and blended learning (OBL)?	Qualitative data from 15 articles were included in the systematic review. Six different synthesized findings were identified and integrated into a visual framework, constituting the key components of TPD for OBL.	The synthesized findings included: 1-Design and development of a supportive TPD for OBL program and environment. 2-Acknowledgement of the existing context towards OBL. 3-Addressing the teacher change associated with the transition to OBL. 4-Determination of the overall goals and relevance of TPD for OBL. 5-Acknowledgement of the teacher professional development strategies associated with the change to OBL. 6-Evaluation of the TPD and the dissemination of the knowledge, skills, and attitudes.
3	Redecker C./ 2017. (6)	Research publication, produced by the Joint Research Centre (JRC), European Union.	The DigCompEdu framework is the result of different professional meetings, workshops, debates and deliberations with experts and professionals. It is based on a review and synthesis of existing tools at the European and international levels.	The framework has come up with the following six main themes: 1-Professional engagement. 2-Digital resources. 3-Teaching and learning. 4-Assessment. 5- Learners' empowerment. 6-Facilitation of learners' digital competence. The framework has highlighted the following six proficiency levels: A1: Newcomer A2: Browser B1: Integrator B2: Expert C1: Leader C2: Pioneer
4	Carretero et al/ 2017. (7)	-Ditto-	-Ditto-	The framework has proposed the following five competency areas: 1-Information and data literacy. 2-Communication and collaboration. 3-Creation of digital content. 4-Cyber security management. 5-Problem solving, especially conceptual problems in the digital environments. The framework has identified eight proficiency levels. These levels pertain to the following four domain areas: 1-Foundation. 2-Intermediate. 3-Advanced. 4-Highly advanced.
5	Mishra & Koehler /2006. (8)	The TPACK framework is based primarily on addressing the RQ posed by Shulman (1986) i.e., How does the teachers' understanding of educational technologies and pedagogical content knowledge interact with one another to produce effective technology-based teaching? The second RQ is: How to effectively combine technological, pedagogical and content knowledge with the use of digital resources to enhance subject knowledge outcomes?	The TPACK has resulted from the ingenious efforts of the authors to explore and establish the relationships between the core competencies of knowledge and pedagogical approaches with efficient use of technology for enhancing teaching and learning in the educational institutions.	The TPACK presents a holistic model that tries to link the relationship between technological, pedagogical and content knowledge. The main focus is on efficient integration of technology for enhanced learning; hence technology enhanced teaching and learning. The TPACK model identifies the following three major competencies essential for efficient teaching: 1-Technical and technological competence. 2-Discipline and content knowledge competence. 3-Pedagogical and learning design competence. Aforementioned are the core competencies needed for efficient teaching. These should integrate meaningfully to constitute a solid basement, upon which productive, creative and innovative teaching practices shall be established. The use of digital resources helps to enhance the efficacy of teaching and learning.

Table 1. Continued

	Author/ Year of Publication	Study design, Research Questions (RQs)	Participants/ Sample, and Data collection	Key findings/ Emergent themes
6	Falloon /2020. (9)	The conceptual framework of the TDC was based on the work of Janssen et al, 2013. It positions Janssen et al.'s general competencies within the context of teacher education. It extended it further by introducing 'teaching specific' competencies aligned with the TPACK. It also integrated personal/ethical and personal/professional competencies with the already known competencies.	The TDC model was an extension and further elaboration of the original TPACK model.	The main focus of this framework was on the further expansion and elaboration of the core competencies outlined in the aforementioned TPACK model. It emphasized on the technical and technological skills which are required to integrate the digital resources to enhance the efficacy of teaching and learning. The model included the following core competencies: 1-Technical and technological competence. 2-Discipline and content knowledge competence. 3-Pedagogical and learning design competence. 4- Competencies regarding personal-ethical aspects. 5- Competencies relating to personal-professional aspects. The last two competencies have been added to further enhance the efficiency of teacher.
7	Puentedura RR./ 2013. (10)	The SAMR model was created by Puentedura, initially in 2006. Its aim was to provide a framework for the integration of technology in educational activities. It provided a hierarchical progression of the use of technology in an increasingly complex fashion. **RQ**: How to effectively combine technological, pedagogical and content knowledge to use digital resources to enhance subject knowledge outcomes?	The SAMR is a framework that provided description or mapping of the various educational uses of technology in a simple progressive or hierarchical fashion. The hierarchies started from digital Substitution of activities which are classically carried out through conventional means. The hierarchies ended at Redefinition which denoted the digital transformation of various educational attributes of curriculum, pedagogies and teaching practices. SAMR has been widely adopted by teacher educators.	The model identified the following four levels of technology integration in education: 1-Substitution: At this stage, "technology acts as a direct tool substitute with no functional change" 2-Augmentation: At this stage, the technology acts as a direct substitute, with functional improvement. 3-Modification: At this stage, the technology allows for significant task redesigning. 4- Redefinition: At this stage, the "technology allows for the creation of new tasks, previously inconceivable" (Geer, White, Zeegers, Wing, & Barnes, 2017; Hilton 2016).
8	Butcher /2018. (11)	ICT competency standards for Teachers. Research publication, by The United Nations Educational, Scientific and Cultural Organization (UNESCO).	The competency standards were based on the deliberations of experts and educationists.	This framework highlighted the use/ understanding of ICT in six fundamental dimensions of the professional teaching practice: 1-Educational policy and vision. 2-Curriculum and evaluation. 3-Pedagogy. 4-Application of digital skills. 5-Organization and administration. 6-Professional learning. The proficiency levels included acquisition of basic notions, deepening of knowledge and knowledge generation.
9	Crompton S./ 2017. (12)	ISTE Standards. Research publication, by the International Society for Technology in Education.	-Ditto-	These standards described seven roles or profiles that a teacher should progress through, in the process of his professional development. These included the following: 1-Apprentices. 2-Leaders. 3-Citizens. 4-Collaborators. 5-Designers. 6-Facilitators. 7-Analysts.

Table 1. Continued

	Author/ Year of Publication	Study design, Research Questions (RQs)	Participants/ Sample, and Data collection	Key findings/ Emergent themes
10	Education and Training Foundation /2019). (13)	British Digital teaching framework. Research publication, produced in the UK, by the joint collaboration of the Education and Teaching Foundation (ETF) and the Education and Training Foundation. The objective was to increase the understanding of teachers in the use of digital technologies to enrich their teaching practices and improve their professional development.	-Ditto-	This framework consisted of seven key areas. The seven elements were: 1-Pedagogical planning. 2- Pedagogical approach. 3-Student's employability 4-Specific teaching. 5-Evaluation. 6-Accessibility/ inclusion. 7-Self-development. There were three proficiency levels described for each of the above-mentioned areas. These included exploration, adaptation and leadership.
11	INTEF /2017. (14)	INTEF Framework, Spain. Research publication, produced by the INTEF. The objective of the INTEF was to ensure the development of a practice that promoted the inclusion of ICT in the classrooms of the different educational spaces as well as initial and permanent training.	-Ditto-	The following five competence areas were identified: 1-Information and information literacy. 2-Communication and collaboration. 3-Creation of digital contents. 4-Security. 5-Problem solving. The following three proficiency levels were described: • Basic, • Medium and • Advanced

formats and instructional strategies (22, 23). They should acquire the relevant digital knowledge, skills, and positive attitudes in this regard (24, 25). They should receive training on the integration of technological knowledge, pedagogical knowledge and content knowledge (TPACK) (26).

The published frameworks regarding digital teaching competencies are generic and not specific to medical education. A comprehensive summary of some of these frameworks is presented in table 1.

Limitations of the study and future recommendations

Firstly, this review was carried out by three medical educational researchers from Pakistan. It was not carried out through international collaboration. Future studies should focus on international collaborative efforts in this regard. Secondly the search results are based on the relevant publications spanning from 1994 and onwards. The review did not include publications before 1994. Thirdly the review didn't include gray literature which was not formally peer-reviewed. For instance, the conference proceedings, abstracts or citations only, and publically unpublished dissertations.

The findings of the review shall serve as impetus for the planning and execution of more robust studies internationally in future. These studies shall help to evolve the necessary competency profile for digital medical teachers.

CONCLUSION

The available published literature on digital teaching was focused predominantly on primary and secondary school students. The digital competency frameworks were designed for the transfer of the knowledge component and dealt mostly with children. These frameworks did not meet the specific requirements of medical teachers. The latter have to transfer not only the knowledge domain, but also teach clinical skills and professional attitudes to their adult learners. Hence, they need a framework which should provide for these added competencies and real-life, patient-oriented clinical scenarios.

Ethical considerations:

Ethical issues including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc. have been completely observed by the authors.

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