Impact of Artificial Intelligence on Dental Education

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Most dental educators have limited knowledge and skills to assess AI applications, as they were not trained to do so. Also, AI technology has evolved exponentially. Factual reliability and opportunities with OpenAI Inc.'s ChatGPT are considered critical inflection points in the era of generative AI. Updating curricula at dental institutions is inevitable as advanced deep-learning approaches take over the clinical areas of dentistry and reshape diagnostics, treatment planning, management, and telemedicine screening. With advances in AI language models, communication with patients will change, and the foundations of dental education, including essay, thesis, or scientific paper writing, will need to adapt. However, there is a growing concern about its ethical and legal implications, and further consensus is needed for the safe and responsible implementation of AI in dental education.

Keywords: AI ; generative AI ; AI academic implementation ; ChatGPT ; Dental education

1. Introduction

Current clinical trends and research advances in utilizing Artificial Intelligence (AI) in dentistry have experienced spectacular development and growth over the past two decades. It took more than a decade for three-dimensional (3D) printing technology to disrupt existing dentistry workflows, which was considered an unprecedently rapid progress [1][2][3]. AI took less than half of this time to achieve a more significant impact on dentistry's clinical and pedagogical aspects. The coronavirus pandemic has accelerated the adoption of virtual technologies in dental education [4][5][6][7][8]. As the arrival of web 2.0 technologies induced a paradigm shift in e-learning more than a decade ago [9][10][11][12], now the new generation of released AI systems like ChatGPT represents a critical turning point in a series of AI release events [13][14][15][16].

3D scans with smartphones and applications to support AI diagnostics and therapy of patients are already commonplace in dentistry, but development is still ongoing. For instance, the dental community has expressed interest in using the metaverse. The metaverse is a virtual environment that simulates the natural world and could be used in dental education and telemedicine consultations. The use of the metaverse could also facilitate the use of blockchain technology and smart contracts in the dental industry [17][18][19]. The current AI-driven transformation of dental education can be viewed from two aspects:

(1)Impact on theoretical skillset, including soft skills and scientific research.

(2)Impact on practical/clinical skillset for the provision of dental health care.

A recent study by Lin et al. [20] explored the perceptions of high-performing undergraduate (UG) dental students in learning dental materials science. All employed learning strategies, including 'Memorizing and repeating', 'Peer learning', 'Search of resources', 'Study planning', 'Attention in classes', and 'Use of mnemonics' can be nowadays enhanced by modern technologies. Dental schools should ensure that the curriculum is underpinned by fundamental pedagogical theory and that the teaching approaches explicitly align with the student's learning strategies.

In this rapidly changing world, a core curriculum for dental education needs to be revised because health care is fundamentally changing, and teaching and learning methods are undergoing a radical transformation. Indeed, many benefits are foreseeable from the presence of AI in dentistry. For example, adapting the dental AI core curriculum can help increase dentists' AI literacy so that they can critically evaluate and consciously use AI applications [21][22].

Concerning dental education curricula and AI, a recent article by Schwendicke et al. [21] identified four domains of learning outcomes, with most outcomes at the "knowledge" level:

(1)Basic definitions and terms, the reasoning behind AI and the principle of machine learning, the idea of training, validating, and testing models, the definition of reference tests, the contrast between dynamic and static AI, and the

problem that AI is a black box and needs to be explained should be known.

(2)Use of case: the types of AI required for them should be taught.

(3)Consideration should be given to assessment measures, their interpretation, the relevant impact of AI on patient or community health, and relevant examples.

(4)Issues of generalizability and representativeness, explainability, autonomy and accountability, and the need for governance should be emphasized [21].

The goal of the Schwendicke team was to define a core curriculum for UG and postgraduate (PG) or graduate programs that established a minimum set of outcomes that learners should acquire when taught about dental AI [21].

The implementation of AI in dentistry is a relatively recent development, and the specific timeline for its adoption depends on the specific AI applications considered. Some possible examples of the use of AI in dentistry include:

(1)The use of machine learning algorithms to automate the interpretation of dental imaging procedures, such as radiographs and CT scans, which have been studied since the 1980s.

(2)The development of AI-powered tools to automatically detect dental caries and other oral diseases has been an active area of research since the 1990s.

(3)The use of AI to support dental diagnosis and treatment planning, which has been explored more recently and is still in the early stages of development.

At this point, the use of AI in dentistry is a rapidly evolving field, and the exact timeframe for its adoption depends on the specific applications, which are difficult to predict accurately, albeit it is inevitable that AI will significantly impact future dental education. The impact will be impossible to ignore and will likely depend on how AI is used and integrated into clinical practice and academic settings. Some potential changes that could result from the use of AI in dentistry include the following:

(1)A shift toward more evidence-based, data-driven dental diagnosis and treatment planning approaches.

(2)The use of digital diagnostic technologies, such as 3D imaging and machine learning algorithms, is greater in dental education.

(3)More emphasis is on training dental students to use and interpret AI-based diagnostic tools.

(4)The development of new educational resources and curricula that address AI and its applications in dentistry.

(5)Integrating AI-powered tools into dental simulations and other hands-on activities for dental students.

AI in dentistry will likely lead to a greater emphasis on technology and data analytics in dental education and a need for dental professionals to master these tools. Research shows that AI in dentistry is primarily used to evaluate digital diagnostic methods, particularly in interpreting oral and maxillofacial radiographs. However, it is also increasingly used in other general dentistry areas. Dental radiology and orthodontics are currently leading the way in implementing AI. This recent AI boom has been growing at an unprecedented rate of about 35% per year since 2017, fueled by the shift to advanced 3D/4D diagnostics and the availability of Big Data, accelerated by the pandemic [23].

It is evident that dental curriculums at universities need to be updated because of the AI paradigm shift. The use of AI in dentistry is an emerging field, and specifics about its incorporation into dental education depend on the availability and effectiveness of AI technology, as well as the willingness of universities to incorporate it. It is also essential to consider the potential ethical implications of using AI in dentistry and the need for dental professionals to be properly trained in its use. Ultimately, any decision to update dental curricula to include AI would need careful consideration and likely require input from experts in the field. Demand from dental students and clinical practice will be critical, as the benefits of AI to patients will be undeniable. Another aspect will be the rapid adaptability of students in implementing AI writing tools, which will force educators to rethink the instruction and student assessment in consideration of AI technology, which could become a gift for student cheaters, a powerful teaching assistant, or a tool for creativity.

Regarding the clinical aspect of dental education, it is currently difficult to define what dental students need to learn, as AI-powered software is just being developed, and application scenarios for AI applications are just being introduced. AI is

taking over digital image analysis, growth simulation and prediction, 3D and 4D data segmentation, and even patient management and communication workflows are being fundamentally disrupted. A deep understanding of the role of AI in these systems will be the subject of broader academic discussion, albeit priority will remain on the successful clinical use of these powerful tools. As the clinical use of AI in dentistry is still being explored and is dynamically changing, it will be possible to develop a more detailed notion of curriculum adaptation as current AI software matures.

From the aspect of theoretical education, including soft skills and scientific research and publication, it can be concluded that the AI introduction is poised to have a more substantial impact than the introduction of electricity. Thus, it shall be compulsory to have students understand at least basic principles and terminology regarding AI. There are already some general points that dental students should know about AI:

- What AI refers to, basic terminology, principles, and application examples.
- That AI is already used in all specializations in dentistry to help improve diagnosis, treatment planning, and other aspects of dental care.
- The use of AI in dentistry is still early, and more research is needed to determine its effectiveness, potential risks, and benefits.
- As future dental professionals using AI in their practice, they shall receive training and be aware of any potential ethical considerations.
- Using AI in dentistry will lead to more efficient and effective dental care. However, it is crucial to approach it cautiously and consider its potential impact on patients and the dental profession.

2. ChatGPT

The world of generative AI is rapidly evolving. On 30 November 2022, the public was given access to the AI-driven ChatGPT on OpenAI's website. ChatGPT was trained on a sea of digital text from the internet and fine-tuned on top of GPT-3.5 using supervised learning and reinforcement learning.

ChatGPT is an AI model developed by OpenAI that is specifically designed to generate human-like text in response to input. It is based on the Generative Pretrained Transformer 3 (GPT-3) architecture, a type of neural network that uses a large dataset of text to learn the patterns and structures of human speech. ChatGPT is like other AI models in that it uses machine learning algorithms to generate text based on input data. However, it is specifically designed to generate more natural and human-like responses than other AI models. It can also be trained on specific data sets or tasks to generate responses tailored to specific applications, such as chatbots or conversational agents. Compared to other AI models, ChatGPT has the advantage of being able to generate human-like responses that are more natural and fluid. This makes it a valuable tool for applications that require the ability to generate human-like text, such as chatbots or virtual assistants. However, it also has some limitations, such as the need for large amounts of data and computational resources to train and run the model [13].

There is a difference between ChatGPT, a new demonstration of this type of technology, and GPT-3, which has already been in use in various contexts. In terms of performance, ChatGPT is not as powerful as GPT-3, but it is better suited for chatbot applications. It is also generally faster and more efficient than GPT-3, making it a better choice for real-time chatbot systems. ChatGPT and GPT-3 are powerful language models, but they are designed for different purposes and have different strengths and weaknesses [24]. The conversational approach allows the new GPT option to respond to more dynamic interactions and will answer rather than ask. Unlike Chat GPT, which was explicitly trained for this purpose, GPT-3 was previously used by the end user to initiate an interaction. It uses a method known as reinforcement learning from human learning [25].

Various large language models have been introduced to generate texts that appear authentic but are inaccurate. The frequent errors reflect the general concerns of linguists that such artificial language models effectively operate via a trick mirror—learning the form of English without inherent linguistic skills that would demonstrate actual understanding. As the models grow in size and complexity over time, it becomes increasingly difficult to document the details of the data [26][27].

3. AI, Academia, and Legal Aspects

The world of generative AI is advancing rapidly. The essay has been at the center of humanistic pedagogy for generations. This age-old tradition is about to be disrupted from the ground up. Neither the engineers developing language technology nor the educators encountering the resulting language are fully prepared for the consequences. Humanities departments judge their students based on their essays. They award doctorates based on the composition of a dissertation. What happens if both processes can be largely automated? Stephen Marche estimates that it will take ten years for academia to come to grips with this new reality: two years for students to become comfortable with the technology, three more years for professors to realize that students are using the technology, and then five years for college administrators to decide what, if anything, to do. Teachers are already among the most overworked and underpaid people in the world. The humanities academic faculty are already dealing with a crisis [28].

Students today use thesauruses, grammar correction tools, or style guides available in all major word processing programs. They are not using someone else; the program is not someone else. The problem is using effective AI tools. Using AI for text generation may raise legal concerns related to plagiarism. Plagiarism occurs when they use someone else's work without proper acknowledgment or permission. In the context of AI texting, this can occur when a user passes off a text generated by a machine learning model as their work without properly citing the source or obtaining permission from the copyright holder. It is only a matter of time before the AI tools steering writing style, and syntax will be integrated into widely used commercial words processors like MS Word or Google Docs.

In general, it is essential to appropriately credit all sources used in a text, including AI-generated texts. This can usually be done by citing or referencing the AI model in the text or a footnote. Depending on the circumstances and laws of the country where the text is used, it may also be necessary to obtain permission from the copyright holder of the AI model before using the generated text. It is also crucial that students are aware of the potential legal implications of using AI for text generation and take steps to properly label and obtain permission for any generated text that is used in any work.

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