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Adopting Artificial Intelligence in Dental Education: A Model for Academic Leadership and Innovation

Nadim M. Islam, DDS, BDS[1], Lory Laughter, RDH, MS[2], Ramtin Sadid-Zadeh, DDS, MS[3], Carlos Smith, DDS, MDiv, FACD[4], Teresa A. Dolan, DDS, MPH[5], Geralyn Crain, DDS, PhD[6], Cristiane H. Squarize, DDS, MS, PhD[7]

1. Department of Oral & Maxillofacial Diagnostic Sciences. University of Florida College of Dentistry, Gainesville, FL
2. Department of Periodontics, University of the Pacific, San Francisco, CA
3. Department of Restorative Dentistry and Digital Technologies, University at Buffalo School of Dental Medicine, Buffalo, NY
4. Dental Public Health and Policy, Virginia Commonwealth University School of Dentistry, Richmond, VA
5. Chief Dental Officer, Overjet AI, Boston, MA
6. College of Dental Medicine, Roseman University of Health Sciences, South Jordan, UT
7. Laboratory of Epithelial Biology, Department of Periodontics and Oral Medicine, University of Michigan School of Dentistry, Ann Arbor, MI

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Corresponding Author:

Cristiane Squarize, DDS, MS
Laboratory of Epithelial Biology
Department of Periodontics and Oral Medicine
University of Michigan
1011 N University Ave
Ann Arbor, MI - 48109-1078
e-mail: csquariz@umich.edu

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ABSTRACT

The continual evolution of dental education, dental practice and the delivery of optimal oral health care is rooted in the practice of leadership. This paper explores opportunities and challenges facing dental education with a specific focus on incorporating the use of artificial intelligence (AI). Using the model in Bolman and Deal's Reframing Organizations, the Four Frames model serves as a road map for building infrastructure within dental schools for the adoption of AI. The framework suggested in this paper, while specific to AI, could be adapted and applied to a myriad of innovations and new organizational ideals and goals within institutions of dental education.

Keywords, Information Management/Computer Applications, Information Technology, Health Information Technology, Management System, Database, Learning Management Systems,

INTRODUCTION

Artificial Intelligence (AI), in general, refers to programs and machines that can project defined rules, learn from experience, and perform tasks that typically require human intelligence. The term Artificial Intelligence (AI) was first defined in the 1950s as "the science and engineering of making intelligent machines", and has long-standing roots since the first mathematical logic framework of AI was proposed. [1] AI has continued to evolve when the first federal investment for AI was made in 1963, and terms like "deep learning" and "expert system" were defined in the 1980s.[2] The development of AI underwent a significant revolution during the '90s with the development of statistical pattern recognition.[3] As algorithms became more sophisticated and processing speed and storage expanded, AI limitations dwindled. Since then, the field of AI has expanded drastically and AI now plays a central role in human lives.

One clear application of AI is processing large amounts of data, which might otherwise take too long or simply be impossible for a human to handle, such as identifying plagiarism in academic publications. In the healthcare field, AI is being used in the reading of radiology and histopathology images and providing treatment choices to healthcare professionals.[4, 5] In the dental field, different forms of AI have started to impact dental imaging and radiology, orthodontics, periodontology, endodontics, cariology, and forensic dentistry. [7-17] In restorative dentistry, AI technology is being developed for designing CAD-CAM generated prostheses such as framework design for removable partial dentures.[18, 19] Since dental schools will soon face the challenge of AI integration in the curriculum, the clinic, or to enhance operations of the institution, the purpose of this paper is to provide a possible scaffolding for the implementation of AI in a dental educational setting.

METHODS

The proposed framework for the implementation of AI in dental education is presented in a format that utilizes Bolman and Deal's Four Frames model, which views an organization from four different perspectives. Due to the complexity of organizations, Bolman and Deal suggest viewing an issue within an organization through multiple perspectives to gain deeper insight and address the issues in a more comprehensive manner. The four perspectives or frames are the Structural, Human Resource, Political and Symbolic frames.[20] The implementation of AI in a dental school, whether it is within the curriculum, the clinic, or to enhance operations of the institution, is a complex matter and lends itself to deeper understanding through the use of the Four Frames model. The sections below describe each of the four frames in greater detail within the context of their application in implementing AI in a dental school setting.

DISCUSSION

Structural Frame

In Bolman and Deal's Four Frames model, the Structural frame focuses on how an organization is organized to accomplish its work and includes such things as the hierarchy, delegation of responsibility, rules and regulations, and other elements that can affect the pursuit of organizational goals. As applied to our example of implementing AI, clearly defining roles and responsibilities, setting measurable targets, clarifying tasks, agreeing on metrics and deadlines, and creating various systems to support AI are key.

Two aspects central to an organization's structure are differentiation and integration. Differentiation refers to allocating work, and integration refers to coordinating this work once it is allocated. Within differentiation, or allocating work, a familiar model is the hierarchical or "top-

down, chain of command" organizational structure in which the senior administrative leaders make the majority of the organization's decisions, or at least, provide final approval. In contrast, another model is a more "flattened organization" in which decision making can occur outside or in coordination with the hierarchical channels. It stands to reason that due to its broader and inclusive nature, the "flattened organization" model could benefit from new unknown talents in the organization that might otherwise go unnoticed.

AI Strategic Planning Committee

An example of one structural element within a flattened model would be establishing an inclusive AI strategic planning committee where strategic decisions or recommendations are made with representation from multiple areas in the school, particularly those who will work closely with AI once it is implemented. The AI strategic planning committee could be composed of one or more individuals with interest or expertise in AI, and enthusiastic individuals that could include one or more course directors, interested faculty, staff, students, and administrators (e.g., the Dean, Assistant/Associate Dean, department chair, graduate program director, financial officer, IT expert, etc.).

Within the committee, smaller task force teams could be created to address targeted agendas to produce results more quickly. An AI strategic planning committee with task force subcommittees could increase teamwork and decrease bureaucratic and lengthy decision-making processes about the implementation of AI. Members of these subcommittees could be selected from faculty and staff members who are empowered to analyze information and take calculated risks in planning and decision-making surrounding AI. Ideally, in this "flattened" model, these

individuals would have the autonomy, accountability, and authority to make decisions or recommendations related to the school's AI initiatives.

Depending upon the level of expertise within the organization, consideration could be given to including an external voice on the committee or hiring a consultant to orchestrate the taskforce groups to streamline the process. During these meetings, the team might look into what has slowed down the implementation of past innovative ideas (e.g., electronic health records, digital dentistry), so that these obstacles could be avoided in the future. Obstacles within the structural frame can differ depending upon the individual setting.

One common obstacle associated with the implementation of innovations or change is faculty/staff resistance. Some structural elements that could be considered to mitigate resistance to the use of AI include presenting successful implementation models and examples in other institutions; demonstrating how the use of AI can increase efficiencies; setting up processes that allow broader participation in planning and decision-making; incentivizing enthusiastic faculty and staff; and excluding those who are not yet agreeable or who are resistant to the proposed ideas. Other obstacles that the committee or task force groups might need to consider include the limitations in hiring appropriate faculty, staff, and IT personnel, inadequate policies and procedures, and limited financial and other resources.

Communication

Once the differentiation or allocation of work is established, integration or the coordination of the work must occur. Decisions that are considered or that have already been made must be shared, and the importance of communication cannot be underestimated. To ensure that decisions are transferred to different units, the task force or committee members could bring decisions to

other meetings in the school, such as the executive council, town hall, department meetings, etc. This would not only enhance information sharing, it would facilitate receiving feedback from other units and provide an opportunity for voices to be heard. If the opposition forces are strong, the task force could consider inviting presenters to share examples of success in the field in similar settings.

Another method for soliciting feedback could include a survey of faculty, staff, students, alumni, and others to provide data to better understand attitudes and perceptions regarding AI technology and to plan future development and training accordingly. In addition, in order to generate "buy-in" and enthusiasm, the task force could find innovative methods to encourage innovation around the application of AI by providing start-up funds for faculty who create educational research around the application of AI, providing travel awards to faculty and staff members who are willing to learn how to incorporate AI in the curriculum, and by providing recognition, for example, during town hall meetings and newsletters, of those who are early adopters or innovators using AI technology in the school.

Curriculum Committee

If the aim is to incorporate AI technology more broadly into the curriculum, the curriculum committee and the academic dean should be considered an integral part of viewing the AI initiative through the structural frame. Course directors and faculty members who are part of the AI strategic planning committee could discuss the importance of AI technology within the curriculum committee meetings and foster the discussion for future changes. In order to cultivate an environment for shared decision-making around AI in the curriculum, the members could share with the curriculum committee examples of schools that have incorporated AI technology into existing courses, describe the advantages and obstacles, and point out how the AI could help

address possible shortfalls that the curriculum committee currently sees. Moreover, a pilot implementation of AI in a course could be conducted to determine student and faculty perceptions, to operationalize the incorporation of the AI technology, and to pilot outcomes assessment. The strategic incorporation using a pilot, together with positive perceptions and learning outcomes, could play a significant role in the future expansion of a school's AI initiative.

Human Resource Frame

In today's competitive environment, hiring and retaining the best talent requires a heavy lift from Human Resource (HR) teams. HR is expected to deliver great employee and candidate experiences across recruitment, training, and operations with speed, accuracy, and personalization. As viewed through Bolman and Deal's Human Resource frame, the things that employees need in order to do their job or to accomplish a desired goal come into focus. AI offers several ways that can support employees such as through the automation of some HR functions, enhancing the hiring process, and other innovative applications.

Automation

Chatbots, the friendly customer-facing feature of powerful behind-the-scenes algorithms, can now simulate person-to-person conversation very well. Available any time on any device, chatbots offer the immediate response time that today's users expect when they have hiring questions, benefits concerns, or training issues. In a dental school environment, faculty, students, staff and other employees can take advantage of this to query and receive immediate responses of day-to-day HR challenges avoiding in-person involvement. Subsequently, HR employees would be freed up to problem-solve more challenging situations.

Nothing beats analytics when it comes to the rapid identification of emerging trends and problems. If significant numbers of students or employees are asking the same questions or expressing similar concerns, you would know quickly and can move with speed to capitalize on opportunities to address problems before they escalate. In a dental school setting this can help by maintaining consistency in grading, calibration for preclinical courses and immediate feedback about clinical treatment outcomes.

Hiring

With the right solutions and technology partnerships, AI can strengthen recruiting, employer branding, hiring, and development of new employees. In addition, AI can enable a university to target and tailor their recruitment better and faster, making it more relevant for both the candidates and the HR team. Plus, with deeper insights into the audience, one can promote the dental school's culture and values in authentic, engaging ways, no matter who they are trying to reach. AI can also deliver important time savings in initial résumé screening. Today's AI capabilities increase efficiency and can assess an applicant's fit based on potential instead of past performance.

Opportunity to Innovate

Worth noting is that some dental schools have internal HR offices while others rely on university HR offices that lie outside of the dental school. An unexplored are of research could explore differences in workflow, processes, understanding of HR best practices and their operationalization in dental schools that are solely dependent on larger university support versus in-house HR support. Results of those studies could suggest the benefits of welcoming helpful technologies and being open to new ways of thinking and working every day.

As we integrate the best of people and technology during the pandemic, an unprecedented period of disruption in our working lives, now is the ideal time for forward-thinking HR leaders to prepare for profound and lasting change. Successful adoption of AI has the potential to enable HR teams to spend more time on the "human" part of human resources–listening to employees' voices and supporting their wellbeing–a winning situation for everyone. The approach of senior leadership has the potential to make all the difference. [21]

Political Frame

Bolman and Deal describe the Political frame as the realistic process of making decisions in an environment with divergent interests and limited resources.[20] Two important aspects of the political frame are power and conflict which often occur as a part of the decision-making process, particularly during periods of change. Power, which Bolman and Deal define as the capacity or potential to influence the behavior of others, is a currency within the day-to-day dental school organizational culture that requires our attention. Having the position may give an individual power but positional power is rarely enough to accomplish the task. [22] As stated by Bolman and Deal, those that get and use power to their advantage will be winners which makes it important for leaders to understand and effectively utilize the political frame.

In thinking through how leaders within a dental school can use power to drive transformative change, one must examine the competing agendas and priorities surrounding the implementation of AI that might be surface when considering such things as altering the status quo way of doing things, combatting fear of being replaced by technology, and generating positive buy-in from faculty. The dean and others should proactively consider the political roadblocks and levers when considering influencing factors including broader university goals, CODA

requirements, the dean's priorities, other administrator and faculty agendas, alumni and donor stakeholders' interests, and current and prospective student desires.

Leadership and Change

The manner in which change is driven and how leadership styles impact receptiveness to change across the organization cannot be underestimated. Is the dean leading the charge with a top-down approach, delegated the task to an associate or assistant dean, or is AI being implemented with a more collaborative or grass roots methodology such as a task force or standing committee? The political frame sees the academic leader as advocate, negotiator, and strategist. The political frame recognizes empowerment of individuals and groups across various coalitions as necessary and central to the accomplishment of any task. No matter what leadership structure is utilized, one must be careful to clearly allow for questioning and open debate - cornerstones of academic culture. [23]

Productive and forward moving dialogue must be given the opportunity to evolve into collaborative partnerships so that inquiry and discovery are not seen as disloyal or contributing to a toxic organizational culture. Senior leaders and other influencers should consider taking every opportunity to rationalize how AI technological advances will create: a) an educational advantage for current and prospective students; b) improved delivery of oral health care services; c) increased clinical revenues; and d) ensure a level of national prominence in education, research and clinical care that can help a school to remain competitive.

Communication

Communications plans are needed both internally and externally to optimize any change. A school might consider utilizing a team approach for gathering how AI technology is seen by the various stakeholders' groups including current and prospective students, the faculty, broader university members, CODA, etc. Communication plans should also include department level and town hall style meetings that could be used to address faculty and staff questions and buy-in. Department level and town hall meetings could be used to advance dialogue on how AI will positively impact the education of students, improve faculty and staff workflows, improve employee engagement, and contribute to an enhanced and more inclusive organizational climate and culture.

Ethical Considerations

The Political frame also presents leaders with an opportunity to ask very pointed questions centered on ethical implications and advancement of equitable practice. Who or what may be left behind as we increasingly incorporate technology into our daily lives? Who has access to the technology? For example, while dental schools and well-resourced organizations may be able to afford new and often increasing expensive technologies, are there gaps that would foster opportunities to partner with smaller safety-clinics for delivery of oral health care utilizing AI in underserved areas? How do we advocate for state of-the-art technology, and accessibility for all? Similar questions revolve around our dental school decision making processes. When assembling teams and implementing new agendas, leaders must ask themselves if someone or various groups are missing from the proverbial discussion table. Dental leadership must be careful and consciously aware that advances in AI do not further exacerbate existing issues of inclusive

excellence along health equity, promotion and tenure, hiring practices or even diverse student recruitment lines.

Symbolic Frame

In Bolman and Deal's model, the Symbolic frame focuses on mission and values. This frame highlights the branding of an institution and the things that contribute to the reputation of the school, alumni, donors, and other associates. This frame focuses on issues of meaning and belief and can be described as those things that express the heart and soul of an organization, or that bring an organization to life. [23]

Celebrating the Wins

Overlapping with other frames in the model, the Symbolic frame can be used to focus on celebrating the initiatives associated with implementing AI into an institution. Utilization of the institutional website, newsletters, and meetings to share the progress is a way to build buy-in for the initiative. Recognizing those individuals serving on committees to guide the introduction of AI and those publishing on the topic brings awareness both internally and externally to the importance of AI among the institutional priorities and infuses acceptance of AI into the organizational culture.

Collaborative Effort

School websites and other media platforms allow the institution to collect feedback from a broad range of stakeholders, creating a multi-directional communication stream between the school, donors, interested corporations or individuals and those with the role of implementing AI. Contact information could be gathered in the communications to allow for survey distribution to

stakeholders and interested public entities. A strong belief in community is showcased through seeking input and collaboration and a positive reputation among both the private and corporate sectors can result.

Donor, Faculty, and Staff Recognition

It is important to recognize those who are supporting and contributing to the implementation of new technologies such as AI. Donor names on monitors inside the school would allow those working and attending there to see the community partners and the broad support that the school has for the AI initiative. Visitors to the school, some of whom are potential donors, will recognize the value that the institution places on donor relations. Internal communications by way of newsletters and emails are another way to highlight those lending financial support to the initiative.

Faculty and staff devoting their time to committees, task forces or other work teams could be recognized in much the same way as donors are recognized. An effectively worded email from the President or Dean summarizing the AI initiative followed by the names of those giving time and talents to the cause gives well-deserved recognition to these individuals and may sway others to become engaged.

Change as an Opportunity

Publications and other media emphasizing the institution's implementation of AI could positively impact student and faculty recruitment. Explaining the implication of AI on education and patient care at the school has the potential to attract students and faculty interested in both improved patient care and technology-driven treatment, and working and teaching in a modern

curriculum. Clarifying the possibility of reaching more patients in need through AI-driven programs and protocols brand the school as community focused and caring, attracting student applicants with the same values. Attracting potential candidates who are enthusiastic to be involved in early adoption of technology in education and healthcare will help advance the further implementation of AI.

The current faculty needs to be assured that the change is positive for their future. Stressing change as an opportunity for professional growth and clearly tying rewards to adopting the change will assist in alleviating the fear of job reductions or loss that often accompanies technology implementation. Continuing education and faculty training focused on preparing faculty, administrators and practitioners for AI shows a commitment to current stakeholders and their success in the future.

CONCLUSIONS

Institutions of higher education and dental schools, more specifically, are dynamic, fluid, ever-changing organizations and the incorporation of AI is one example. In this paper, an approach has been provided based on Bolman and Deal's Four Frames model for the thoughtful and deliberate practice of leadership that is required to harness and realize the broad and comprehensive benefits of incorporating AI into the day-to-day operations of dental schools and dental education curricula. AI technology that complements tasks that would otherwise require human intelligence, is far reaching, and its adoption could enhance educational experiences and the delivery of care, and prove to be extremely beneficial for both current function and future innovation. By presenting Bolman and Deal's Four Frames approach as a guide, we hope that

schools will find it useful for viewing the issues and may help uncover perspectives in advance that might otherwise be missed or overlooked.

CONFLICT of INTEREST

T. A. Dolan, DDS, MPH is employed as Chief Dental Officer at Overjet, a dental AI company, and serves as professor and dean emerits, University of Florida College of Dentistry. The additional authors declare no conflict of interest regarding the content of the manuscript.

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