

E-learning and the future of dental education: opinions of administrators and information technology specialists*

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Abstract The digital revolution and growth of the Internet have led to many innovations in the area of electronic learning (e-learning). To survive and prosper, educators must be prepared to respond creatively to these changes. Administrators and information technology specialists at six dental schools and their parent institutions were interviewed regarding their opinions of the impact that e-learning will have on the future of dental education. Interview questions encompassed vision, rate of change, challenges, role of faculty, resources, enrolment, collaboration, responsibility for course design and content, mission and fate of the institution. The objective of this qualitative study was to sample the opinions of educational administrators and information technology specialists from selected US universities regarding the impact of e-learning on dental education to detect

trends in their attitudes. Responses to the survey indicated disagreement between administrators and informational technology specialists regarding the rate of change, generation of resources, impact on enrolment, responsibility for course design and content, mission and fate of the university. General agreement was noted with regard to vision, challenges, role of faculty and need for collaboration.

Key words: electronic learning; information technology; dental education.

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Introduction

EDUCATORS are struggling to assess the significance of innovations in the area of electronic learning (e-learning) brought on by the digital revolution and growth of the Internet. Duderstadt in *A University for the 21st Century* quotes Jacques Attali as saying 'The impact of information technology (IT) will be even more radical than the harnessing of steam and electricity in the 19th century. Rather it will be more akin to the discovery of fire by our early ancestors, since it will prepare the way for a revolutionary leap into a new age that will pro-

foundly transform human culture' (1). Duderstadt continues with the observation that although IT is currently used to enhance traditional teaching methodology, 'in the future it will change the entire learning paradigm and impact the relationship among faculty, staff and the university'.

Dental schools may have some advantages over universities as both evolve into 'learner-centred' institutions capable of 'providing the kind of lifelong, continuous learning that an ever-expanding knowledge base makes necessary' (2). The nature of dental education has demanded that content be current and evidence based and that educational methods be highly pragmatic and experiential.

Hendricson and Cohen reported that utilisation of technology to enhance student learning, both in informatics and operator simulation, is on the reform agenda for dental education in the United States (3). Advanced technology has the ability to facilitate small group, collaborative learning among

*Electronic learning: Term covering a wide set of applications and processes, such as web-based learning, computer-based learning, virtual classrooms and digital collaborations. It includes the delivery of content via Internet, intra/extranet (LAN/WAN), audio- and videotape, satellite broadcast, interactive TV, CD-ROM and more. (From: Learning Circuits Glossary, <http://www.learningcircuits.org/glossary.html>.)

students to solve simulated and live patient problems and to foster increased contact among students, patients and faculty members.

Kassebaum et al. surveyed US dental schools and found that increased use of computer-based technology was the 'most often selected curricular innovation already incorporated into the curriculum in the past three years (86 per cent of responding schools)' (4). Eighty-two per cent of the responding schools surveyed projected an increased use of computer-based technology within the next 3 years.

However, Hendricson et al. reported that, 'E-curriculum implementation among North American dental schools is following the classic innovation pattern in which a few early adopting institutions proceed rapidly while the majority of potential adopters make modifications slowly'. They noted that, 'few dental schools use online courses, and at most schools, few faculty have received training in online instructional techniques' (5).

Nattestad and Attstrom, in their *Introduction to Theme 4: The virtual potential*, a report of Phase One of a Global Congress of Dental Education held in Prague in March, 2001, proposed the development of a 'virtual dental school based on a collaborative effort without national or intellectual boundaries and sharing existing resources' and the extensive use of advanced IT in the delivery of dental education in a global context (6). Studies have found that students, staff and professionals consider computer-assisted learning (CAL) stimulating and motivating and that students easily adapt to CAL, even when computer literacy was low (7).

The objective of this study was to assess and compare the opinions of educational administrators and IT specialists from selected US universities regarding the future impact of e-learning on dental education to discover trends that may be of global interest. Although the views of academics and students are also of interest, this study was limited to educational administrators and IT specialists.

Methods

The schools surveyed for this study are representative of the authors' parent institutions at the time of manuscript preparation, although the authors are currently engaged as faculty at dental schools in Colorado, Iowa, Michigan, Pennsylvania, Nevada and Arizona. The representative schools vary with respect to enrolment, geographic distribution, funding and structure.

A list of 10 questions regarding the future of e-learning in university and dental education was developed for discussion during interviews at each of the authors' institutions (Table 1). The questions encompassed vision of the future, rate of change, challenges, role of faculty, resources, enrolment, collaboration, responsibility for design and content, mission and fate of the institution.

Interviews were conducted with 33 individuals including nine high-level university administrators from the parent institutions, five dental school deans, three associate deans and 16 IT specialists (Table 2). Interviewees were assured that their responses would be anonymous and presented only in summarised form (Table 3).

Results

Vision

Virtually all university and dental administrators agreed that e-learning would play an important role in the future of education. It will allow and encourage institutions to offer didactic instruction to students at any location at any time. Distance education, particularly telecommunication, offers new opportunities for continuing education for students from remote populations and for faculty sharing of information.

TABLE 1. Interview questions

1.	What is your vision of the future of technology in education (for the school, the university and the nation)? Specifically what is your vision of computer-aided learning, distance education and the role that it will play in higher education, as well as dental education?
2.	Do you believe that the fate of the school/university rests on changes that could result from new technologies? Why or why not?
3.	Will these changes improve the school's ability to achieve our mission?
4.	In your opinion, what is the time frame for these changes? Will change evolve more slowly or more rapidly in dental education?
5.	Where will the resources for change come from and how might these changes affect the cost of education?
6.	Will collaborations be necessary to effect the changes and if so, with whom?
7.	Do you think these changes will affect student enrolment in any way?
8.	How do you think the role of faculty will be affected, including recruitment and/or retention?
9.	Who will be responsible for design/content of new digital technology for education?
10.	What are the challenges facing the institution with regard to making these changes?

TABLE 2. Interviewees

University president	2
University executive vice president/chancellor	2
University vice president	3
University provost	1
University associate provost	1
Dental school dean	5
Dental associate dean	2
Dental assistant dean	1
Information technology specialists	16

Several university administrators mentioned clinical simulation, but only two dental administrators suggested its use in the dental school environment. IT specialists envisioned a future for dental education, which would include clinical simulation. One individual suggested that, 'Virtual reality, with the ability to provide feedback, will eventually replace traditional preclinical laboratories'. Another predicted 'virtual patient encounters'. Online and distance education courses with three-dimensional imaging may supplement or replace hands-on training in dental anatomy and many of the biomedical science disciplines.

Several IT specialists suggested that dentistry could form a national consortium of schools to develop standardised courses taught by recognised authorities in dental education. This would allow for greater sharing of limited resources, improved calibration, increased access to information and provision of meaningful assessment among institutions. Increased use of computer-assisted learning might also result in a dental educational system that could integrate online delivery of learning to the student at home with hands-on clinical instruction provided within the dental school building.

Rate of change

University administrators agreed that the change to a more technologically advanced curriculum would take time, particularly in dental schools. Reasons cited for a slow implementation included funding, caution and reluctance on the part of the faculty, potential for loss of local control of the didactic curriculum and students who, although competent in the use of computers, are used to learning the 'old way'.

Dental administrators disagreed on the rate of change that might occur in the dental school. One associate dean believed 'Academia has deeply engrained institutional traditions which work against any change. Dental institutions will take even longer to change due to our system of basic and clinical education and our traditional route to administration; where the genesis of most change occurs'. A dean suggested, 'These changes are occurring today and will continue to evolve at a rapid rate. Dental

education in the very near future will be dependent on information technology'. Another proposed that change would occur slowly as 'energy is sometimes redirected to a "survival" mode in teaching, research and service, with limited resources and time to make change happen quickly'.

A majority of the IT specialists predicted a rapid rate of change limited only by funding and leadership priorities. New technological tools are being developed every day, and the pace of change will be determined by educators and their willingness to explore new solutions based upon technology. One IT specialist mentioned that computer-assisted learning would evolve much more rapidly than distance education, which requires more infrastructure. Another suggested that, 'In about 10 years we should be able to realise all that distance education will be able to offer'.

Challenges

Nearly all respondents listed financial resources as a major challenge facing academic institutions with regard to making technological advances. Many of the interviewees discussed faculty limitations including release time for course conversion, lack of faculty expertise in technology and faculty resistance to change.

Other challenges cited were the need for expertise in software development, ongoing technical support to provide necessary updates, inability to reward appropriately those who devote time and effort to technology, competition for university resources and the attitude of students who might expect significant contact with faculty in return for paying high tuition.

Role of faculty

Thirty of the 33 interviewees agreed that the role of faculty would change dramatically with the evolution of e-learning in education. Only three believed that technology would have no effect on faculty recruitment and/or retention. There was a general sentiment among respondents that faculty would transition into 'content experts,' 'information facilitators' and 'course moderators,' working with software developers and designers.

While some faculty might embrace this new role, it was anticipated that others, who cling to traditional models of teaching, would resist it and be passed by or driven away from education altogether. One university administrator suggested that institutions would need to 'recruit a new generation of teachers' to accommodate this new paradigm. A dental administrator remarked that, 'Given the aging faculty and expected turnover of faculty, the entry of technology

	Greatly affected by technology	Generally not affected by technology	Undecided
Vision			
University administrators (9)	7	1	1
Dental deans (8)	4	2	2
IT specialists (16)	13	1	2
Total	24	4	5
Rate of change			
University administrators (9)	1	7	1
Dental deans (8)	3	4	1
IT specialists (16)	8	4	4
Total	12	15	6
Challenges			
University administrators (9)	9	–	–
Dental deans (8)	8	–	–
IT specialists (16)	16	–	–
Total	33		
Role of faculty			
University administrators (9)	9	–	–
Dental deans (8)	7	1	–
IT specialists (16)	14	2	–
Total	30	3	
Resources			
University administrators (9)	3	5	1
Dental deans (8)	8	–	–
IT specialists (16)	16	–	–
Total	27	5	1
Enrolment			
University administrators (9)	5	4	–
Dental deans (8)	2	5	1
IT specialists (16)	3	12	1
Total	10	21	2
Collaborations			
University administrators (9)	9	–	–
Dental deans (8)	8	–	–
IT specialists (16)	16	–	–
Total	33		
Responsibility for course design and content			
University administrators (9)	1	7	1
Dental deans (8)	1	6	1
IT specialists (16)	1	14	1
Total	3	27	3
Mission			
University administrators (9)	7	1	1
Dental deans (8)	4	2	2
IT specialists (16)	13	–	3
Total	24	3	6
Fate of the institution			
University administrators (9)	–	9	–
Dental deans (8)	2	5	1
IT specialists (16)	8	8	–
Total	10	22	1
Overall responses by group			
University administrators	51	34	5
Dental deans	47	25	8
Administrators and deans total	98 (57.6%)	59 (34.7%)	13 (7.7%)
IT specialists			
Total	108 (67.5%)	41 (25.6%)	11 (6.9%)
All responses total	206 (62.4%)	100 (30.3%)	24 (7.3%)

TABLE 3. Results of interviews

into teaching practice will likely occur with the recruitment of younger faculty. Technology will be important to recruitment of younger faculty’.

Several interviewees suggested that manpower needs for didactic teaching would decline and might allow an increase in time dedicated to clinical teaching. It was also noted that development and maintenance of

new teaching methods are not generally rewarded in the university and, to provide an incentive to faculty, should be considered ‘scholarship in teaching’.

Resources

According to university administrators, most of the funding for technological change would not come from

the parent institutions, but instead would be generated from external and non-traditional sources. Philanthropic societies, research grants, alumni donations and allocations from related hospitals were offered as potential sources of capital. Reappropriation or reallocation of general educational funds was suggested by only two university administrators, and one recommended that a universal or common didactic curriculum might be created to consolidate expenditures. Half of the dental administrators agreed that new technology could be subsidised through an increase of student tuition and fees. The others suggested reallocation of internal funds and fund-raising efforts from private, corporate and alumni sources.

In contrast, IT specialists generally took a more entrepreneurial approach and suggested the use of revenue acquired through videoconferencing, development and sale of commercial software products and distance learning. Increased student fees, collaborations and corporate partnerships were mentioned as other possible revenue streams.

Enrolment

Five of the nine university administrators expected that an increased use of technology would have a positive impact on student enrolment. One university president saw distance education as a means to reach students in rural populations who might not otherwise have an opportunity to participate in higher education. A vice president stated that increased technology 'will be a significant recruiting tool ... (which) will start to differentiate between the haves and have not'.

Among university administrators who felt that enrolment would not be affected by technology, one associate provost described the physical university as a transitional place, a 'place for people to get together. It is a part of our culture's socialization process'. A vice president noted that enrolment could vary depending on the mode of delivery of the new technology: 'Implementation of asynchronous education lends itself to enrolment increases while synchronous delivery could be limited by faculty size'.

Of the dental administrators, most felt that enrolment would be unaffected by e-learning, and only two assumed that technological advances within the school would enhance applications and/or enrolment. Of today's technologically savvy students, one dean remarked 'what makes the biggest difference to them is the perceived quality of the clinical education they will receive which has more to do with the faculty and the curriculum than it does with technology'.

Twelve of the 16 IT specialists did not anticipate a positive change in enrolment from the use of e-learning, but most recognised that a university or school that failed to adopt new advances in technology might experience a decrease in the applicant pool. 'Not adopting new teaching and learning tools is already influencing students' choices,' stated one online learning programme director.

Collaboration

Interviewees unanimously agreed that meaningful technological advances would require a high degree of collaboration. A team approach was encouraged with other universities, health science centres, academic dental institutions, private corporations, technology experts and library systems. One vice president suggested that, 'a collaborative model of didactic instruction could eliminate the need for portions of the national board exams in dentistry; make the final in biochemistry the board exam since all students would be taking the same course'.

A general model of using faculty as content experts, working with software programmers and network designers (possibly from private enterprise), emerged as a common theme. Shared resources resulting from collaboration would help distribute the cost of initial investment in course development and increase the rate of advancement. Two respondents suggested that a dental education association might be willing to serve as a broker for collaborative efforts.

Responsibility for course design and content

Although faculty educators were considered by nearly all interviewees to be responsible for course content, there was some disagreement as to the source of instructional design expertise. One university administrator called for a research centre in education where course design, multi-institutional trials and long-term support could be provided. An IT specialist envisioned that a few experts for content delivery could design courses using a generic template that would then be customised by each school. The clarification of intellectual property rights was mentioned as an important issue by many of the interviewees.

It was suggested that there would be an increased need for instructional designers, writers, editors and web designers to assist with content organisation, add media components and manage the visual presentation of online courses. Some respondents expected that design professionals would come from within the institution, while others believed they would come from outside the university. Still others thought that faculty would be trained in software design to have

total control over the end product. However, this training might necessitate sabbaticals or leaves of absence for faculty members, thus placing added human resource pressures on schools.

Mission

University and dental administrators generally agreed that changes in educational technology would improve the institution's ability to achieve its stated mission, specifically by making it more efficient and allowing for cost shifting. One vice president said, 'The improvement of technology is not the answer in and of itself, but the progress being made in this area will help us to improve our product and help us to meet the educational goals of the institution'. The president of one institution stated that, 'we will create a virtual faculty,' while another university administrator believed that technology, though important for information transmittal and retrieval, would provide no instruction on the fundamental skill sets of professionalism, humanism and doctor-patient relations. A dental dean summarised that, 'it still boils down to human contact, ... faculty members mentoring dental students and passing on the skills needed to deliver excellent dental care will continue to be the hallmarks of dental education'.

Information technology specialists reported that a school would enhance its ability to accomplish its mission by using content experts to develop course material and by decentralising the clinics to increase oral healthcare delivery to a more diverse population. The design of the curriculum might become more flexible and additional courses could be offered.

Fate of the institution

For the most part, university and dental administrators did not believe that the fate of their institutions would rest on changes, which could result from the implementation of these new technologies. Sentiments included, 'Universities are very robust. We have staying power'. 'The evolution of these technologies is only adjunct to professional education and will not be responsible for irrevocably altering the face of education'. 'One purpose of the university is to provide leaders for tomorrow... Leaders must be educated in a group setting, and digital groups are not an adequate laboratory for leadership,' and 'Distance education can never totally replace the faculty-student one-on-one mentoring relationship'.

Although the majority of university and dental administrators felt strongly about the permanence of the university, most acknowledged that it would be vitally important to stay abreast of new technologies. A university that failed to incorporate technology

might suffer in the areas of reputation, ability to acquire funding, and student and faculty recruitment and retention. Only one dental dean believed that, 'The fate of the university/dental school as we know it rests on information technology. Those that embrace it and support it will flourish and attract faculty and students. Information technology will drive education in the very near future'.

Information technology specialists were split with regard to this issue. Half felt that future students would expect a high level of technology, and institutions that could not provide it would experience a decrease in the applicant pool and ultimately fail. Competition with commercial courses developed in private industry was considered to be a looming threat. One IT specialist thought, 'It is quite possible that some day all dental schools will be a part of a big dental educational network where a major part of the dental curriculum is available online at any time of the day or night. We need to be prepared to step into the 21st century'. Others believed that the fate of the institution would rest with the faculty, not with technology, since technology is merely a tool.

Discussion

Responses to this survey indicated differing opinions between administrators and IT specialists regarding the rate of change, resources, impact on enrolment, responsibility for curricular design and content, mission and fate of the university. However, general agreement was noted with regard to vision, challenges, role of faculty and collaboration. Although not infallible, the areas of agreement would seem to be most predictive of the impact of e-learning on dental education in the future, and this section will focus on those areas.

Administrators and IT specialists agreed that advances in digital IT hold great potential for their institutions. Their opinions are bolstered by recent studies that reported that 56% of higher educational institutions believe that online learning is critical to their long-term strategy (8). However, they may not be aware of the dangers that may accompany these technological advancements. For example, economist and telecommunications expert Eli Noam has pointed out that the three major functions of scholarly activity: the creation of information and knowledge, the preservation of information and knowledge and the transmission of information and knowledge to others, are based on a set of technologies and economics (9). Together with history and politics, they give rise to a

set of institutions. Change the technology and economics and the institutions must also change. The Internet is creating alternatives to the traditional flow of information and may have serious negative consequences for institutions of higher education (10).

The greatest challenge to increased adoption of e-learning is limited financial resources. The cost of advanced technology, including infrastructure, hardware, software and personnel is very high. At a time when many dental schools are facing diminishing resources, it will be essential to find external sources of funding. Aggressive fund-raising efforts will be required for dental schools to remain competitive.

Other, less-obvious consequences of diminished resources may occur. If higher education continues to rely on the traditional classroom-based, faculty-centred, labour-intensive mode of instruction (the credit-for-contact model), costs will increase as personnel costs rise. As the overall cost goes up and the cost of IT declines, universities might choose to use IT to increase student enrolment while diminishing the amount of faculty time needed per student (11). While this choice might make economic sense, Twigg warns that our efforts to apply technological solutions to educational methods should be designed to increase, not decrease, contact time between faculty and students (12). As higher levels of technology are implemented, more attention should be placed on satisfying the emotional and social needs of learners (11). As IT is incorporated more thoroughly in dental education, it will be important to provide high levels of personal support and connectivity among individuals.

Increased use of online teaching materials will change the role of faculty (13). They will become facilitators or learning coaches and create more opportunities for one-on-one and small group interactions with students. Through the use of e-learning, faculty may help students develop better problem-solving skills and acquire knowledge from many different sources. There will be increased opportunities for mentorship relationships to develop. Faculty functions of the future may include designing e-learning courses, mentoring and certifying students during their course of study and assessing educational outcomes. Some of the world's best teachers could become widely available across campus boundaries.

Not all faculty members will embrace the implementation of e-learning in education. Lack of time, inadequate computer skills and comfortable teaching habits were cited as possible reasons for resistance. Faculty will need training, technical support, instructional design support and meaningful rewards for time spent redesigning their courses.

Collaborations of many types will be necessary and desirable to achieve the promise of e-learning. For example, a large-scale multiuniversity collaborative effort in the US, the Sakai Project, was founded to produce open-source Collaboration and Learning Environment software, similar to the proprietary Blackboard® or WebCT® course management or e-learning systems (<http://www.sakaiproject.org/>). This \$6.8 M software development project involving the University of Michigan, Indiana University, the Massachusetts Institute of Technology, Stanford, the uPortal Consortium and the Open Knowledge Initiative, with the support of the Andrew W. Mellon Foundation, shows what can be accomplished through collaborations when the need and market are large. Other examples of an increasing emphasis on sharing open-source programmes in higher education include programmes in course management (Moodle, Pachyderm), libraries and archives (DSpace, E-Prints, Fedora, Kepler, Digital Document Assembly Kit), web portals (uPortal, CampusEAI 'Portlets'), student portfolios (E-Portfolio), productivity tools (Chandler, Lion Share), administrative tools (Kuali), security (Shibboleth, Pubcookie, Signet) and scientific computing (Globus). On a global scale, Phase 1 of the HINARI (Health InterNetwork Access to Research Initiative) project was launched in 2002 (<http://www.who.int/hinari/>). This project was specifically designed to improve access by developing countries to scientific information for health sector institutions by providing availability to high-quality biomedical and social journals at affordable prices through the World Wide Web.

Collaboration among dental schools may lead to sharing of educational content and development of a standardised core curriculum. This could lead to the marketing of courses designed by teams of IT specialists and content experts. Several among those surveyed for this study mentioned the promise of using entrepreneurial efforts to generate resources for change. Other collaborations with industry and publishing firms to develop specialised software and courseware to meet the needs of the dental education community is a possibility, but only if the economics of such relationships proves beneficial to all parties. Also, conflicts related to intellectual property rights may pose substantial barriers to collaboration and will need to be addressed.

Differences found in the responses of administrators and IT specialists may be attributed to the different frames of reference of each group with respect to e-learning. Administrators are entrusted with ensuring the educational and financial viability of the institution; while IT specialists are tasked with finding ways to use

IT to help the institution achieve its mission. At times, these agendas may differ in focus, however, the authors agree that university and dental administrators working in concert with IT specialists will be required to achieve the promise of e-learning in dental education.

Overall, responses indicate that educational administrators are actively trying to understand the impact of e-learning on the future of dental education to take advantage of the opportunity for positive growth and development while avoiding potential pitfalls. Decisions regarding the allocation of scarce resources cannot be taken lightly by any dental school, especially those experiencing severe economic constraints. And yet, the vision of the ability to share information in unprecedented ways, globally and inexpensively, holds the promise of a worldwide golden age for dental education.

Conclusions

- 1 Digital technology will play an important role in the future of dental education. Factual-based didactic material lends itself well to computer-assisted learning, and the use of case simulations widens students' exposure to various clinical situations, and eventually the manipulation of 'virtual reality' may even be used in the development of skills that previously could only be gained by treating patients.
- 2 Collaborations of many types will be necessary and desirable to achieve the promise of digital technology. This applies especially to the area of design and content where many issues related to instructional design and intellectual property rights will need to be worked out. Collaboration among dental schools may lead to sharing of material and development of standardised cores of curriculum. Central control and/or marketing of commercially available courses, designed by technology specialists working with a few content experts, are a real possibility.
- 3 The greatest challenge to the increased adoption of digital technology is availability of financial resources. The cost of advanced technology, including infrastructure, hardware, software and personnel is very high. At a time when many dental schools are facing diminishing resources, collaborations and external sources of funding will be essential. Aggressive negotiations and fund-raising efforts will be required for dental schools to remain competitive. There will be increased pressure to raise tuition.
- 4 Increasing adoption of IT will not decrease the number of faculty required to deliver the curriculum, but their roles in the dental school will change. The faculty role in digital technology will be one of content expert working with software developers and/or instructional designers, and faculty development programmes will be needed in order for faculty members to understand the scope of the possibilities opened up by the new technology. Faculty will require incentives to make the needed changes. Digital technology will facilitate the process of assessing educational outcomes.
- 5 Dental student enrolment is unlikely to change with implementation of e-learning. However, students, in their increasing role as consumers, will be looking for the greatest value for their educational investment. The quality of the faculty and clinical education are important to students. The perception of inferior IT services could reduce a particular school's applicant pool. Educational technology must be utilised in a way that is learner and user centred. Student resistance to inquiry-driven learning must be overcome.
- 6 University and dental administrators generally predict a slow process of implementation of advanced IT in dental education, while IT specialists anticipate a rapid rate of change limited only by funding and leadership priorities and driven by student demand. This disparity may reflect the different frames of reference for these two groups, although attitudes of administrators may be a limiting factor.
- 7 The increased distribution of free and open-source software for course management and other e-learning purposes, along with the development of inexpensive Internet access and tools, will have important effects on dental education worldwide.

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