



Enhancing Health Professions Education through Technology: Building a Continuously Learning Health System

Proceedings of a conference chaired by
Gail Stuart, PhD, RN, FAAN and **Marc Triola, MD, FACP**

April 2015 | Arlington, Virginia

October 2015

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PREFACE

GEORGE E. THIBAUT, MD

The Macy Conference entitled “Enhancing Health Professions Education through Technology: Building a Continuously Learning Health System” was held April 9th to 12th in Arlington, Virginia. It was the third in a series of Macy Conferences that dealt with the need to more closely link health professions education with a changing healthcare delivery system in order to better meet the needs of the public. The first conference, entitled “Transforming Patient Care: Aligning Interprofessional Education with Clinical Practice Redesign” focused on using an interprofessional approach to both education and collaborative practice as a key vehicle for this alignment. The second conference, entitled “Partnering with Patients, Families, and Communities: An Urgent Imperative for Health Care,” focused on strengthening the partnership with patients, families, and the communities we serve to create the “sweet spot” needed for informed alignment. In each instance, conferees acknowledged that new attitudes, knowledge, and skills will need to be taught to learners at all levels, new pedagogical methods will need to emerge, and significant faculty development will need to occur if these goals are to be achieved.

In the third conference, conferees were asked to address the questions of how educational technologies might be harnessed to achieve the overarching goal of health professions education—the Triple Aim of better health of the public, better patient experience, and lower costs. We are all aware that technologies are changing the way we access information, communicate, conduct our personal and commercial affairs—and yes, even the way we think. Also, aggregations of large databases (so-called “big data”) are producing new insights about natural and man-made phenomena.

We are already seeing the impact of technology in many areas of higher education outside the health professions. It seemed a propitious time to ask how these trends in technology might be harnessed to achieve our goals of transforming health professions education and better aligning it with a changing delivery system and with changing public needs. We engaged this question ever-mindful of the fact that

there are human dimensions and human outcomes for health professions education that are different from other educational endeavors. These differences could either limit the uses of technology or lend themselves to unique applications and solutions.

As with prior Macy Conferences, we assembled a diverse group of national thought leaders representing different fields, geographies, and types of institutions. In this case, participants came from the fields of higher education, health professions education, informatics, technology development, healthcare delivery, and consumer advocacy. We prepared attendees for the meeting by assigning readings and three excellent commissioned papers that dealt with trends in higher education, existing technologies in health professions education, and a vision for a future state of technology-enhanced health professions education. Conferees engaged in two and one half days of spirited, structured discussions in both breakout groups and plenary sessions leading to a series of consensus conclusions and recommendations.

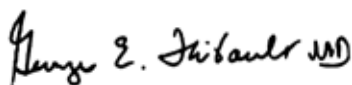
In the end, the conferees were even bolder than I had imagined they would be. They generated a vision for a Continuously Learning Health System, shown schematically on page 29. This concept is not a new one. It is similar to the conclusion of an Institute of Medicine's (IOM) Roundtable on Value and Science-Driven Health Care and its committee on The Learning Healthcare System in America.¹

What is unique, is that we took a different direction than the IOM and arrived at a similar conceptual framework. We started by asking and responding to the question "How can technology enhance health professions education?" The vision is both simple and radical, and it led to a series of actionable recommendations. These recommendations (detailed in pages 23–41) deal with the use of technology for the individualization of education, for faculty development, for competency-based education, for the linkage of education and healthcare delivery, for the use of individual and population data to inform education, and for sharing and scaling educational materials to achieve greater efficiency and equity. While this would require a dramatic transformation of our current way of doing business, we know it is possible because we have identified existing examples for each of the recommendations.

¹ IOM (Institute of Medicine). 2013. Best care at lower cost: The path to continuously learning health care in America. Washington, DC: The National Academies Press.

In the end, the conferees themselves were energized and transformed by the process. Conferees described the conference as "intense," "invigorating," "engaging," "impressive," and "productive."

A conference and a monograph such as this are the product of the efforts of many talented and dedicated people. We were blessed to have Gail Stuart, PhD, RN, FAAN, and Marc Triola, MD, FACP, as skillful and insightful co-chairs. We had a particularly dedicated planning committee/writing committee that oversaw the planning and execution of the meeting and produced the executive summary and conference recommendations. All conferees brought wisdom and dispassion to the table and to the work, and we are grateful to each and every one for their unstinting efforts. Finally, we were blessed by a talented writer, Teri Larson, and a skilled administrator, Yasmine Legendre, who kept the effort going and pulled it all together.

A handwritten signature in black ink that reads "George E. Thibault MD". The signature is written in a cursive, flowing style.

George E. Thibault, MD

President, Josiah Macy Jr. Foundation



GAIL STUART, PHD, RN, FAAN



MARC TRIOLA, MD, FACP



INTRODUCTION

GAIL STUART, PHD, RN, FAAN
MARC TRIOLA, MD, FACP
CONFERENCE CO-CHAIRS

This is a pivotal moment in the education of future generations of health professionals. Not since the end of the 19th century has the health professions education environment encountered both tremendous forces for change and tremendous opportunities for transformation. The current healthcare environment is dramatically different from the one that shaped our existing educational programs and pathways. Patient care is moving out of the hospital and into the community; providers who have traditionally worked in silos are now part of interprofessional teams; there is greater accountability for quality, value, and cost in health care; and providers of all types need a wide variety of new competencies, including those related to technology and information management.

These changes in our healthcare system also are driving changes in the higher education landscape. There is movement towards competency-driven personalized pathways, tailored to the unique strengths and pace of each learner. New educational modalities, such as simulation- and team-based learning, are replacing the traditional lecture. The teaching-learning process is no longer bound by geography or conventional time constraints. Educational innovators are seeking new ways to deconstruct curricula, dis-aggregate courses and content, and test new technologies to enhance both individual and team-based learning. This is all happening against the backdrop of growing concern about rising tuition costs and the extended duration of health professions education programs.

This conference captured both the excitement and the potential of this intersection of the changes in health care and health professions education as actualized by existing and emerging educational technology. It acknowledged that there has been an explosion in the diversity and adoption of educational technologies across higher education, but it also recognized that important questions remain unclear to many educators.

What characteristics should we look for in educational technology?

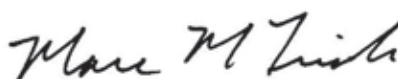
- What preparation do faculty members need to understand, evaluate, and optimally utilize these technologies?
- How do educators, clinicians, and administrators keep up with the pace of change in technology?
- And most fundamentally, how can educational technologies help bridge the gap between a changing healthcare system and an evolving educational system?

Many feel that the power of educational technologies to transform our health professions education system still largely lies in its potential. The conference represented a unique opportunity at this precipitous moment in time to discuss these compelling issues.

The recommendations in this document were informed by the rich tapestry of varied viewpoints represented by the participants, who included health professions educators, leaders of health care systems, technology developers, innovators, patient advocates, and others. What emerged was a series of recommendations and principles that stand upon the shoulders of many current, successful examples of using technology to revolutionize health professions education, while also recognizing that much work remains to be done. The passion, wisdom, and experience of the conferees were the greatest strengths of the event. Their dialogue, debate, and deliberations were underscored by their hard work and collaboration, which ultimately led to the quality of the final recommendations. Under the guidance of the Foundation, this group accomplished a great deal in short order. As co-chairs of the conference, we were uniquely privileged to have had the opportunity to engage with these dynamic and thoughtful individuals. It is our hope that these recommendations foster broader change in the education of health professionals and new directions for how the use of educational technologies can enlighten our thinking and accelerate our progress towards a Continuously Learning Health System.



Gail Stuart, PhD, RN, FAAN
Conference Co-Chair



Marc Triola, MD, FACP
Conference Co-Chair



CONFERENCE AGENDA

THURSDAY, APRIL 9 EVENING

- 3:00 – 6:00 pm Registration
- 6:00 – 7:00 pm Welcome Reception
- 7:00 – 9:30 pm Dinner

FRIDAY, APRIL 10 MORNING

- 7:00 – 8:00 am Breakfast Buffet
- 8:00 – 12:10 pm **Session 1**
 - 8:00 – 9:45 am Brief introduction of participants and opening remarks
George Thibault, Gail Stuart, Marc Triola
 - 9:45 – 10:25 am Discussion of themes from commissioned paper 1
Swirl: Trajectories for Digital Technology in Higher Education
Malcolm Brown (by phone), Marni Baker Stein
Moderators: Gail Stuart, Marc Triola
 - 10:25 – 11:05 am Discussion of themes from commissioned paper 2
Educational Technologies in Health Professions Education: Current State and Future Directions
David Cook, Marc Triola
Moderator: Gail Stuart
 - 11:05 – 11:15 am Break
 - 11:15 – 11:55 am Discussion of themes from commissioned paper 3
The Future of Health Professions Education
Catherine Lucey, Sandrijn van Schaik, David Vlahov
Moderators: Gail Stuart, Marc Triola
 - 11:55 – 12:10 pm Charge to breakout groups

FRIDAY, APRIL 10, AFTERNOON

12:10 – 1:00 pm	Lunch
1:00 – 5:00 pm	Session 2
1:00 – 2:45 pm	Commissioned Paper Breakout Sessions
	Breakout 1
	Commissioned Paper 1
	<i>Swirl: Trajectories for Digital Technology in Higher Education</i>
	Representing Author: Marni Baker Stein
	Moderators: Jan Bellack, Gail Stuart
	Breakout 2
	Commissioned Paper 2
	<i>Educational Technologies in Health Professions Education: Current State and Future Directions</i>
	Authors: David Cook, Marc Triola
	Moderators: Jeffrey Cooper, Stephen Schoenbaum
	Breakout 3
	Commissioned Paper 3
	<i>The Future of Health Professions Education</i>
	Authors: Catherine Lucey, Sandrijn van Schaik, David Vlahov
	Moderators: Beth Mancini, Charles Prober
2:45 – 3:00 pm	Break
3:00 – 4:15 pm	Plenary Session
	Report out from Breakout Groups
4:15 – 5:00 pm	Plenary Session
	General discussion of themes of the day to set agenda for the following day
	Gail Stuart, Marc Triola
5:00 pm	Adjourn

FRIDAY, APRIL 10, EVENING

6:30 – 9:00 pm Reception & Dinner at the Phillips Collection

SATURDAY, APRIL 11, MORNING

7:00 – 8:00 am Breakfast Buffet

8:00 – 12:00 pm **Session 3**

8:00 – 8:45 am Brief recap of Day 1 and Charge to Breakout Groups
Gail Stuart, Marc Triola

9:00 – 11:30 am Five Breakout Groups

Breakout 1
Implications for programs in health professions education: curriculum design, time allocation, etc.
Facilitator: Charles Prober

Breakout 2
Implications for faculty development
Facilitator: Jeffrey Cooper

Breakout 3
Implications for accreditation and regulation
Facilitator: Jan Bellack

Breakout 4
Implications for the healthcare system
Facilitator: Stephen Schoenbaum

Breakout 5
Implications for technology developers
Facilitator: Beth Mancini

11:30 – 12:00 pm Group Photo

SATURDAY, APRIL 11, AFTERNOON

12:00 – 1:00 pm	Lunch
1:00 – 5:00 pm	Session 4
1:00 – 2:15 pm	Plenary Session <i>Report out from Breakout Groups</i> Moderators: Gail Stuart, Marc Triola
2:15 – 3:00 pm	Response to reports from Breakout Groups Moderators: Gail Stuart, Marc Triola
3:00 – 3:15 pm	Break
3:15 – 5:00 pm	Plenary Session
5:00 pm	Adjourn

SATURDAY, APRIL 11, EVENING

6:30 – 9:30 pm	Reception and Dinner
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SUNDAY, APRIL 12, MORNING

7:00 – 8:00 am	Breakfast Buffet
8:00 – 11:45 am	Session 5 – Conference Conclusions and Recommendations George Thibault, Gail Stuart, Marc Triola
11:45 – 12:00 pm	Summary Remarks George Thibault
12:00 pm	Adjourn





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CONFERENCE CONCLUSIONS AND RECOMMENDATIONS

ENHANCING HEALTH PROFESSIONS EDUCATION THROUGH TECHNOLOGY: BUILDING A CONTINUOUSLY LEARNING HEALTH SYSTEM

The opportunities to remake America's health professions education and healthcare delivery systems are boundless. We are limited only by our willingness to change and our capacity to innovate. It is an exciting time, with necessary and important shifts well underway. We are reorienting health professions education and clinical practice toward increased access and value, better care, and improved health outcomes for all. And technology, evolving at a seemingly faster and faster pace, is a significant factor in those changes. Harnessing its power will enable advances in both education and care delivery that will improve the efficiency and effectiveness of teaching, learning, and patient care.

A fundamental next step is to bring together all these transformative efforts. By thoughtfully and creatively integrating and enhancing health professions education and clinical practice, facilitated by appropriate technology, we can maximize the health of the people and communities we serve. Advancing this urgently needed integration was the focus of a Macy Foundation conference, *Enhancing Health Professions Education through Technology*, which was held April 9–12, 2015, in Arlington, Virginia.

"We're seeing innovations in health professions education, in healthcare delivery, and in technology all around us," said Macy Foundation President George Thibault. "Things are moving and changing very quickly, and we have a tremendous opportunity right now to bring these forces together to achieve optimum health for all."

THE STORY BEHIND THIS CONFERENCE

In 2013, participants at a previous Macy Foundation conference, *Transforming Patient Care: Aligning Interprofessional Education and Clinical Practice Redesign*, recommended linking interprofessional education and clinical care redesign to ensure a health professions workforce that is prepared to fulfill its societal contract to meet the health needs of the public. Many of the recommendations from that conference are being acted upon, but real and lasting change takes time. Macy hosted another conference in 2014—*Partnering with Patients, Families, and Communities: An Urgent Imperative for Health Care*—whose conferees proposed recommendations to help achieve the goal of equal participation of patients, families, and communities in linking interprofessional education and healthcare organizations.

To continue supporting progress toward systems integration, this year's Macy Foundation conference invited a diverse group of experts to explore the role of technology in enhancing health professions education and, in doing so, contributing to the linking of the two systems and the transformation of health care overall. The 38 conference participants—including representatives from health professions education, higher education, healthcare delivery, patient advocacy, and technology development—gathered over two and a half days. They were charged with making recommendations around the use of existing and emerging technologies to enhance health professionals' teaching, learning, and performance assessment across the learning continuum—from entry into their chosen fields, through graduate education, continuing professional development, and maintenance of lifelong competency. (See Table 1 for examples of educational technologies used in health professions education.)

Why is Macy looking to technology for new thinking, new tools, and new solutions? The use of technology to make processes and products more effective and efficient is not new. Nor is its use in education new. What is new is the wide reach and accessibility of technology and learning-objects for the education of all—from experienced professionals and teachers to health professions students to patients, families, and communities—and the ability to use technology to facilitate interactions among all of them. Also new is the level at which we now incorporate diverse technologies into our daily lives. From tablets to smart phones and watches and from physical activity trackers to 3D printers, recent innovations are changing

the ways we acquire information and even the ways we think. In spite of this rapidly changing landscape, educators, caregivers, and the public at large have not achieved a deep understanding of all the ways to successfully harness these technologies for the public good. There is a tremendous opportunity to leverage already available resources to improve health professions education, clinical practice, and health outcomes.

CONFERENCE PREPARATION

Participants prepared for the conference by reading three commissioned papers that sparked engaging and provocative discussions.

The first paper, *Swirl: Trajectories for Digital Technology in Higher Education* by Malcolm Brown of EDUCAUSE, traces the dramatic changes that technology is spurring in higher education. Brown comments on the speed and breadth of transitions taking place in higher education and reflects on the ways in which technology enables the individualization (or as Brown calls it, personalization) of learning pathways, giving educators the ability to adapt learning activities to meet the unique needs of learners. Brown also considers how to capitalize on the ability to collect and analyze enormous amounts and new kinds of data about teaching and learning outcomes to continuously refine and improve learning activities. Finally, he proposes the concept of “swirl” to describe the ways in which students are disaggregating traditional, linear educational pathways and reaggregating them in new ways that cross old boundaries of curricula, time, place, discipline or field, and institution.

The second paper, *Educational Technologies in Health Professions Education: Current State and Future Directions* by David Cook of Mayo Clinic College of Medicine and Marc Triola of New York University School of Medicine, describes the state of the art in technology that is already enhancing teaching, learning, and assessment within health professions education. The paper defines educational technologies as “materials and devices created or adapted to solve practical problems related to training, learner assessment, or education administration.” The authors focus on more recent computer-based technologies, which possess “some potentially transformative benefits that other educational approaches lack,” including flexibility, control, and analytics. Flexibility refers to the ability to

“overcome barriers of time, distance, pace, scale, and patient safety.” Control refers to the ability of instructors “to enhance learning by standardizing course quality and content.” And analytics refers to the bigger, richer, and more objective datasets that can be generated, including details on where and when learning happens, learners’ characteristics, and learners’ performance over time.

The third paper, *The Future of Health Professions Education* by Catherine Lucey, Sandrijn van Schaik, and David Vlahov of the University of California, San Francisco Schools of Medicine and Nursing, envisions a potential future state of technology-enhanced health professions education. The authors suggest that health professions education in the future will be redesigned “as a complex, adaptive system, explicitly engineered to address the healthcare and health sciences needs of the nation.” The paper sets out six qualities that would serve as the pillars to support this vision of high-quality health professions education: 1) patient and population responsive, 2) equitable, 3) effective, 4) efficient and flexible, 5) driven and enhanced by technology, and 6) continuous and lifelong.

CONFERENCE THEMES

Several key themes emerged during the conference, including recurring discussions of the critical role of faculty—broadly defined as all who are involved in teaching—in identifying, evaluating, and adapting technologies for education. Technology does not replace faculty, but can and should expand their reach, impact, and efficiency. For this to happen, faculty must be given appropriate assistance and training in developing, using, and integrating technologies, such as how to utilize online modules and assessment systems to improve teaching and learning or how to create simulation scenarios that have clinical impact. Faculty also require professional development and support to serve in new roles as mentors, coaches, and co-learners—all of which they can and must assume in a technology-enhanced education system.

Another major theme was the importance of technology as a teaching and learning tool rather than as an end unto itself. Technology can enhance the fundamentals of effective pedagogy and cognitive science. Technology also has great potential to support other broader shifts in health professions education. It enables collaboration and teamwork between and among faculty and students from

different health professions and sites and it facilitates partnerships with patients, families, and communities to improve care and health outcomes. The challenges will be to identify the desired outcomes of this new pedagogy and to determine when technology—and which technology—helps achieve progress toward those outcomes.

Closely related to the theme of technology as a tool was the recognition that robust data collection, analysis, and interpretation will facilitate the ability to individualize the educational experience. New and emerging technologies—including simulated patients, tools for online assessment and individualized practice of skills, and integrated clinical and educational outcome databases—create opportunities to gather an unprecedented amount of useful information on the educational experiences and performance of learners. These data can be used to design and refine curricula and track learner progress. These new technologies also allow students and professionals to self-regulate their learning and practice activities throughout their educational and professional careers.

The conferees agreed that technology can never—and should never—fully replace face-to-face teacher-learner interaction or personal contact with patients and families. At several points, the conversation touched on the concept of technology as a tool to preserve, accentuate, and augment humanity in education and health care. As the demands on health professions learners and practitioners change and expand, technology—appropriately used—can increase efficiency, thereby preserving time for learners and practitioners to connect, share, and empathize with each other and with patients, families, and communities.

Over two and a half days, conference discussions shifted from the ways technology can enhance the individual experiences of both teachers and learners within health professions education to the ways technology—specifically information technologies, data, and analytics—can improve health professions education and healthcare delivery on the whole, by helping us integrate and align the two. This broader discussion led conferees to consensus around adopting the concept of a technologically enhanced and fully integrated health professions education and care delivery system, known as a “Continuously Learning Health System.”

CONSENSUS VISION STATEMENT

In our vision for the future of health professions education, intelligent use of educational and information technologies supports the linkage between education and delivery systems to create a Continuously Learning Health System. In this system, teachers, learners, and clinical data inform continuous improvement processes, enable lifelong learning, and promote innovation to improve the health of the public.

This vision led to six actionable recommendations to support the activities of a continuously learning health system. The conferees felt strongly that the following actions are possible and that we are at a unique time of readiness to implement these recommendations. It is imperative that we seize this opportunity in the interest of all health professions learners and, ultimately, the health of the public.

Vision for a Continuously Learning Health System

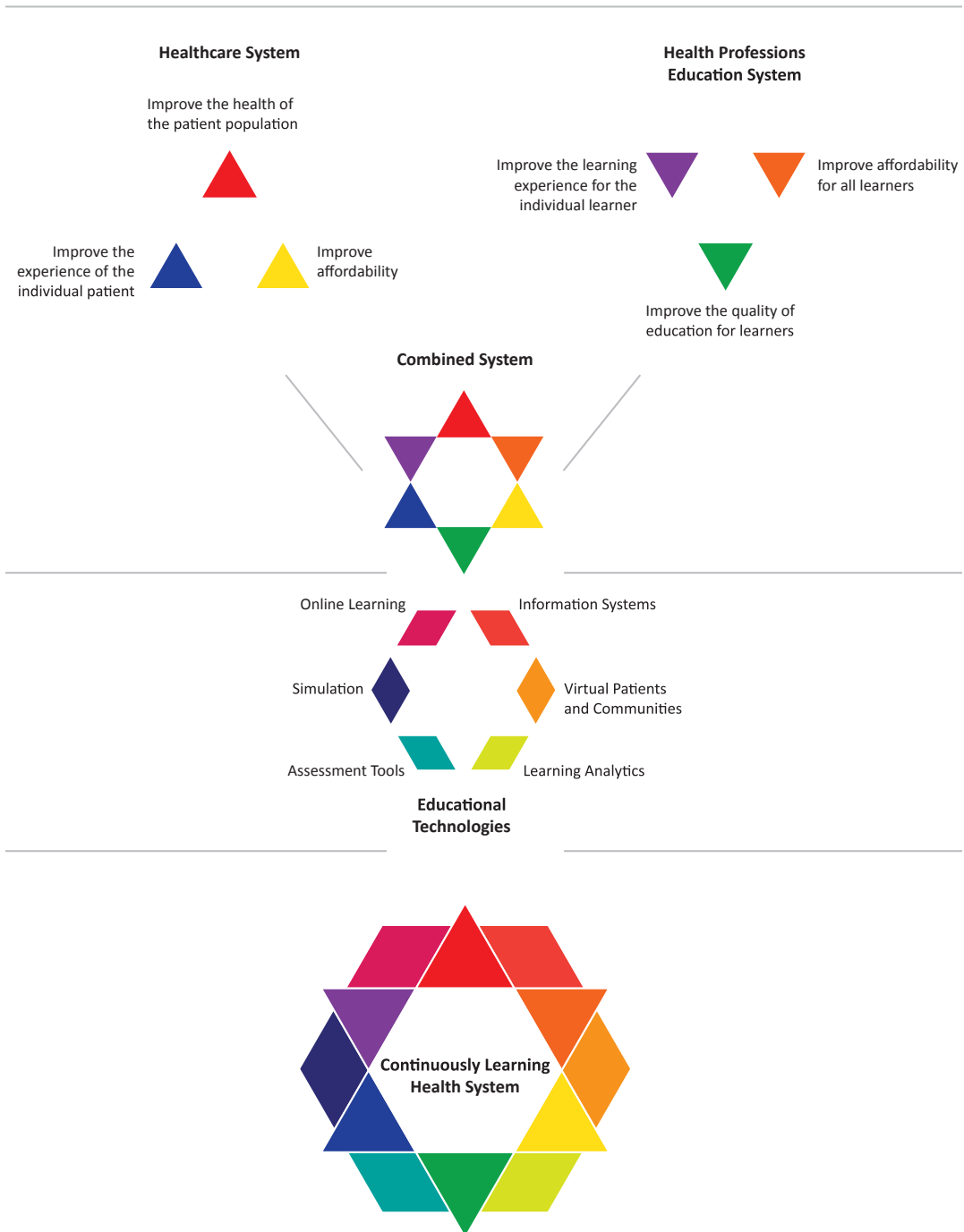


Figure courtesy of Stacy Williams PhD from Allied Health Media LLC.

CONFERENCE RECOMMENDATIONS¹

1. In health professions education, technology should be used to support the ongoing development of learners from undergraduate levels through clinical practice; enhance interprofessional learning opportunities; and empower every student, faculty member, and clinician to embrace the role of both teacher and lifelong learner.
2. Faculty in health professions education should be supported to develop skills and expertise in the selection and effective use of educational technologies to complement the teaching-learning process and assessment of outcomes.
3. Educational technologies should be used to accelerate the transformation of health professions education to a system that is competency-driven, affordable, and accessible to each learner.
4. Technology should be leveraged to bridge the gap between educational and clinical missions, where teaching and learning are embedded within a healthcare delivery system that continuously improves.
5. Leaders of health professions education programs should employ technology to analyze community and population data and use those data to continuously inform the design of curriculum content and learning experiences to reflect the contemporary health and healthcare needs of society.
6. Educational technologies should be used to facilitate the sharing of content and integration of data across systems and programs, thus promoting the scalability and adoption of efficient and effective educational strategies.

¹ The conclusions and recommendations from a Macy conference represent a consensus of the group and do not imply unanimity on every point. All conference members participated in the process, reviewed the final product, and provided input before publication. Participants are invited for their individual perspectives and broad experience and not to represent the views of any organization.

RECOMMENDATIONS

Recommendation I

In health professions education, technology should be used to support the ongoing development of learners from undergraduate levels through clinical practice; enhance interprofessional learning opportunities; and empower every student, faculty member, and clinician to embrace the role of both teacher and lifelong learner.

- Educational technologies should be used to maximize opportunities for lifelong learning “anytime, anywhere” for students, graduate trainees, faculty members, patients, and clinicians.
- Educational technologies should be used to facilitate individualized learning, personalized progression toward mastery, and active collaboration among teachers and learners.
- Educational technologies should be designed and implemented with special consideration given to enhancing the efficiency and effectiveness of teaching and learning across educational and healthcare delivery settings.
- Educational technologies should be developed to expand interprofessional learning opportunities that are not bound by time or place and that allow individuals to refresh knowledge and skills through just-in-time learning and training.

Examples²

- Several health professions education schools and even learners are developing mobile applications (apps) to support individualized learning “anytime, anywhere.” Examples: University of California, San Francisco NeuroExam Tutor (meded.ucsf.edu/tel/neuroexam-tutor-iOS-app); and Osmosis web- and mobile-learning platform, developed by Johns Hopkins

² The examples here and on subsequent pages were provided by the conferees for illustrative purposes only. We have not included all possible examples, nor does inclusion connote endorsement by the Josiah Macy Jr. Foundation or the conferees.

medical students and used by more than 20,000 medical students (www.osmosis.org).

- With funding from Robert Wood Johnson Foundation, Khan Academy—a free online educational resource that provides self-paced, mastery-based education—is building a medical education platform to help students prepare for healthcare professions (www.rwjf.org/en/how-we-work/grants/grantees/khan-academy.html).
- Vanderbilt’s VSTAR learning portfolio system is designed to support learners’ individualized learning plans and to aggregate outcomes to guide improvement of institutions’ education programs (<https://vstar.mc.vanderbilt.edu/>).
- Smart Sparrow uses a software platform that enables faculty and clinical educators to create their own adaptive lessons that match students’ knowledge levels (www.smartsparrow.com).
- NextGenU.org provides free, for-credit online learning resources across the spectrum of health professions education. Courses are competency-based and include peer and mentored training in 128 countries (www.nextgenu.org).

Recommendation II

Faculty in health professions education should be supported to develop skills and expertise in the selection and effective use of educational technologies to complement the teaching-learning process and assessment of outcomes.

- All healthcare education and delivery institutions should commit to developing and training educators in the fundamentals of learning theory and the best uses of educational technologies.
- Leaders of health professions education should create programs to support teachers in developing the skills needed to use educational technologies in their roles as curriculum designers, content organizers, coaches, facilitators, mentors, and assessors.

- Health professions education administrators should identify and implement strategies—including through promotion and tenure criteria—to engage, inspire, and reward faculty for scholarly and curricular innovations using new and emerging educational technologies.
- Health professions education programs should identify ways to best blend educational technologies and in-person learning engagement to help faculty teach in more efficient and effective ways.
- Health professions education programs should implement technology tools that support faculty in the activities of educational planning, advising and mentoring, tracking student progress, and the early identification of, and intervention with, students in need of special academic guidance and support.
- Leaders in health professions education should establish an interprofessional repository of best practices in the uses of educational technology as well as mechanisms for their distribution and ongoing development.

Examples

- Medical University of South Carolina College of Nursing has a dedicated faculty development program to teach faculty the most effective use of simulation technologies for nursing learners.
- Hundreds of health professions educators are certified through the Society for Simulation in Healthcare, signifying their competence in using simulation educational technologies (www.ssih.org).
- Several schools, such as University of California, Irvine's Institute for Online Learning, have created faculty development programs in best practices around use of new educational technologies.
- Stanford Medicine Interactive Learning Initiative is a centralized resource for Stanford's medical educators to receive consultation and other services as they consider developing online resources and new in-class sessions for interactive learning programs (<http://med.stanford.edu/smili/>).

- The Center for Medical Simulation in Boston offers week-long programs for developing healthcare educators' teaching skills for using simulation with an emphasis on debriefing (www.harvardmedsim.org).

Recommendation III

Educational technologies should be used to accelerate the transformation of health professions education to a system that is competency-driven, affordable, and accessible to each learner.

- Educational technologies should be used to assess learner readiness to participate in the care of patients and communities, document formative and summative assessments based on actual performance, and track clinical outcomes of health professionals' practices across their careers.
- Education programs should develop systems to measure and aggregate data assessing the performance of individuals, cohorts, curricula, and institutions over time, and use this information to individualize learner pathways and facilitate program improvements.
- Educational technologies should be leveraged to enable innovation and greater efficiency in fulfilling health professions accreditation standards and licensure, certification, and regulatory requirements.

Examples

- University of California, San Francisco extended its learning management system with a custom curriculum-mapping tool for health professions education competencies, entitled Ilios (www.iliosproject.org).
- Arizona State University uses an electronic dashboard to monitor the progress of all students (not health professions specific); those falling behind are provided personalized counseling (students.asu.edu/academic-success).
- The Education in Pediatrics Across the Continuum (EPAC) project is testing the feasibility of medical education and training based on the demonstration of defined outcomes rather than on time, from early in

medical school through completion of residency (www.aamc.org/initiatives/epac/).

- edX is a non-profit program created by Harvard and MIT to host online courses, including those relevant to medical education, from some of the world's best universities (www.edx.org).

Recommendation IV

Technology should be leveraged to bridge the gap between educational and clinical missions, where teaching and learning are embedded within a healthcare delivery system that continuously improves.

- Clinical and educational technologies, and local clinical policies, should be designed to permit the use of authentic clinical data, extracted from electronic health records (EHRs) and other clinical systems, in the service of educating learners, enhancing quality improvement programs, and improving the healthcare system.
- Educational technologies should be designed to include features that enable, support, and enhance educational research both within and across health professions education programs and the healthcare system.
- Technology developers should work in active partnership with educational and health services researchers to maximize the utility of technology-assisted instruction and assessment to refine instructional design and improve health professions educational and clinical outcomes.
- Health professions education programs should investigate the novel use of educational technologies, distance education tools, and collaborative/ social networking strategies to foster the development of competence in interprofessional teamwork that includes partnerships with patients, families, and communities.
- Simulation technologies should be designed to enable learners to practice both as individuals and as members of interprofessional teams, developing expertise in progressively challenging situations, free from concerns about patient safety.

- Simulation-based preparation should be designed to enable self-assessment, teamwork, and self-regulated learning, which will prepare future clinicians to sustain their lifelong professional development.
- Leaders of healthcare delivery systems and health professions education institutions should convene to discuss how health professions education learners can and do contribute value to the healthcare delivery system. This discussion should address how educational and clinical technologies can be used to further the impact of learners on healthcare value and quality.

Examples

- Nursing students use a mobile handheld electronic portfolio system to capture reflections on clinical cases at the point-of-care and provide real-time updates to remote preceptors.
- Virtual patients created by actual patients and their families provide speech-language pathology students with multiple opinions and access to cutting-edge treatments (<http://sig16perspectives.pubs.asha.org/article.aspx?articleid=1775534>).
- Virtual patients are used widely in clinical education to fill gaps in clinical exposure, and to provide learners the important experience of evaluating undiagnosed patients.
- The IBM WatsonPaths project has created an 'EMR Assistant' that uses computer intelligence to help providers uncover key information from patients' medical records, in order to help improve quality, efficiency, and the steps of clinical reasoning leading to a final diagnosis (<http://www.research.ibm.com/cognitive-computing/watson/watsonpaths.shtml>).

Recommendation V

Leaders of health professions education programs should employ technology to analyze community and population data and use those data to continuously inform the design of curriculum content and learning experiences to reflect the contemporary health and healthcare needs of society.

- Educational technologies should be used to collect data that support educational programs' focus on community needs and priorities.
- Health professions education faculty should leverage health informatics tools to directly support quality improvement activities (e.g., by aggregating clinical and financial data and facilitating analyses to identify local health needs).

Examples

- Indiana University has created a teaching EHR that is a clone of an actual clinical care EHR, populated with panels of patients for students to manage with information gleaned from de-identified patient data.
- In New York University's *Healthcare by the Numbers* curriculum, students conduct their own "big data" analysis of public data on over 5 million New York hospitalizations to understand social determinants of health (education.med.nyu.edu/ace/sparcs).

Recommendation VI

Educational technologies should be used to facilitate the sharing of content and integration of data across systems and programs, thus promoting the scalability and adoption of efficient and effective educational strategies.

- Leaders of health professions education programs should work collaboratively across their educational, clinical, and research missions, and in partnership with technology developers, to implement technical standards for sharing data among the electronic health record, learning management system, and longitudinal learning portfolio. Connecting these systems will lead to an ecosystem of applications and data that drives continuous improvement of educational programs, individual learners, and our healthcare delivery systems.
- Electronic learning and computer-based assessment systems should be designed to permit learners and faculty to access/extract their learning data "anytime, anywhere." Such data portability will allow them to maintain a continuous academic portfolio as they cross the boundaries of programs and institutions.

- Health professions education programs should adopt educational technologies that will facilitate easy repurposing, re-sequencing, and reuse of content to adapt to different contexts, types of learners, educational objectives, and economic circumstances.
- Accreditation and regulatory bodies should leverage educational technologies to simplify and streamline compliance with the educational standards and professional requirements they oversee (licensing, registration, certification), and enable transferability/reciprocity across jurisdictional and organizational boundaries.

Examples

- Mayo Clinic is using EHR-integrated education to standardize clinical practice and automatically document practice-based learning by providers.
- “Infobuttons” embedded within the EHR provide nurses with patient-specific education and links to medical evidence.
- The Vanderbilt KnowledgeMap system performs real-time analysis of medical student clinical notes and maps them to the curriculum (knowledgemap.mc.vanderbilt.edu/research/).
- Tufts University’s TUSK is an open-source curriculum management system and content repository for health sciences that enables interprofessional curriculum development, linkages to competencies, and easy sharing of content across disciplines and institutions (www.opentusk.org).
- The National Council of State Boards of Nursing established the Nurse Licensure Compact to expand interstate mobility of nurses to practice in other compact states through a single multistate license issued by their home compact state. An electronic licensure information exchange system enables implementation and tracking of regulatory compliance across state jurisdictions (www.ncsbn.org/nurse-licensure-compact.htm).

CONCLUSION

Wherever care is delivered there must be ongoing teaching and learning, and all participants including patients should be considered both learners and teachers. These recommendations are designed to leverage technology to build a continuously learning health system for the future. In this system, all learners—from novices to advanced practitioners—will be empowered to shape learning opportunities for their own needs, guided by qualitative and quantitative feedback data from faculty, clinicians, and learners. Also in this system, the purpose of education is learning that improves patient experiences, patient outcomes, and the health of the public.

Our six recommendations focus on the use of technology in the creation of a learning system to enhance the education of all health professionals. We need leaders to guide this system transformation, and we need wisdom to help identify which technologies are appropriate for which programs, cultures, topics, teachers, and learners. And we need skilled technology professionals to create new technologies where existing ones are not sufficient or optimal.

We believe that technology—guided by leaders and enabled by appropriate organizational, governance, reimbursement, and regulatory processes—will allow us to create the incentives and the culture for building a continuously learning health system.

This new system promises nothing short of a revolution in health professions education and healthcare delivery. The continuously learning health system acknowledges and celebrates the natural symbiosis that can and should exist between health professions education and healthcare delivery. Even though they have evolved separately, they now must be integrated on behalf of patients, families, and communities to fulfill their mutual social contract to improve the health of the public. We are at an optimal moment in time to align all these factors and harness evolving technologies to achieve these goals. We must seize this opportunity now.

Table 1: Representative Educational Technologies Used in Health Professions Education³

Technology	Examples in Health Professions Education (HPE)
Technologies for face-to-face instruction	
Audience response systems (ARS)	Nursing students may use ARS to provide immediate feedback on interactive quizzes.
Electronic whiteboards ("SmartBoards")	Used to augment live lectures that broadcast the instructors' "chalkboard" drawings to remote learning sites.
Generative learning activities	Medical students in a problem-based-learning course collaboratively authored wikis to teach each other in small groups.
Technologies for online instruction	
Augmented reality and virtual learning environments	Augmented reality devices have been used during basic science lectures to enhance the experience with clinic-based patient interviews and exam findings.
Learning management systems	HPE programs use a variety of commercially available products to support both live and online course administration.
Learning objects and course materials	Many HPE schools use online learning modules and supplemental online course materials.
Massive open online course (MOOC)	Health professions educators have created MOOCs on rural health nursing and the healthcare system.
Medical visualizations	3D anatomy simulators are used to teach complex anatomic and dynamic physiologic topics in new ways.
Mobile devices and apps	Several HPE schools are issuing mobile devices to learners; both faculty and students are developing apps and resources for teaching and assessment.

³ This is an abstracted version of Table 1 from the commissioned paper "Educational Technologies in Health Professions Education: Current State and Future Directions," by Cook and Triola. These examples are intended for illustrative purposes only and their inclusion does not connote endorsement.

Technology	Examples in Health Professions Education (HPE)
Technologies for simulation-based instruction	
Mannequins	Lifelike full-body and torso models of a complete human are in broad use for clinical education in all HPE fields.
Part-task trainers and workstations	Anatomical physical models that simulate a portion of the body or simulators used to train specific clinical tasks (e.g., interventional cardiology, laparoscopic surgery).
Virtual hospitals	Some hospitals maintain simulated clinical spaces, such as operating and emergency rooms in which learners can practice teamwork, communication, and clinical workflows.
Virtual patients	Virtual patients developed through a collaboration involving a non-profit and national education organizations are in use in more than 90% of medical schools.
Virtual reality (VR) simulators	VR simulators, which provide an immersive sensory experience that simulates a physical place, have been used to practice teamwork and emergency incident response.
Technologies for assessment, evaluation, and administration	
Curriculum mapping tools	Schools are increasingly using these tools to support “mapping” a curriculum. Doing so helps identify redundancies, gaps, common themes, and other opportunities for improvement across classes and program years. Mapping also facilitates connecting course objectives to competencies and milestones.
Computer-aided assessment	In broad use across HPE, these strategies include computer-based quizzes, exams, and assessments. Advantages include automated grading, instant feedback, multimedia and interactive questions, enhanced security, and automated analytics.
Learning analytics	Analytics are being used to answer complex questions about effective teaching and learning, and to render suggestions to optimize education for both individual students and educational programs.
Learner portfolios and coaching systems	Many schools are using portfolios to facilitate the assessment of, and reflection on, information about learners’ educational achievements, performance, and progress.
Technologies that integrate with clinical practice	
Bedside clinical technologies	Clinical technologies are being used by HPE learners to collect data in real-time from patients at the bedside. Learning how to accurately capture and interpret clinical data will enhance patient-centered education.
Point-of-care learning	Academic medical centers are leveraging EMRs, clinical decisions support systems, and computerized provider order entry systems to not only deliver care, but to teach learners about systems, populations, and healthcare quality.







COMMISSIONED PAPER

SWIRL: TRAJECTORIES FOR DIGITAL TECHNOLOGY IN HIGHER EDUCATION

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INTRODUCTION: WORKING WITH TRAJECTORIES

“We look at the present through a rear-view mirror. We march backwards into the future.” – Marshall McLuhan

In this paper, we will be exploring the role of digital technology in higher education teaching and learning over the near term. To do so, we will be thinking in terms of *trajectories* rather than predictions. A prediction asserts that a state of affairs will be obtained sometime in the future. But any unforeseen factor will render the prediction false or off target, and as those variables increase, so too does the likelihood that the prediction will fail. Predictions, too, tend to be mostly projections of the current and the known, ornamented with something that provides a futuristic hue. This is what McLuhan was getting at in the quote above. The fragility of predictions easily becomes conspicuous. Annually, we see lists of predictions at year’s end, but even forecasts looking ahead no further than the next 12 months often end up missing the mark.

A more vivid example is provided by the illustration. In 1910, the French artist Villemard made a series of drawings, depicting life in the year 2000. One of the drawings makes a prediction of what school will be like in 90 years. What is clear is that this prediction is the projection of the then-



Villemard illustration:
school in the year 2000

current understanding of how learning works, namely the transmission of content. Villemard's school of 2000 simply has found ways to accelerate and automate the knowledge transmission process. Indeed, many of Villemard's illustrations make this same basic assumption, namely that in 2000 what we do is the same, but has been automated and sped up by technology.¹

This conundrum of predictions may be at its most acute when it comes to developments involving digital technology. Although the acceleration of change, enabled by digital technology, is apparent and familiar, it still can be unsettling. Companies that one day seem to be in firm control of their markets, such as Nokia and Blackberry, can in what seems like an instant find themselves on the margins, if not out of business altogether. Suddenly we are no longer playing CDs or even owning our music. With change tumbling at this accelerated tempo, it is hard to get the bearings that enable us to think about predicting the future.

With a trajectory, we know where something is *headed* but we cannot say—or we refrain from guessing—where it will *end*. Working with trajectories is an admission that we cannot foresee the unanticipated factors and developments that might influence the trajectory, accelerating it or perhaps derailing the trajectory entirely. In this sense, working with trajectories is a more humble and realistic way of facing the future. A trajectory is also far less fatalistic than predictions. The latter asserts that this is where we *will* end up, whereas with a trajectory we see where we *might* end up.

HIGHER EDUCATION IN TRANSITION

“...it's always been true that whatever pleases teaches more effectively.” Marshall McLuhan

To be meaningful, any discussion of the role of digital technology in post-secondary education must be situated within the overall context of higher education. The *Horizon Report for Higher Education*² is a good example of this kind of contextualization about technology. The core purpose of the publication is to identify emerging technologies relevant to higher education and to anticipate the time when the technology will be in widespread use (the adoption horizon). The first issue (2004) dealt exclusively in describing the technologies, but already in year two the *Report* was embedding the technology discussion in the context of the trends and challenges facing higher education. Today the *Report* is essentially

a triangulation of higher education trends, challenges, and technologies, which illustrates how interconnected and mutually influential they are.

To begin, I would suggest that the meta-trajectory or “über-trajectory” is that of higher education in an unparalleled period of transition. Many may argue that higher education is not transitioning nearly fast enough. But relative to its past, it is clear that higher education is going through transitions at a scope and tempo unlike anything in its past. It is unclear where this will end or even if it will end.

In terms of teaching and learning, I would like to suggest three trajectories (or perhaps characteristics) that provide the context for the technology discussions to follow: personalization, hybridization, and big data. *Personalization* refers to our growing capabilities and willingness to use digital resources to create custom pathways for learning and degree success. Today, both learners and instructors can integrate a wide array of personal resources, connections, and collaborations, all for the purpose of creating unique pathways to achieve personal educational goals. Indeed, at the institutional level as well, there are now opportunities, enabled by custom implementations of academic analytics, to establish collaborations with traditional and non-traditional partners, invent new practices, and to fashion hybrid courses and degree programs.

One of the clearest illustrations of developments in this area may be MIT’s exploration of modularizing its curriculum, breaking its courses down into modules and enabling students and instructors to “reassemble” the modules to construct personalized educational pathways. Indeed, the report explicitly likens this process to constructing a playlist in iTunes.³ Developments such as these lend credence to the suggestion that we have entered the “post-course era” in higher education: the course is no longer the curricular “atom” or fundamental building block.⁴

In this respect, higher education is going through the disaggregation/re-aggregation process that has visited other industries. Digital technology has disrupted the music industry, allowing individuals unprecedented capabilities to craft their personal music environments. The same process is occurring within higher education, as witnessed by phenomena like student swirl, where a student builds a multi-institutional pathway to a degree.⁵

The second trajectory is the *adoption of hybrid learning models*.⁶ This is fueled by two factors. One is the abandonment of the transmission model of education.

Research solidly supports active learning as a far better mode of learning than transmission.⁷

The second factor is the expansion of the online dimension across all venues of higher education, including institutions (such as liberal arts colleges) that traditionally have valued intimate, face-to-face learning. Higher education's "affair" with the massive open online course (MOOC), though now waning, has had one lasting impact. It has greatly accelerated higher education's "migration" into online education.⁸ Significantly, these explorations in online learning also enable instructors to import elements of online pedagogical practices into the traditional face-to-face venues, resulting in hybrid course designs. It has provided institutions with the invaluable opportunity of redefining and revitalizing their faculty development efforts. In this area—as almost everywhere—digital technology is the strategic enabler.

These first two trajectories are intertwined. Instructors, instructional designers, and students can invent and modify learning models and pathways as needed to achieve more individualized learning goals. This idea is captured in the 2014 *Horizon Report*: "Instructors can also leverage components of online learning to make personalized learning scalable in large introductory classes. Compared with the traditional model of learning, in which space is needed to accommodate hundreds of students, hybrid learning can address the learning path of each individual student."⁹

The latest articulation is the rapid growth of competency-based education (CBE), for both courses and degree programs. Over the past year, CBE has evolved from being on the margins of higher education to being the successor to the MOOC in terms of holding higher education's interest as a key point of innovation for promoting increased institutional success in its teaching and learning mission.

The third trajectory is the *analysis of ever-increasing amounts of data and the increasing influence those analyses have in the conduct of higher education*. This use of so-called "big data" affords much more nuanced and timely insights into all kinds of learning processes. It enables the creation of custom reports tailored to specific learning contexts, ranging from institutional dashboards to personalized assistance for learners. It provides the basis to measure progress toward institutional strategic goals. Equally important, analytics enables interventions in nearly real time. This contributes greatly to learner and instructor success, as it allows the institution to assist students at the very moment they appear to be falling behind.

TECHNOLOGY TRAJECTORIES

“If it works, it’s obsolete.” – Marshall McLuhan

In a single paper such as this, it would be impossible to completely describe the role and trajectories of digital technology in higher education teaching and learning. Digital technology is the very fabric of nearly everything associated with teaching and learning. We can think of this as the first technology trajectory: digital technology is the core strategic enabler of learning in higher education. To quote a recent EDUCAUSE publication: “Today every project is an IT (information technology) project.”¹⁰ Given how thoroughly students and instructors are using digital technology, we can no more see an end point for this trajectory of strategic enablement than we can imagine a point where we no longer use cars.

A core trajectory of digital technology in higher education is the shift away from thinking of it as IT *infrastructure* and toward conceiving it as a *digital learning engagement environment*.¹¹ For those of us who have worked in higher education IT, this is an immense shift in our thinking. It means that the technology itself is no longer in the foreground; instead, our attention is focused on the learning and learning practices that it enables. The trajectory here is that the academic digital environment will be less about the applications that the IT organization selects on behalf of the campus and more about creating an open and integrated digital environment that enables students and instructors to use their own tools and resources.¹²

The “old school” way of thinking about IT in the context of higher education was as infrastructure, as a set of tools and functions (hardware and software) that campus users could use. It was bit like proffering a toolbox with hammers, screwdrivers, and saws, making it available for use. Seen this way, digital technology resembled the library’s book collection, an assemblage of tools that could be utilized or not. Components included campus networking, the data pipes that convey digital information, servers, and the applications that run on those servers. Issues like privacy, security, and accessibility have all been part of this mix. Traditionally, the higher education IT landscape has been divided into silos, such as administrative computing and academic computing. Indeed, in this old school paradigm, at larger institutions it is not uncommon for the chief information officer (CIO) to be focused on administrative computing, networking, and security, and not on teaching and learning success.¹³

One way to see the shift that has since taken place is to look at the evolution of the *Horizon Report*. When first published in 2004, the report identified "...six technologies that the research suggests will become very important to higher education within three adoption horizons over the next one to five years."¹⁴ The focus was clearly on technology. If we fast forward to the 2014 edition, we see that the focus has evolved to identifying the "important *developments* in educational technology for higher education."¹⁵ Indeed, some of the six developments identified in the 2013 and 2014 reports can hardly be called technology, such as MOOCs and the flipped classroom.

Shifting to the perspective of a learning environment means that what is in the foreground is no longer the tools themselves, but rather what practices those tools enable. To put it metaphorically, it doesn't matter what hammer you use if hammers are ubiquitous and largely the same. Instead, what matters is the object you are using the hammer to build. Whether you use a tablet, laptop, this or that app, this or that cloud service: all that really matters is what it *enables* you to do.

Thinking of the digital landscape as a learning environment brings into relief another trajectory, that of a renewed focus on the learner and the learning process. This does not entail an abandonment of faculty and instructors. On the contrary: since there is no learning without instruction, faculty development is still of core, strategic importance.¹⁶

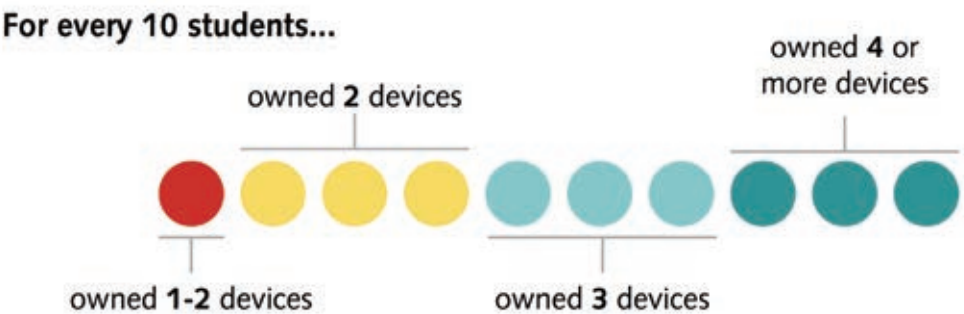
Thinking of the digital landscape as a learning environment grants it an almost organic coherence, designed to enable the fundamental teaching and learning mission of the campus. Further, it is conceived of as being learner-centered, with the goal of learner success as the cornerstone. It is conceived, not as being around courses (e.g., the first generation learning management system, LMS), but rather about engaging instructors and students alike around the learning enterprise in all its dimensions, with the bottom line being the success of learning. It sets for all campus players the ambitious goal of a learning ecosystem that is responsive and can be personalized.

INDIVIDUAL TECHNOLOGY TRAJECTORIES

Device ownership and mobile first

In the past, there was much discussion of the digital divide. In higher education, it was the problem of some students being able to afford digital equipment whereas others could not. While not altogether resolved, the trajectory here is that the picture has shifted. The combination of lower costs for hardware and the mobile computing revolution of the past decade has altered this landscape. Mobile computing is a key technology in teaching and learning, and the trajectory is that it will continue to be so.

One way to appreciate this trajectory is by taking a look at results of the annual student study, conducted by the EDUCAUSE Center for Analysis and Research (ECAR). A decade ago, the 2004 student study revealed that student technology ownership was divided between desktop and laptop computers. Most owned only this single device. The ownership of “personal digital assistants” was just under 12%.



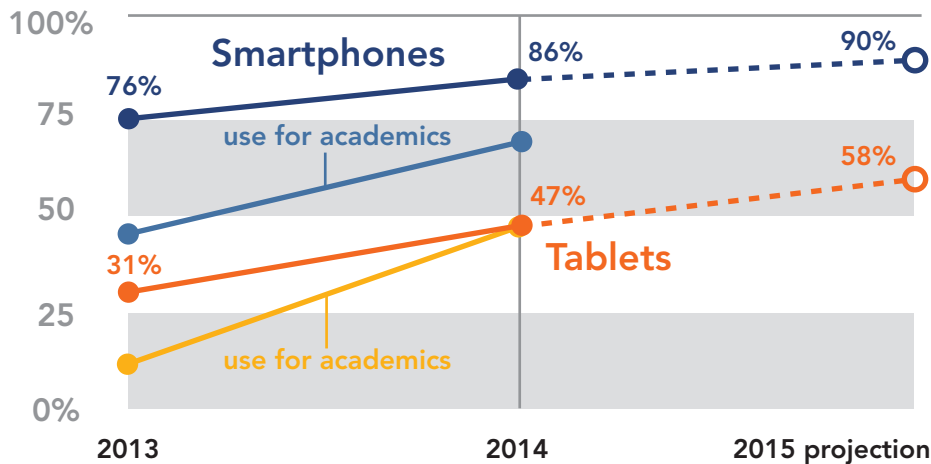
ECAR 2013 student study: student device ownership

If we jump to the most recent studies, we see how thoroughly this landscape has changed. According to the results of the 2013 study, 30% of the respondents owned four or more “internet-capable devices, such as tablets, smartphones, gaming consoles, and laptop computers.” Ownership of smart phones and tablets had increased by 14% and 15%, respectively, over the previous year (2012). According to the 2014 study, smart phone ownership jumped to 86% and is projected to be 90% in 2015. Tablet ownership in 2014 jumped to 47%, and its 2015 trajectory is 58% ownership. Significantly, the percentage of students using these

devices directly for academics is increasing: moving from roughly 50% (2013) to 70% (2014) for smartphones, and for tablets from 12% to close to 50%.

DEVICES

Mobile device ownership continues to grow...



...and use for academics also continues to grow

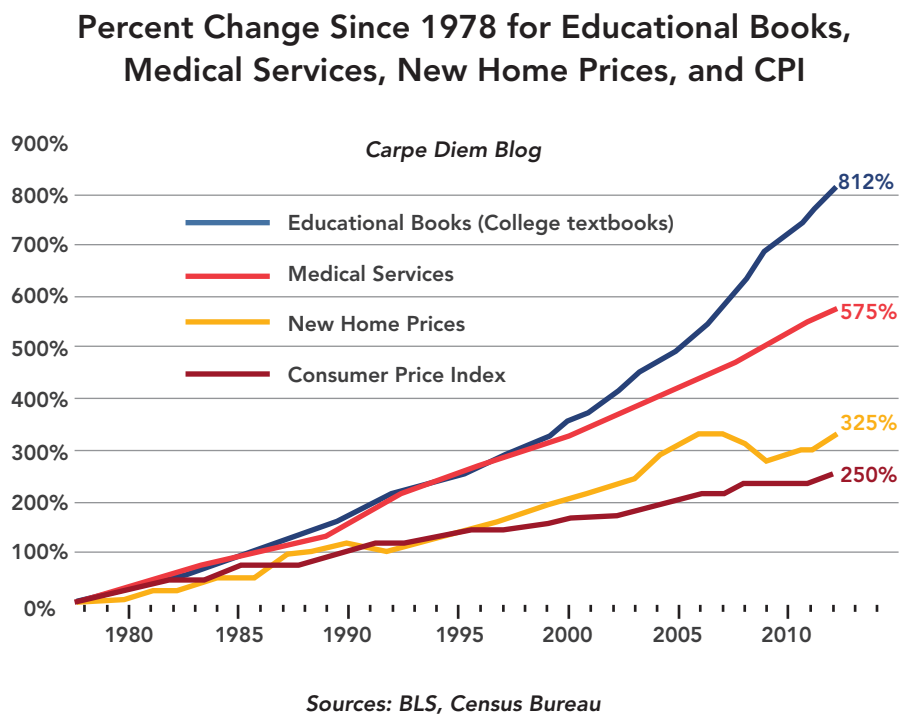
Such ubiquity enables institutions to leverage the mobile environment. Many are moving to a “mobile-first” approach. One of the first schools to make the move is Abilene Christian University, which has, since the introduction of the iPhone, integrated mobile technology into its courses. Lynn University is moving its LMS functionality off the traditional LMS application and onto a component-based approach, one informed by this mobile-first approach.¹⁷ Tennessee Technical University’s Mobile Learning Environment and Systems Infrastructure, first introduced in the College of Engineering, is now poised to be introduced more broadly through the curriculum.¹⁸

Mobile technology affords students and instructors an unprecedented degree of independence from the campus IT organization. Certainly they need campus networking, but even here, their cell phone connectivity provides Internet access. It is helpful if the campus has an agreement in place for Google docs, but if it doesn’t, they can use Google docs anyway. The use of apps, such as VoiceThread for audio annotations or diigo for collaborative tagging, requires neither permission from nor enablement by the campus IT organization, again apart from networking. To access

resources from iTunesU or to participate in a MOOC requires only the campus network; instructor and student devices do the rest.

The textbook and open educational resources

This trajectory is surprising. The textbook is undergoing a remarkable bit of evolution: it's vanishing, at least in its traditional form as a book whose text is furnished by a third-party company and is sold at the campus bookstore. As paradoxical as it sounds, this is due largely to the companies that have in the past provided textbooks for higher education, companies such as McGraw-Hill, Cengage Learning, and Pearson. These companies are coming to view that profits lie in the value they can add to the core text, and not in providing the texts themselves. These companies "...just want to be out of the *textbook* business. They want to sell software and services that are related to educational content, like homework platforms or course redesign consulting services."¹⁹ We read something similar in this blog post: "The textbook publishers are well aware of the expanded competition presented by the Internet, and have begun to adjust their business models accordingly. Pearson, for example, is shifting from the supply of educational *materials* to the provision of education *services*. Such services include testing, assessment, student information systems, and course management platforms."²⁰



One dimension of this trajectory is the decline of the purchase of commercial textbooks, driven largely by their increasing costs. We see from the accompanying chart, based on information from the US Census Bureau, that the trajectory of the increase in the prices of textbooks is very steep indeed. This has motivated students and instructors alike to seek alternatives. According to the ECAR student study, 71% of students used open educational resources (OER) in 2013 (up from 25% in 2010), and 54% say they are extremely important. The ever-growing abundance of ancillary content relevant to education, such as iTunesU, MOOCs, and repositories like OpenStax CNX, enable students to skip purchasing core textbooks altogether and instead seek basic explanations of content from these open resources. The course textbook is no longer a requirement, but an option.

There are also initiatives entirely devoted to making it possible for students to create their own custom course content, largely from OER. The company Boundless will actually mimic the table of contents of a commercial textbook, supplying OER alternatives for each chapter of the book. The BlueSky project uses a specially designed search engine, called Gooru, to enable anyone to find appropriate OER. As an indication of how rapidly untraditional all this is becoming, BlueSky is owned by Pearson, but at the same time, Pearson is one of the major companies suing Boundless.²¹

This trajectory seems to counsel us to expect the classic higher education textbook to continue its vanishing act, replaced by a variety of resources, the most important of which is OER. We also may expect to see the traditional commercial companies invest in services such as adaptive technologies.

Adaptive learning technology

Situated “next door” to OER is adaptive learning technology.²² This appears to be the core service on which textbook publishers are betting. Adaptive learning technology is in its start-up phase, similar to where learning analytics was two years ago. While its trajectory is not fully established, the interest around adaptive technology is keen, and it certainly has the potential to exert a forceful influence on teaching and learning over the next three to four years.²³

Adaptive learning technology takes a “non-linear approach to instruction and remediation, adjusting to a learner’s interactions and demonstrated performance level and subsequently anticipating what types of content and resources learners’ need at a specific point in time to make progress.”²⁴ It is then a kind of automated

tutor. What is fascinating is how quickly the major textbook publishers have cast an anchor into this technology:

- Pearson has teamed with Knewton to offer MyLab and Mastering adaptive learning tools for a broad range of subjects, mostly in the sciences.
- McGraw-Hill has introduced ALEKS and Smartbooks, the latter based on their LearnSmart adaptive technology.
- Macmillan's New Ventures division has a partnership with Knewton and has access to PrepU's technology.
- Wiley has announced a partnership with Snapwiz to produce a new product called WileyPlus.

There are other companies and even universities in the mix here as well:

- Companies such as Smart Sparrow, CCKF, and ScootPad.
- The LMS company BrightSpace (formerly Desire2Learn) acquired the startup Knowillage and its adaptive learning technology called LeaP.
- In Europe, roughly a dozen institutions have formed the INTUITED consortium, with the objective "to enhance e-learning content and learning management systems with features that so far have been provided only by human tutors."
- The University of Phoenix has invested considerably in its adaptive learning technology "Academic Activity Stream."
- Professors at Ohio University created an adaptive learning module (called MOOCulus) that they grafted onto the Coursera platform for their MOOC on calculus.

Adaptive technology has established a beachhead in higher education practice. Notable early projects include Arizona State University's use of Pearson's MyLab and Essex Community College's use of ALEKS. Reports from these projects are mixed, as is to be expected with a young technology that is just getting going. The considerable interest²⁵ and investment promise are combining to make this a key technology for the foreseeable future.

Learning spaces

The term "learning spaces" is an umbrella term referring to physical spaces specifically designed to accommodate learning activities, including (but not limited to) formal classrooms, the learning commons, labs, and makerspaces. The trajectory

here is that these spaces are evolving away from being places of presentation and toward being places of discovery, invention, and knowledge construction.²⁶

The makerspace²⁷ is perhaps the clearest example of this. Currently these rooms are places for invention using physical objects. Often these rooms house a variety of equipment, available to students individually or in teams. As always, technology provides a very wide range of possibilities. 3D scanning and printing technologies are common to almost all makerspaces, enabling students to capture and reproduce objects in three dimensions. Programmable circuit boards, such as Arduino and Raspberry Pi, enable a wide variety of projects. Some schools, seeking to enable as wide a range of projects as possible, provide equipment such as sewing machines, miter saws, computerized routers, 3D microscopes, large sheet printers, oscilloscopes, and soldering irons. The idea is to provide raw materials and tools to foster discovery and invention.²⁸

But this trend toward discovery, content sharing, and knowledge creation is not limited to makerspaces. Increasingly it informs formal and informal learning space design, and once again digital technology is the enabling agent. Wireless projection is a good example. Until recently, access to projection on the main classroom screen was limited to the person at the podium, reinforcing the message that the classroom was more about presentation than participation. Over the past year, it has become common to install wireless projection capabilities, which enables any participant, appropriately equipped, to project his/her material on the main screen. Wireless projection also allows the instructor to roam the room, controlling the display of content using a tablet.

Technology further enables team-based classroom design. These designs are also called scale-up or active learning classrooms.²⁹ Traditional classroom design provides seats in rows with a podium for the instructor at the front. This design is informed by the idea that the primary purpose of the room is to enable presentations by the instructor. By contrast, team-based classrooms provide seating at circular tables, with 6 to 10 seats per table. Most often the room has no “front” in the traditional sense. The team-based room is designed to make collaborative student work the focus of face-to-face class sessions. The instructor functions as a guide or mentor instead of presenter. Students, working in teams, learn by actively working in collaborations and partnerships. These designs are enabled by extensive wireless networking, display screens distributed around the room, room-wide access to electrical power, and mobile furniture.

The learning space trajectory clearly embodies the “new” priorities of learner-centeredness, the social/collaborative dimensions of learning, and the importance of active learning engagements.³⁰ The built environment is particularly conspicuous, both because of its cost and since it physically affords certain kinds of usage while discouraging others. Classrooms are “architectural embodiments of educational philosophies.”³¹ New designs, such as the team-based classrooms, offer faculty the opportunity to completely rethink and transform their pedagogy.

The learning management system

Much like the institution’s student information and fiscal administration applications, the learning management system is now a fixture of the higher education technology landscape. Since its inception in 1997, the LMS has matured to the point where nearly every institution of higher education runs at least one LMS. This success notwithstanding, it is clear that there is widespread impatience with what we might call the “LMS 1.0.” The trajectory here is the collective anticipation of and investigation into an entirely new model for this function, one that is, from the ground up, learner-centered, unlike the LMS 1.0’s orientation around the course. The community is clearly seeking to replace the current LMS with a robust and comprehensive digital learning environment.

While it is somewhat trendy to deride the current LMS, a recent ECAR study shows very clearly that the LMS 1.0 has been a success.³² What the report makes very clear is that the current model of the LMS is very effective — both from its design and from the way faculty use it — for the *administration* of learning, especially in the conduct of a course. According to the study, 99% of institutions have an LMS in place, and on average 85% of faculty use it. Further, 56% of students report that they use it in most if not all of their courses. For post-secondary teaching and learning, this level of adoption is unprecedented.

In contrast to these high percentages, the percentages of students and faculty who use the more advanced features are low. According to the study: “Faculty and students value the LMS as an enhancement to their teaching and learning experiences, but relatively few use these systems to their full capacity.”

While the ECAR study reports that overall satisfaction with the LMS is high for both instructors and students, we also learn that—paradoxically—that one in five institutions intend to replace their LMS in the next three years.³³ Compared with the turnover rate of administrative enterprise applications, this is a significantly large

percentage, suggesting a fair degree of restlessness. This restlessness is due in large part to the increased emphasis within higher education on the *learner*, while the LMS 1.0 was designed primarily with the *instructor* in mind.

What would a LMS 2.0 look like? EDUCAUSE, in partnership with the Bill & Melinda Gates Foundation, has been conducting research into this very question. The research has revealed five dimensions that will be important to the re-imagining of the LMS.

1. **Interoperability and integration.** Integrating third-party applications and customizing the LMS to integrate with the campus environment has been difficult and expensive. The development of interoperability standards, such as those promoted by IMS Global Learning Consortium, will play a very large role in the future.³⁴
2. **Integration of education analytics.** The new digital learning environment will need to be able to accommodate a wide variety of tools and applications that enable faculty, students, and administrators to track progress toward learning and completion of goals, in something close to real time.
3. **Personalization and customization.** As we discussed earlier, the successor to the LMS must support multiple learning modes, as well as personally designed pathways and arrays of custom course content.
4. **Collaboration support.** Collaboration and the social dimensions of learning have emerged through research and practice as key elements of deeper learning engagements. The new digital learning environment must be able to support the formation and conduct of learning collaborations, at both the intra- and inter-institutional level.
5. **Accessible designs.** Learning involves not just the consumption of content but also the creation of knowledge artifacts. The designs of the new digital learning environment will need to be truly universal, ensuring that *all* learners can both participate *and* express.

To achieve all of this, a new paradigm is needed. In the past, the instinct of the IT community, when confronted with a challenge like this, would be to develop a new and “large” enterprise application, built to meet the new requirements, such as those described above. But it is no longer clear that this classic approach will work. The construction of a single application assumes that a single design can meet the needs of the majority of schools, instructors, and students. But if one thinks about

the diversity of schools, instructors, and students that constitute higher education, the idea of one-size-fits-all seems dubious, especially in a post-course era where personalized, custom education pathways are emerging as the priority.

One sign of out-the-box thinking about the LMS of the future is the formation of the Unizin consortium.³⁵ Unizin explains itself this way: “The Unizin Consortium is universities coming together in a strategic way to exert greater control and influence over the digital learning landscape. It enables each institution, its faculty, and students to draw on an evolving set of tools to support digital learning for residential, flipped classrooms, online courses/degrees, badged experiences for alumni, or even MOOCs, if desired. Unizin supports the differing missions and strategies of universities.”

Almost exactly a decade ago, at a similar moment of restlessness with the LMS, several universities pooled resources to build their own LMS application, called Sakai. Today, Unizin is taking a very different approach: it will be a set of pooled resources and volume purchasing discounts. The key is Unizin’s goal to facilitate the promotion of a digital learning environment, while at the same time recognizing that institutions will have different cultures and priorities. Every school in the Unizin consortium will blend the components in a way that is appropriate to its culture and its strategic ambitions.

Learning analytics and dashboard advising systems

All analytics for teaching and learning are intended to increase student success. The key ingredient is sustaining student momentum.³⁶ Research indicates that students who experience early success in a learning endeavor tend to complete courses and degree programs at higher rates than students who do not experience early success. It also is now becoming clear that students who are metacognitively participatory in their learning also experience higher success rates than students who do not. Analytics for teaching and learning seek to promote learner success by providing near real-time information to instructors and advisors to help them build and sustain positive learner momentum. Analytics that are student-facing also seek to address the metacognitive dimension by providing data to the learner so that he/she has a more objective basis for learning decisions.

We will focus on two types of analytics for student success. One we can call *learning analytics*, which enables instructors and students to monitor engagement and progress at the course level. The other is *integrated planning and advising*

services (IPAS), an enterprise-level technology that blends data from a variety of campus systems.

Learning analytics. The adoption of learning analytics has been accelerated by the integration of these capabilities into the major learning management systems. This enables a campus to license a learning analytics module, flip the “on” switch, and quickly provide this service. For example, Blackboard, Desire2Learn, and Canvas have all released learning analytics modules for their LMS applications (all called “Analytics,” as in “Blackboard Analytics” and “Canvas Analytics.”) They all provide similar capabilities: identifying at-risk students, measuring student engagement and participation, and ways to see which curricular activities seem to be producing the best results. This is now an established technology and its trajectory suggests that it will continue to see increasing adoption.

While integration with the core LMS makes it relatively straightforward to provide learning analytics services, the key question is whether students and instructors will avail themselves of those services. In the past, the majority of instructors have confined their use of the LMS to its more basic functions. The integration of these services into dashboards and presentation of analysis using charts and graphics could well contribute to more widespread adoption. The other question is how vigorously institutions work to encourage instructors to use learning analytics and how much support is provided to conduct the interventions needed when a student is flagged as being at risk.

Integrated planning and advising services (IPAS). Learning analytics can be seen as a part of the larger IPAS suite of student success services. IPAS seek to realize a comprehensive vision: a technology-enabled and integrated digital environment that provides students, advisors, and faculty with these capabilities:

- education planning (identifying the degree and the best path to its achievement);
- progress tracking (is the learner on course toward degree completion?);
- advising and counseling (services such as mentoring and tutoring); and
- early-alert systems (pro-active intervention with at-risk students).

The top “drivers” for investing in an IPAS system “are the strategic priority of student success and the desire to reorient the institution from an enrollment to a completion culture.”³⁷

At the technology level, IPAS requires a fluid exchange of data between major applications such as the student information system (SIS) and the learning management system. At the level of institutional culture, IPAS requires a viable cross-institutional partnership between IT and other campus offices. The key stakeholder groups are faculty (who often have workload concerns) and, of course, students.

The analytics trajectory is one of growing and fairly rapid adoption. In light of this momentum, it is likely to be a key and increasingly ubiquitous academic technology in the future. As the ECAR IPAS benchmarking study put it: "IPAS is coming to a student success effort near you. Our study-group institutions overwhelmingly said it is important to their efforts and that they plan aggressive adoption and investment."³⁸

CONCLUSION: SWIRL

**"We shape our tools and afterwards our tools shape us."
– Marshall McLuhan**

In higher education, the term student swirl refers to the practice of students formulating a custom, multi-institutional pathway to a degree. This is not a recent term; one source suggests it originated in 1990 by administrators at Maricopa Community College. We do know this phenomenon is gaining momentum, with the number of students who swirl increasing.³⁹

Student swirl is essentially a disaggregation/re-aggregation cycle. Traditionally, learning and degree conferral were aggregated into a single institution. The hop from a two-year institution to a four-year institution was the nearest thing to student swirl. Today, the traditional aggregation of learning and degree conferral has broken apart. Students now have more options. In short, the path to the degree no longer is nor needs to be linear or uniform in the traditional sense. The image of swirl is a good one for this phenomenon, as it connotes movement, unpredictability, and motion. Again, it is digital technology that is the enabler.

Other traditions have broken as well, such as the traditional four-year path to an undergraduate degree and even the degree itself. The tempo of progress toward academic goals can accelerate or decelerate, depending on the requirements

of the learner. Indeed, there are already indications shifts in *pacing* have arrived: the NYU School of Medicine, for example, now offers an accelerated track to the MD degree, a development about which there is some discussion.⁴⁰ As to the degree, schools are exploring badging and micro-credentialing as ways to mark progress toward an academic goal, especially in the domain of competency-based education.⁴¹ Obviously there are discussions and debates we must have about the quality of these new, “swirled” academic pathways, but the options have emerged and are being explored.

If swirl is essentially a disaggregation/re-aggregation process, then technology in post-secondary education is undergoing swirl as well.

Consider just some of the key trends we have looked at in this paper:

- the eclipse or morphing of the campus IT organization, both in its role as the provider of the IT environment and also with respect to its role in teaching and learning;
- the increased independence of instructors and students, using their own tools to form their own connections, resulting in custom pathways to achieve learning goals;
- the trend away from large central applications, run on campus servers, in favor of confederations of apps, many of which run in the cloud;
- the increasing importance of interoperability and interface standards;
- the increase in multiple mobile device ownership; and
- the capacity of data analytics to proffer custom portraits of learners and to make predictions and suggestions based on those portraits.

In each case, there is a similar pattern: an individualization or fragmentation, together with a re-assembly of the micro-units into new, custom configurations. This swirl in post-secondary educational technology is perhaps the most important trajectory of all. Indeed, it is tempting to conclude that post-secondary teaching and learning is undergoing swirl as well: we need only recall the MIT idea of disaggregating its courses into modules, enabling custom re-aggregation by students and instructors. That means we have entered into a period of both *dislocation*, when the known and familiar begin to disappear, and *relocation*, where we invent new methods, techniques, and configurations. But perhaps what characterizes our current situation best is the rapid tempo of these swirl processes, a tempo that shows no sign of abating.

It is a time that is both stressful and energizing, with both loss and new opportunity. Perhaps our task as educators is to carefully sift through these new options, being wary of both clinging to the past as well as of digital snake oil. Perhaps the fundamental challenge before us is to no longer look into the future via a rearview mirror, as Marshall McLuhan would have it, nor to allow our tools to shape us. Change is inexorable, and the only way forward is through thoughtful participation in the swirl.

The author would like to thank Jan Bellack, PhD, RN, FAAN for her guidance with this paper.

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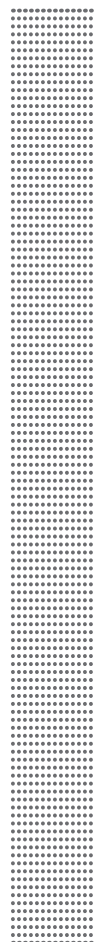
EDUCATIONAL TECHNOLOGIES IN HEALTH PROFESSIONS EDUCATION: CURRENT STATE AND FUTURE DIRECTIONS

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INTRODUCTION

Health professions education (HPE) is adapting to ongoing changes in health care by critically examining curricular content and organization, experimenting with new teaching strategies, and restructuring fundamental aspects of degree-granting programs. Such changes require creative solutions that often involve new educational technologies. Other features of HPE further foster the development and adoption of educational innovations: the decentralized and workplace-based nature of HPE pulls learners out of the classroom and into the lab, clinic, or bedside, creating a need for learning activities that cross boundaries of distance and time.



The increasingly technological and digital nature of clinical practice suggests a natural alignment with the use of educational technologies in instruction. Demands for bedside learning, procedural training, and clinical apprenticeship-based instruction are often limited by concerns for patient safety and the availability of suitable patients; technology can help meet these demands. The longitudinal nature of HPE education, from undergraduate schooling through profession-specific training programs and then into independent practice, produces a data-rich trail marking each learner's unique trajectory; technology-based approaches can leverage that information to personalize education and shape curricular change. Yet the increased interest in and adoption of technology in HPE has highlighted numerous areas of uncertainty and concern. Key questions include:

- When (for whom, in what context, for what objective) should a given technology be used (or not used) in HPE?
- How can or should schools keep up with rapidly changing trends and new innovations, and "choose wisely" among a myriad of technology solutions?
- What are the strengths and weaknesses of different educational technologies, and how do these features affect their use?
- How does a technology-enabled world change the roles of instructors and learners?
- What programmatic and curricular changes are enabled through educational technology?
- What resources, skills, and organizational structure are required to support educational technology at the school and program level, and how can schools and faculty acquire, develop, and/or disseminate these?

We will address many of these questions by considering broadly the various technologies currently available to HPE and the evidence informing their use, discussing how well technologies as a whole have delivered on promised transformations, and exploring how we might maximize the value of educational technologies. We conclude with six principles to guide the use of educational technologies in HPE that we believe will stand the test of time and inevitable (and accelerating) change.

WHAT DO WE MEAN BY EDUCATIONAL TECHNOLOGY?

Technology has been defined as the “application of knowledge to the practical aims of human life or to changing and manipulating the human environment ... to make life easier or more pleasant and work more productive.”¹ Notably, this definition does not stipulate the use of the Internet, the presence of a computer chip, or even the use of electricity. Technology—and educational technology in particular—simply involves the practical application of current knowledge. Taking this broad view, educational technologies have existed since the dawn of humankind. Charcoal on a cave wall can, in a sense, be viewed as an educational technology. More advanced technologies have since evolved—chalk, whiteboard markers, and electronic interactive whiteboards—but the fundamental educational function is unchanged. In Plato’s *Phaedrus*, published more than 2,000 years ago, Socrates laments that the introduction of the written word—a transformational technology of the time—will “create forgetfulness in the learners’ souls, because they will not use their memories; they will trust to the external written characters and not remember of themselves,” and that by contrast with the spoken word, the written word “is an aid not to memory, but to reminiscence; ... they will be hearers of many things and will have learned nothing.”² This ancient debate highlights that the novelty of educational technologies—and the turbulence that accompanies their introduction—transcend the mobile devices and virtual-reality simulators currently in vogue.

We define educational technologies as materials and devices created or adapted to solve practical problems related to training, learner assessment, or education administration.³ Maintaining a broad view of educational technologies helps us put into proper perspective current trends and fads, and suggests that online learning and high-fidelity manikins may eventually be replaced by newer, more fashionable technologies. Yet, given their immediate impact on present challenges and opportunities, for the purposes of this report we will focus on educational technologies that have been developed or become popular within HPE in the past 25 years. These relatively new developments include a diverse range of Internet-based software, mobile devices, computer-based applications, high-fidelity simulators, 3D virtual reality programs, and more. Table 1 lists several key technologies and conceptual issues related to their use in health profession’s education.

TRENDS IN EDUCATIONAL TECHNOLOGY

In the past quarter century, a sea change has occurred in the availability and access to electronic information. The introduction of the Internet in 1991, the rise of the affordable personal computer, the falling price of robotic and simulator devices, and now the presence of globally ubiquitous smartphones and tablets have contributed to an explosion in the diversity of educational technologies. The progression of chalk to electronic whiteboard is one example; the evolution of lecture broadcasting is another. Medical schools began experimenting with delivering lectures by radio in the 1920's. When reel-to-reel audiotape recording became affordable in the 1950's, the concept of "capturing lectures" and making them available to HPE learners became common practice.⁴ Over time audiotape was replaced by CDs, then mp3 files, and ultimately Internet-mediated streaming. With these changes in technology came changes in our thinking about the lecture itself, culminating in today's vision of the "flipped classroom"⁵ in which the pre-recorded lecture is preparatory homework instead of an in-class performance.

Some other key educational technology trends in HPE include:

- 1. Internet-based instruction:** The introduction of the Internet in 1991 was a tipping point in both access to and creation of computer-based learning resources. Today, faculty, students, and even the lay public can create, publish, and access learning resources, much of which is available at nominal or no charge. As the devices connected to the Internet have proliferated, so too have efforts such as massive open online courses (MOOCs) that offer education—often free—to millions of learners who otherwise would not have had access. MOOC providers such as Coursera (<http://www.coursera.org>) and the Khan Academy (<http://www.khanacademy.org>) have partnered with a global network of dental, nursing, medical, and other health professions schools to provide a growing variety of school-authored courses. One study found that 32% of higher education students now take at least one course online.⁶
- 2. Hands-on simulation devices:** Simulation-based training and assessment have become a staple of modern dental, nursing, and medical education. Perhaps most indicative of their impact is that many schools have constructed elaborate "simulation centers" to house these tools and provide needed technical and instructional support. Simulation is a

technique, not a technology,⁷ but a dizzying array of technologies of varying technical complexity have been developed to support simulation-based education. Technology-enhanced simulators include computer-based virtual reality simulators; high-fidelity and static manikins; models made from plastic, cloth, or food products; live animals; inert animal products; and human cadavers.³ Simulation-based education serves numerous educational purposes including safe repetitive practice of risky or complex procedures, rehearsal of team-based skills, and conditioning the response to rare events, as well as assessing performance for such tasks.^{3, 7-9}

3. **Mobile devices:** Just a few decades ago, access to a physical computer was one of the main barriers to participating in computer-based educational innovations. Now, most learners at all levels have smartphones or tablets that offer constant access to online resources, applications (apps), and clinical information. These devices can also be used to collect evaluation and performance data both manually (e.g., entered by the student or teacher) and automatically (e.g., by unobtrusively monitoring clinical activities and information-seeking behaviors). Mobile devices are particularly well suited for HPE given the nature of clinical training that mandates progressively greater time out of the classroom and at the bedside, clinic, or laboratory.
4. **Virtual and augmented reality:** Virtual reality (VR) uses the computer to provide an immersive sensory experience that simulates a real or imagined physical place. VR systems accomplish this by stimulating the senses, most often sight and/or sound, but also touch (e.g., haptics) or smell, and responding to authentic user inputs (e.g., hand or head movement, voice). Recent advances in computer graphics, haptics, and real-time processing have made VR increasingly feasible and affordable. VR is not tied to physical simulation centers, and thus has the potential benefits of “anytime and anywhere” simulation of clinical scenarios and procedures limited only by access to needed equipment (e.g., head-mounted display, movement sensors). New technologies such as the Oculus Rift VR headset (www.oculus.com) make VR available to a much broader audience of consumers, learners, and educators. Less immersive technologies such as virtual patients—screen-based simulations of a clinical encounter in which “learners emulate the roles of healthcare providers to obtain a history, conduct a physical exam, and make diagnostic and therapeutic

decisions”¹⁰—may also play a critical role in promoting the development of clinical reasoning skills.¹¹

Augmented reality differs from VR in that it overlays computer-generated sensory signals (e.g., images, sounds, pressure) onto the user’s perceptions of ongoing real events to enhance the user experience. The intent is not to fully simulate a virtual environment, but rather to augment actual experiences with context-relevant information. Google Glass (www.google.com/glass) offers augmented reality by overlaying information from a computer directly onto the learner’s view of the environment. This may find educational applications in procedural supervision and self-regulated learning.

5. **Point-of-care learning and assessment:** Educational technologies facilitate teaching and assessing learners at the point of actual patient care.^{12, 13} Electronic medical record (EMR) systems can now embed patient-specific information, including educational materials, directly into the workflow of patient care.¹⁴⁻¹⁶ Learners also have unprecedented access to other self-directed information sources.^{13, 17-19} Given trends toward early clinical education in undergraduate training^{20, 21} and outpatient experience in postgraduate training,^{22, 23} this capacity is a fortuitous opportunity. Support for point-of-care learning may be even more important, however, for practitioners after completion of training as they address lifelong learning needs.^{19, 24}
6. **Learning analytics:** Computer- and simulation-based education can capture information about individual learners, teachers, and systems. This information can subsequently be used to answer important questions to improve educational systems and tailor instruction—so-called learning analytics.²⁵ Education data warehouses can aggregate this information within programs, across programs within an institution, or even between institutions, and over an extended period of time.²⁶ Such data warehouses may provide unprecedented insight into how HPE translates into improved patient health, especially if prospectively collected information encompasses long observation periods as participants cross institutional, clinical, and educational boundaries.²⁷

WILL TECHNOLOGY TRANSFORM HEALTH PROFESSIONS EDUCATION?

Many have seen in these technologies the promise of a much-needed transformation in health professions education; namely, that online learning (or simulation-based team training, or iPads, or flipped classrooms) will usher in a long-awaited era in effective, efficient, personalized, low-cost learning. As a result, education leaders may seek to adopt new technologies for fear of falling behind their competition, while instructors latch onto a new technology and actively search for opportunities to apply this in practice. Yet these recent innovations are only the latest in a long line of technologies upon which educators pinned great hopes but that ultimately fell short of expectations. Radio, television, and digital videodiscs all enjoyed a moment of high hope before reality set in.

Magic bullets do not exist in education any more than they do in clinical practice. In the rapid and repeated introduction-and-disappointment of technologies in recent years, one group has observed a recurrent pattern—the “hype cycle.”²⁸ A “technology trigger” is followed by a rapid rise to a “peak of inflated expectations,” but when reality fails to deliver hoped-for solutions, there is a decline to a “trough of disillusionment.” Fortunately, over time, users begin to understand the proper role of the new technology—the objectives and contexts within which benefits outweigh costs—and this upward “slope of enlightenment” eventually settles into a “plateau of productivity” (see illustration and details at <http://www.gartner.com/technology/research/methodologies/hype-cycle.jsp>). By way of illustration, 2012 was dubbed “the year of the MOOC,”²⁹ but fascination with this approach already appears to be waning.³⁰

New technologies must be chosen and introduced with care. Disadvantages and unanticipated consequences of educational technologies have included social isolation, de-individualized instruction, high development and maintenance costs (including increased development time, specialized support staff, and a robust technical infrastructure), a need for increased faculty development, technical problems, and poor instructional design.³¹ In most cases educational technologies are more (not less) expensive to develop than traditional approaches, take more (not less) time to develop, increase (rather than decrease) faculty effort, and may decrease teacher-learner interaction.³² Most importantly, they do not replace the human teacher as the master architect of learning activities. A craftsman may use a power saw and drill for some tasks and a handheld knife and screwdriver for others.

Not only must the master craftsman (and the master teacher) know which tool to use and when, but he or she must also have a vision of the final product and skill in wielding the tools to bring that vision to fruition. Far from supplanting the human teacher, in many ways modern educational technologies demand even more from educators—there are more tools and more effective approaches than ever before.

However, computer-based educational technologies do possess some unique and potentially transformative benefits that other educational approaches lack. Advantages cluster into three domains: namely, flexibility, control, and analytics.³³

- 1. Flexibility:** Flexibility suggests the capacity to overcome barriers of time, distance, pace, scale, and patient safety.³¹ Virtual reality simulation, Internet-based MOOCs, iPads, e-textbooks, and even services like Twitter now give people all over the world anytime access to educational materials. These benefits are obvious for computer-based instruction (including online learning and virtual patients). Both computer-supported and non-computer, simulation-based instruction also offer this advantage by allowing the rehearsal of rare or dangerous events, replication at distant sites, and repetition until mastery.^{8, 34, 35} Online modules, discussion groups, and virtual patients can be designed to allow learners to participate at any time from any location. Examples of flexible simulation-based instruction include granting trainees access to training facilities off-hours,³⁶ providing for learning at home,³⁷ and training teams at a distant site using live videoconferencing.³⁸ These technologies also allow adaptation³⁹ to the needs of individual learners (e.g., skipping material if prior knowledge already indicates mastery, repetition if further practice is required, or other adjustments based on measurable learner characteristics), which in turn can optimize efficiency. Computer-controlled adaptations are often challenging and expensive to design, test, and implement in practice,⁴⁰ but learner-paced instruction is inherent to many e-learning activities. Adaptive learning can be implemented in simulation-based instruction as well through mastery learning⁴¹ and other self-regulated activities.⁴² Technology enables educational programs to implement new curricula faster and more broadly, creatively assess learning, and connect learners and teachers in new and meaningful ways.³³
- 2. Control:** Instructors can enhance learning by standardizing course quality and content, ensuring that objectives have been met (e.g., through repetition until mastery), and organizing the topic, sequence, and

complexity of teaching cases and materials to optimize representation of a topic without redundancy. Competency-based education⁴³ may particularly benefit from such control. New technologies can also allow education leaders to constructively influence instructors by, for example, mandating faculty development as a prerequisite to their gaining access to new tools.

3. **Analytics:** As noted above, computer applications can collect detailed information on when and where learning happens, on each learner's characteristics, and on their performance over time. These datasets are bigger, richer, and more objective than those currently available to most educators. Analyzing these learning data will usher in an era of true educational epidemiology⁴⁴ that informs the most effective use of technology-enhanced instruction⁴⁵ and enables educators to move quickly through the hype to the stable plateau of productivity.²⁸

In summary, it is unlikely that any educational technology will by itself bring about a transformation in education. Rather, such transformations will require the diligent efforts of human educators and the use of a broad spectrum of educational approaches.

WHAT IS THE EVIDENCE?

It seems useful at this point to consider the evidence informing the use of educational technologies. Several systematic reviews have synthesized this evidence using narrative and quantitative analyses,^{3, 46-53} and we will briefly summarize the findings of these reviews. In presenting a meaningful summary it is essential to group and analyze studies according to the research question they addressed. For studies evaluating training interventions it is helpful to classify the study question according to the comparison group. We recognize four broad conceptual clusters of comparison: no comparison (e.g., descriptions, or single-group posttest-only evaluations), comparison with no intervention (which includes both single-group pretest-posttest studies and studies with a distinct comparison group), comparison with a different medium (e.g., comparing online learning versus face-to-face lecture or training with a part-task model), and comparison within the same medium (e.g., comparing one online learning intervention against another, or one simulation-based course against another). We will consider the last three groupings in turn.

Comparisons with no intervention: Teaching works

Systematic reviews of health professions education using online learning, virtual patients, and technology-enhanced simulation confirm that, almost without exception, training using these technologies is more effective than no intervention (Figure 1).^{3, 47, 48} Stated differently, these studies show that teaching a course or task is better than not teaching.⁵⁴ One may legitimately question the need for further research into what might seem a self-evident truism; yet a cumulative meta-analysis of simulation-based training indicates that although the question, “Do people learn with simulation?” was decisively answered with only a handful of studies, hundreds of additional studies were subsequently published addressing this question.⁵⁵

Comparisons with different media: Delivery does not matter for cognitive tasks (knowledge, reasoning)

Studies making comparison with other media show wide variation (Figure 2).^{47, 48, 52} Many studies favor older approaches such as lectures, textbooks, and face-to-face small groups, while others favor newer educational technologies. A careful analysis of these studies, using multiple learning outcomes, reveals two key messages. First, results depend on the learning objective (task) and outcome. For cognitive learning objectives (outcomes of knowledge and clinical reasoning), the differences between new versus old approaches, or between two new approaches, are small⁵² or negligible.^{47, 48} For procedural tasks (skill and behavior outcomes), hands-on simulation-based training is better than non-hands-on training with lecture or computer.⁵² These empiric findings corroborate a model proposed by Cook & Triola¹¹ that matched the desired learning outcome with an educational approach optimized for economics, efficiency, and effectiveness (Figure 3).

Second, the wide variation from study to study, even within a task, suggests that the instructor and the instructional design matter greatly.⁴⁵ A well-designed lecture (e.g., interactive and led by an experienced instructor) will be better than a less-well designed online course, whereas the opposite will be true if the online course is better designed (e.g., improved activities to encourage learning and retention). However, meta-analyses attempting to identify the specific activities that best promote such learning have failed to demonstrate consistent findings across outcomes.⁴⁷ These inconsistencies are likely due to between-study variability, and suggest the need for head-to-head comparisons of different instructional designs within the same medium.

It is also worth noting that educational technologies are *not* inherently more efficient than other approaches. One rigorous meta-analysis of time required to learn using computer-based versus non-computer instruction found approximately equal numbers of studies favoring each intervention, with a pooled effect size that approached zero. While online learning can be more efficient (one study of adaptive online learning found an 18% time savings⁴⁰), this is a function of the instructional design rather than the delivery medium.

Comparisons within media: Instructional design matters

Although there are far fewer within-medium studies (comparing, for example, two versions of an online course or the number of repetitions in a simulation-based training activity), these studies yield useful insights into the design of future instruction.^{48, 50, 53} Limited evidence suggests that theory-predicted features such as interactivity, increased time on task, more practice, distributed practice, feedback, and mastery learning all improve learning outcomes.^{41, 49, 50, 53, 56} We expect further insights from ongoing research in health professions education exploring the effectiveness of design features^{50, 53, 57} such as desirable difficulties (e.g., mixed vs. blocked practice),^{58, 59} self-regulation,^{42, 60} testing-for-learning,^{61, 62} mastery learning,^{41, 63} and Mayer's principles of multimedia instruction.^{64, 65}

Generational differences should not take precedence in instructional design

The label "net generation" applies to people who grew up after the advent of the Internet (in 1991) and thus never knew a world without the connectedness and ubiquitous information this technology offers. Authors have claimed that students born in this age cohort have a natural predilection and desire for online learning and other educational technologies.⁶⁶ It is true that those in the rising generation of health professionals use certain technologies more often than prior generations did at the same stage in training; many of these technologies were not widely available or did not even exist when current faculty were in training. However, the fact that today's students heavily use multimedia, electronic communication, and social networking tools in their personal lives does not equate with a demand or desire for the use of technology in their educational activities. Our assumptions around students' preferences for educational technologies have not been substantiated, and in fact the limited evidence available suggests that students would prefer *less* (not more) online learning. Three rigorous literature reviews over the past 12 years have arrived at similar conclusions—namely, that *there is no pent-up demand for*

educational technologies in the classroom, and that generational *differences* are largely *rhetoric* rather than real.⁶⁷⁻⁶⁹ As one author concluded, “Is generational difference a variable important enough to be considered during the design of instruction or the use of different educational technologies? At this time, the weight of the evidence is negative.”⁷⁰

Claims about superior technology-related skills are also unfounded; older students and instructors (so-called “digital immigrants”) are able to acquire high proficiency with new technologies when needed, while younger students (“digital natives”) often *lack* the skills required to effectively use technology in their academic lives.⁷¹ More salient needs in this emerging digital era concern learners’ abilities to function as well-rounded digital citizens regardless of generation. These needs include competence in information literacy (seeking, appraising, and integrating information), self-regulated lifelong learning, team-oriented communication and collaboration, and teaching with technology.

A FOCUS ON VALUE: MAXIMIZING BENEFITS AND MINIMIZING COSTS

Although computer-based educational technology has been around for 60 years, the velocity and ubiquity of its use have gained critical mass only in the past decade. Higher education is spending billions of dollars and there is a voracious appetite for implementing new technologies,⁷² despite the paucity of evidence guiding their most effective use. As we seek to identify the proper place of various technologies in HPE (i.e., cut through the hype, scale the slope of enlightenment, and reach the plateau of productivity) it helps to focus on their value—the benefits in relation to their costs—and try to maximize the return on investment.

A key question of many teachers when developing new curricula is, “Which technology do we use and when?” By way of analogy, we can answer the same questions in regards to magnetic resonance imaging (MRI).³² Healthcare providers today must weigh the advantages of this imaging test—namely, the excellent resolution in diagnosing many diseases—against its high cost. Current guidelines clearly indicate that most patients do not need an MRI even though it is clearly superior in confirming the diagnosis (see <http://www.choosingwisely.org/>). The key question is not *whether* it works, but *when* to most appropriately use the MRI vs. another imaging approach or no imaging tests at all.

HPE, using expensive educational technologies today, faces a similar value proposition: the technology may offer superior results under certain conditions, but it would be inappropriate for use in every educational activity, and for successful existing activities there may be no reason to move to a new technology. The imperative facing educators today is to determine when a given technology will provide added value. The evidence needed to inform such decisions is as-yet incomplete, but growing.

For each potential use, HPE schools must also consider the other “moving parts” involved in changing to a new technology—including faculty (and faculty development needs), available resources and technical support, fringe and long-term benefits of the technology (e.g., online educational interventions not only meet immediate instructional needs, but over time may accumulate data to inform future changes), local policies and governance on use, and security of educational and clinical data. Key questions for educators to ask include the following:³³

- What problem am I trying to solve?
- What approaches (e- or otherwise) might help remedy that problem?
- Which of these can I most easily implement using available technology infrastructure and human resources?
- What disadvantages might accrue if I use that approach (e.g., decreased learning effectiveness, efficiency, student engagement, or faculty support)?

How can HPE programs maximize the benefit of educational technologies?

As with any educational activity, computer-based and simulation-based learning activities should be clearly aligned with learning objectives, and designed to reflect the best available evidence for a given set of learners, topics, and desired outcomes. Techniques to maximize benefit from an educational activity share several core features, regardless of the modality used to teach, including feedback, repetitive practice, curriculum integration, and self-directedness. Many of the educational theories developed for non-technologic teaching approaches can be applied directly, and should be considered.^{60, 73-80} As we describe in more detail below, educators will increasingly need to think of “new” and “old” educational technologies as part of a single integrated toolbox. The more we blur the boundaries between educational activities, the better we can exploit each activity’s unique features.

How can HPE programs minimize the cost associated with the use of educational technology?

Reducing costs requires that we focus on high-value, cost-conscious education.⁸¹ In clinical practice, we usually encourage patients with heartburn to start with a simple antacid, even though more effective treatments exist. If that doesn't work, we might encourage them to next try an H2-blocker like ranitidine or an over-the-counter proton pump inhibitor like omeprazole. Only if these treatments fail would we recommend a non-racemic proton pump inhibitor, such as esomeprazole, which is more effective but much more expensive. Here, the clinician intentionally recommends an inferior treatment (antacid) because in many cases it is sufficient for the need. Similarly, educators should choose the least expensive technology that meets their needs and the learners' needs.

The concept of disruptive innovations⁸² supports this approach at a programmatic level, suggesting that a *less* effective approach is sometimes the best course if it costs substantially less or can reach more users. Disruptive innovations are, by definition, *inferior* to the current standard approach—at least initially. However, they capture a new market segment (e.g., reducing cost and thereby reaching a larger audience) and are *good enough* to meet the needs of that market. Over time, the *good enough* option improves without losing its cost advantage, and eventually displaces the older (higher-performing but no longer competitive) approach. It may be worth making a small sacrifice in educational effectiveness in order to achieve a large cost savings (e.g., 80% of the benefit for 30% of the cost). Of course, it may be difficult to know which 20% of the benefit (i.e., learning) can be safely sacrificed, and sometimes the more expensive approach will be best. Formal cost-reduction strategies require robust evidence regarding both effectiveness and cost. Unfortunately, extremely few studies in HPE even attempt to measure costs,⁸³ and almost none have incorporated a complete cost accounting.⁸⁴ However, we suspect that such immunity to market pressures will not long endure in today's climate of competition, economic pressure, and evidence-based practice. The extended reach, enhanced control, and big data analytics offered by new technologies will facilitate the accumulation of much needed information.

In the absence of rigorous evidence, rational approaches to reducing development costs can be pursued. These include the following strategies:

- Taking a “lean startup” approach to introducing new technologies.⁸⁵ This involves conducting short, limited pilots of products during development rather than waiting for a finished product, collecting extensive data using carefully selected metrics, and responding rapidly with product improvements.
- Encouraging user-friendly authoring tools, or using case/content templates. Authoring tools^{86, 87} are computer programs that convert content developed in one format (e.g., PowerPoint or raw text) into another (e.g., polished online modules or virtual patients). Tools to support low-cost production and implementation of educational videos, patient simulations, games, and online collaborative learning are also emerging. Templates take this a step further by creating a course shell—with placeholders for elements such as specific objectives, content, cases, questions, and other activities—into which the educator simply drops new topic-information. For example, the instructional approach for teaching office management of diabetes, hypertension, and hyperlipidemia might be sufficiently similar (e.g., principles, guidelines, and practice cases) that once one module has been polished it could serve as a template for the others. Though they may not eliminate the need for support from instructional designers, authoring tools and templates will help instructors in creating more content themselves.
- Investing in fidelity only where it counts. Highly realistic 3D computer models and lifelike manikin simulators are expensive educational technologies, yet published evidence does not always support their use. Rather, research suggests that learners value function and relevance far more than realism, and that high fidelity can at times actually impede learning.⁸⁸⁻⁹⁰ As Hamstra⁸⁹ noted, “The field of simulation should shift emphasis away from structural properties of the simulator (i.e., physical resemblance) to functional properties of the entire simulation context that align with learning objectives (i.e., functional task alignment). There is now plenty of evidence that physical resemblance can be reduced with minimal or no loss of educational effectiveness, provided there is appropriate correspondence between functional aspects of the simulator and the applied context.”
- Not reinventing the wheel. There are growing repositories of shared educational technology resources and content online, often for free. Re-using or adapting shared content from another school could dramatically cut costs and implementation time.

ENDURING TRUTHS, AND IMPLICATIONS

Given the above arguments and evidence, what can we say about the future of educational technologies? While no crystal ball is infallible, we believe the following six principles will offer guidance amidst the inevitable uncertainties (Box 1).

1. There will always be something new

It is impossible to predict *what* new technologies will arise in coming years, but it is nearly certain that new technologies *will* arise, and at an increasingly rapid pace. This poses at least two important challenges to educators. First, they will find it increasingly difficult to stay abreast of the latest developments. Second, they will find it increasingly difficult to select among the growing menu of available options, especially given the hype that invariably accompanies each new technology.

What are educators to do? The only recourse is to focus on learning needs rather than technology. Educators must refrain from asking, “When can I use this technology?” and ask instead, “What technology will help with this problem?” When confronted with an enticing new technology, they should ask, “Does the current approach need to change?” If it isn’t broken, it doesn’t need fixing. And, when searching for technologies to address an identified need, educators will generally need to stop short of considering all possible solutions (which is already becoming a nigh-impossible task), and instead focus on solutions within their reach (i.e., those within their budget, supported by local infrastructure and staff, or within their personal expertise). Adopting the paradigm of cost-conscious medical care, a slightly less effective technology may be preferred if it is less expensive or more readily implemented in a given context.⁸¹

2. Technologies will get cheaper, more powerful, and increasingly ubiquitous

The electronic technologies available today are not only more powerful than those ten years ago, they are also available at a fraction of the cost, much easier to use, and used more often by more people. These trends are likely to continue, such that past and present barriers of cost and technical expertise will become increasingly less problematic. This has the side effect of increasing the number of viable technology options available to educators, which—as per the discussion above—is both a blessing and a curse.

What are educators to do? It will become imperative that educators become highly adept at selecting technology tools that meet their needs. It will be impossible for educators to maintain equal familiarity with all available options, just as a primary care provider cannot be expected to have equal familiarity with all medications for hypertension or diabetes. Clinicians are advised to familiarize themselves with broad evidence-based guidelines, and within those guidelines to gain in-depth knowledge and comfort in using a few select treatments, focusing on specific advantages (e.g., indications) and disadvantages (e.g., side effects). Specialists in a given field are naturally expected to have deeper knowledge of specific treatments in that field, but such expertise typically comes at the expense of breadth of clinical knowledge.

We offer the same advice to educators. The “generalist” educator of the future will not need to master all available and emergent technologies, but he or she will need to understand conceptually the categories of technology available and the relative advantages and disadvantages of each category for a given situation (learning objective, trainee type and level, and training context), and will likely need at least some degree of comfort in using at least one specific technology within each group. “Subspecialist” educators may have greater expertise in a given domain (e.g., virtual reality simulation) and less in another (face-to-face lectures or online learning). Central to all of this is the need to select the technology based on the needs of the learner (just as a clinician tailors treatment to each patient). Many faculty will need to further develop skills in the selection of optimal technology.

3. Development and implementation will get easier

Just as technologies are becoming cheaper and easier to use, we anticipate that the development of high-quality educational offerings will become easier and faster and thereby less expensive.³² As noted above, authoring tools and templates will facilitate the efficient creation of new educational materials. In addition, shareable resources and freely available information will, in many instances, obviate the need for new materials at all. Rather than create new educational products *de novo*, a teacher’s time might be better spent identifying and appraising existing information resources and instructional materials, and then sequencing instructional activities that draw upon these resources to promote active learning. Sharing materials such as online modules or simulation scenarios across institutions may also reduce cost and thereby enhance value.

What are educators to do? First, we need to invest in authoring and development tools, and train faculty to use them. Second, we need to build an infrastructure that facilitates the creation and use of templates as noted above. Third, we need to teach instructors (and learners) how to identify trustworthy content. Finally, we need to transition from a paradigm in which instructors develop all learning materials to one in which they emphasize effective sequencing of various learning resources. Shifting the instructor's role from content creator to content organizer and designer of instruction may represent a fundamental transition (and corresponding faculty development need) over the next decade.⁹¹

4. New and old technologies will progressively blend and blur

Over the past decade electronic information and communication technologies have become a seamless, unconscious part of our lives. We no longer consider it exceptional to talk on the phone from our car; send a message to a colleague around the world; watch movies from a handheld device; search advanced knowledge repositories while sitting in a restaurant; or take, edit, and share a photo of an important event before the event is even over. Yet 25 years ago, all of these activities would have been viewed as prohibitively difficult and expensive, if not impossible.

Educational technologies will need to receive a similarly transformed reception if they are to achieve their full potential. We must get to the point that we do not think about the technology, but instead focus simply on teaching using whatever tools we have at our disposal. We currently talk about blended learning in which some elements occur online while others occur face-to-face. This paradigm only reinforces the misguided perception that important differences distinguish these modalities. We anticipate that blended learning will be replaced by blurred learning—in which the boundaries between modalities are indistinct and de-emphasized.

What are educators to do? They must stop viewing technologies as special or worthy of attention just because they are new or computer-based. They will need to move beyond blended learning to truly *blurred* learning. This will require them to learn to integrate new technologies with other technologies and modalities to capitalize upon each approach's unique strengths and offset weaknesses.

5. The fundamentals of learning will not change

The fundamental pedagogical principles that underlie effective learning, which results in long-term retention and transfer of knowledge to new situations, have not changed with the advent of new educational technologies. There is good evidence that reading, and possibly visual processing, is different (usually less efficient) when reading on-screen text vs. text on paper.⁹² However, the processes of elaboration, storage, and retrieval are, as far as we can tell at present, identical when learning with electronic and non-computer technologies. This is bad news for those looking for a magic bullet that will make learning easier and faster, because it reminds us once again that the rate-limiting step in learning is not the transmission of information from teacher to learner, but the processing of information by the learner. Yet once we accept this fact, the non-difference in approaches is quite comforting and liberating, for it gives educators freedom to use whatever technologies will most effectively help learners assimilate, integrate, and apply.

What are educators to do? First, they must learn to employ key principles of learning that appear to be true across objectives and technologies, such as activation of prior knowledge, demonstration, application, integration, and situating learning in the context of an authentic problem.⁹³ These principles can be embodied in various ways using diverse technologies,^{57, 94, 95} and the book is far from closed on how to effectively promote learning, especially in higher cognitive skills such as clinical reasoning. Second, they must develop sufficient familiarity with the strengths and weaknesses of available technologies and delivery approaches (both new and old) that they can make informed choices regarding when and how to best use these technologies to promote desired learning processes. This will require more evidence than we presently have about what works, for whom, in what contexts, and for which objectives.^{96, 97}

6. Healthcare professionals care for humans, not computers

Finally, even when computer-based instruction and simulation-based training are (appropriately) emphasized as an integral part of a course, educators cannot lose sight of the long-term objective: healthcare professionals care for human patients, not computers or manikins. This may appear obvious, yet it seems that, in practice, technology presents a very slippery slope. Authors have expressed similar concerns that EMRs may engender depersonalization and increase the distance between patients and learners.⁹⁸ Others have noted that excessive use of email and texting may impair voice communications and human social relationships.⁹⁹ If we are not

careful, we may inadvertently find that use of Internet, simulation, and social media for learning may impair provider-patient and healthcare team relationships.

What are educators to do? We do not wish to discourage the use of educational technologies to simulate clinical scenarios. On the contrary, these can be highly effective in teaching clinical reasoning,¹¹ management of rare events,⁸ and procedural skills⁷ in a safe and resource-constrained environment, and can replace some clinical training activities without detriment.¹⁰⁰ Yet such training activities will never supplant training at the patient's bedside and in face-to-face teams. Achieving the right balance will require deliberate attention.

CONCLUSION: PROPOSED ACTIONS REQUIRING FURTHER DISCUSSION AND EVIDENCE

In conclusion, we propose the following as key actions required to fully capitalize on what educational technologies offer (Box 2). We phrase these as recommendations, but recognize that implementation of these propositions will require further discussion and in many cases new evidence.

First, educators should not look to technology as the key to educational transformation. Transformations will come from creative, passionate instructors and eager, motivated learners, not from the bells and whistles of any new technology. Technology can extend our reach,¹⁰¹ enable innovation, and encourage application of effective instructional approaches, but it cannot replace the vital roles of human instructors in deliberately and creatively planning, designing, and implementing educational innovation.

Second, educators need to focus on fundamental principles of learning. Computers may facilitate the transmission of information and the collection and analysis of data, but will not, by themselves, accelerate the elaboration of information that promotes effective learning and long-term retention and retrieval. However, well-designed instruction (using old or new technologies) can do so using tried-and-true principles, such as activation of prior knowledge, demonstration, application, integration, and problem-based learning.⁹³ Faculty development programs need to reinforce this balance and foster the new competencies of teaching in a technology-enabled world.

Third, educators and administrators must develop a technical and human infrastructure that supports local learning needs. Such needs vary from institution to institution, and leaders must resist the tendency to blindly emulate the technical solutions that other organizations have developed in the context of different learners, teachers, learning objectives, financial resources, and existing infrastructure. Indeed, given the diversity of technologies now available and the uniqueness of institutional contexts, it may be impossible to mandate any specific infrastructure as universally required other than access to human expertise in developing and implementing needed solutions. This suggests that investing in people may be more important than investing in technology.

Fourth, administrators will need to develop both depth and diversity in local teaching expertise. The clinical concept of generalists vs. specialists may be appropriate: some educators will need a moderate command of a broad array of technologies, approaches, and methods (generalists), while others will become focused experts in a narrow technology or method (specialists). Access to and support for technology could be used as leverage in incentivizing faculty to improve their skills.

Fifth, we hope that, over time, a culture of sharing will develop. Such sharing might include both technical infrastructure (such as open-source learning management systems, EMR emulators, and virtual patient players) and specific content (such as datasets for experiential data mining, video clips, online learning modules, and simulation scenarios).

Finally, we perceive a need to better develop the evidence base that will undergird the use of educational technologies broadly.^{96, 102} Educators need evidence, not hype, to identify the technology solutions relevant to a given need, and evidence, not intuition, to create effective, efficient instructional activities. We call for increased scholarly efforts directed to answering questions that look to the future (how to design and effectively implement future courses) rather than the past (how does this new course compare with the old way of doing things).¹⁰³ Box 3 outlines some of the critical unknowns that might inform such a research agenda.

FIGURES

Figure 1. Outcomes of studies comparing educational technologies with no intervention

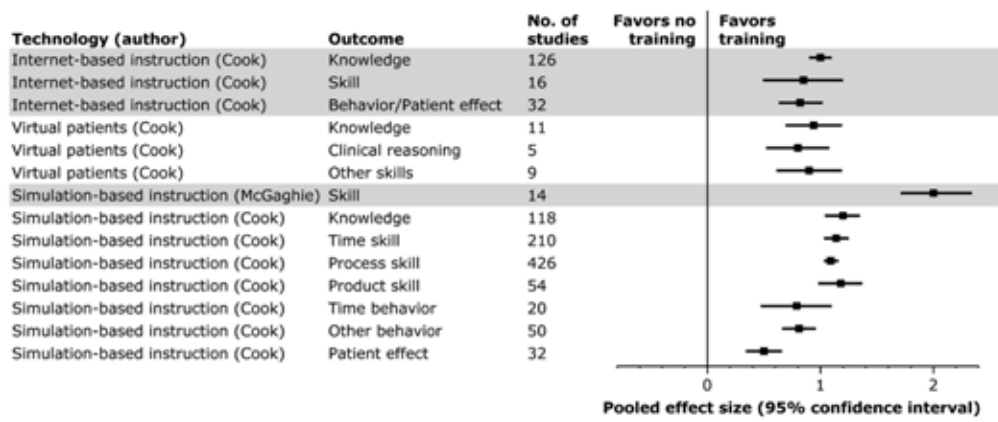


Figure 2. Outcomes of studies comparing educational technologies with other media

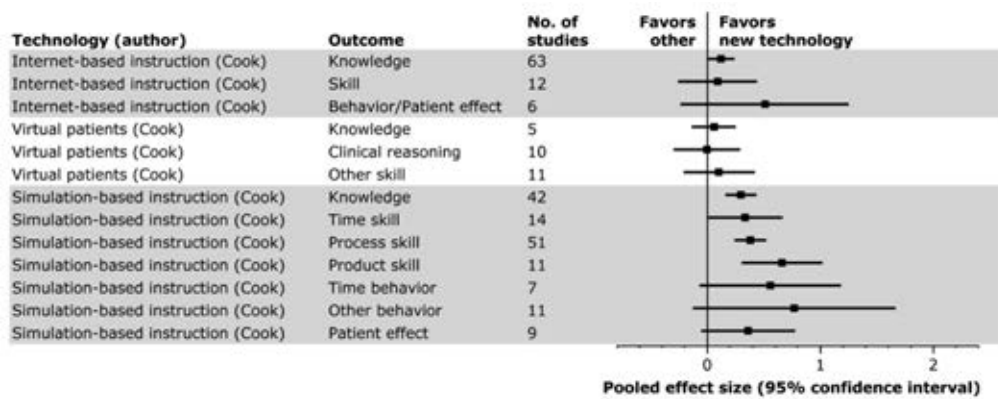


Figure 3. Model for matching educational objectives with educational approach

Note that the arrows point upward, emphasizing the importance of starting with the objective and then selecting the appropriate educational approach.
Adapted from Cook & Triola¹¹

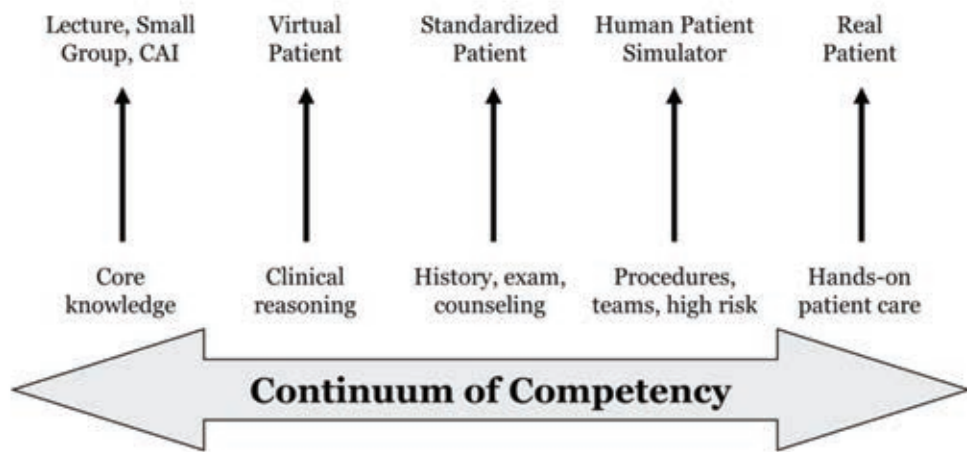


Table 1. Key educational technologies and related concepts

TECHNOLOGY AND DESCRIPTION	SPECIFIC EXAMPLES IN HEALTH PROFESSIONS EDUCATION*
Technologies for face-to-face instruction	
Audience response systems (ARS) Systems to promote interactivity between instructor and learners in a live education setting (e.g., lecture), linking a learner’s handheld transmitter or mobile device with the instructor’s computer. Usually used with software that allows learners to visualize group responses in real-time.	 Nursing students used ARS to provide immediate feedback on interactive quizzes. ¹⁰⁴ Medical student case presentations used ARS to collaboratively generate differential diagnoses ¹⁰⁵ Commercial products: Pingo (trypingo.com), Turning Technologies (turningtechnologies.com), Polleverywhere (polleverywhere.com)

TECHNOLOGY AND DESCRIPTION	SPECIFIC EXAMPLES IN HEALTH PROFESSIONS EDUCATION*
<p>Computers to support generative learning activities</p> <p>The use of computers by learners as tools for active, generative learning, often in “traditional” (e.g., face-to-face) or blended contexts (as contrasted with using computers for delivery of information, communication, or course administration). Examples include the analysis of large clinical datasets using statistical software, and the creation of integrated knowledge summaries (e.g., instructional Web pages or videos).</p>	<p>In the NYU <i>Healthcare by the Numbers</i> curriculum (education.med.nyu.edu/ace/sparcs), students conduct their own “big data” analysis of public data on over 5 million New York hospitalizations to understand social determinants of health.</p> <p>Medical students in a problem-based-learning course collaboratively authored wikis to teach each other in small groups.¹⁰⁶</p>
<p>Interactive electronic whiteboards (“SmartBoards”)</p> <p>Systems that integrate a whiteboard with computer. Instructors can write directly onto computer-displayed graphics, manipulate images, integrate dynamic multimedia, and save or share this with learners at distant sites. Examples of effective use are fewer than for most of the other technologies in this table.</p>	<p>Interactive whiteboard used to augment live lectures that broadcast the instructors’ “chalkboard” drawings to remote learning sites.¹⁰⁷</p> <p>Commercial products: SMART Technologies (education.smarttech.com), Medical Education IWB (www.sotouch-tech.com)</p>

TECHNOLOGY AND DESCRIPTION	SPECIFIC EXAMPLES IN HEALTH PROFESSIONS EDUCATION*
Technologies for online instruction	
<p>Learning management systems (LMS)</p> <p>Systems that provide a suite of tools to support online course administration including course materials (e.g., syllabi, videos, online modules), homework assignments, tests, surveys, learning tools (e.g. discussion groups, blogs, whiteboards, wikis), and instructor support functions (e.g., gradebook).</p>	<p>Open-source products: Sakai (sakaiproject.org), TUSK (tusk.tufts.edu)</p> <p>Commercial products: Canvas (www.instructure.com), Blackboard (www.blackboard.com), LCMS+ (lcmsplus.com)</p>
<p>Massive open online course (MOOC)</p> <p>Free, online courses in which anyone can participate (open) and, thereby, enroll hundreds or thousands of learners (massive). They often include traditional course content, online lectures, and paced progression through teacher-guided and proctored activities.</p>	<p>MOOC courses created by HPE faculty: <i>Rural Health Nursing</i> (from University of New Mexico, on Coursera), <i>Health Care Systems</i> (from Stanford, on Khan Academy).</p> <p>MOOC providers: Coursera (http://www.coursera.org), EdX (http://www.edx.org), Khan Academy (http://www.khanacademy.org)</p>

TECHNOLOGY AND DESCRIPTION	SPECIFIC EXAMPLES IN HEALTH PROFESSIONS EDUCATION*
<p>Learning objects and course materials</p> <p>Materials designed to meet a specific instructional objective with little dependence on the surrounding educational context, and so can be repurposed for different learning applications and contexts.</p>	<p>Module series intended for use by other training programs: CLIPP pediatrics cases (http://www.med-u.org/clipp), WISE-MD surgical curriculum (http://www.med-u.org/wisemd), DocCom series (webcampus.drexelmed.edu/doccom)</p> <p>Repositories of learning objects: AAMC MedEd Portal (mededportal.org), MERLOT (merlot.org), Nursing Education And Technology Project (webcls.utmb.edu/neat/)</p>
<p>Mobile devices and apps</p> <p>Mobile devices are handheld computers with a touch-input display screen or small keyboard. Current devices run interactive software applications (apps) and most use either cellular or wi-fi data connections. Mobile devices are used to collect evaluation and performance data, access interactive educational materials, or use the clinical systems and decision-making tools.</p>	<p>Healthcare education apps: University of California San Francisco NeuroExam Tutor (meded.ucsf.edu/tel/neuroexam-tutor-iOS-app), Osmosis test-preparation app (developed by students at Johns Hopkins Medical School: http://www.osmosis.org).</p> <p>Mobile app catalogs: iTunes (itunes.apple.com), Google Play (play.google.com)</p>

TECHNOLOGY AND DESCRIPTION	SPECIFIC EXAMPLES IN HEALTH PROFESSIONS EDUCATION*
<p>Augmented reality and virtual learning environments</p> <p>Augmented reality overlays computer-generated sensory signals (e.g., images, sounds, pressure) onto the user's perceptions of ongoing real events to enhance the user experience. For example, Google Glass projects computer-generated images directly in front of the wearer's right eye. Virtual learning environments allow users to interact and collaborate with one another in a computer-generated space (e.g., virtual world).</p>	<p>Google Glass during basic science lectures augments the experience with clinic-based patient interviews and exam findings.¹⁰⁸</p> <p>Commercial augmented reality devices: Google Glass (http://www.google.com/glass), Microsoft HoloLens (http://www.microsoft.com/microsoft-hololens)</p> <p>Virtual learning environments: Second Life (secondlife.com), ActiveWorlds (activeworlds.com)</p>
<p>Medical visualizations</p> <p>Simulated environments that immerse learners in an authentic and realistic scenario or medical visualization. May involve virtual reality to create a simulated environment in which learners interact and collaborate.</p>	<p>3D anatomy simulators can teach complex anatomic and physiologic topics in new ways.¹⁰⁹</p> <p>Commercial 3D anatomy simulators: Biodigital Human (http://www.biodigital.com), Visible Body (http://www.visiblebody.com)</p> <p>Virtual microscopes can replace traditional modalities of teaching.¹¹⁰</p> <p>Virtual microscopes: Aperio ePathology (http://www.leicabiosystems.com/pathology-imaging), NYU Virtual Microscope (education.med.nyu.edu/virtualmicroscope)</p>

TECHNOLOGY AND DESCRIPTION	SPECIFIC EXAMPLES IN HEALTH PROFESSIONS EDUCATION*
Technologies for simulation-based instruction	
<p>Virtual patients (VP)</p> <p>A “specific type of computer program that simulates real-life clinical scenarios; learners emulate the roles of healthcare providers to obtain a history, conduct a physical exam, and make diagnostic and therapeutic decisions.”¹⁰ Virtual patients have a particular role in training and assessing clinical reasoning skills.</p>	<p>VP authoring and player systems: OpenLabyrinth(openlabyrinth.ca), Web-SP (websp.lime.ki.se), DecisionSim (decisionsimulation.com)</p> <p>VP case repositories: eViP (http://www.virtualpatients.eu), MededPORTAL (http://www.mededportal.org)</p> <p>Indiana University has created a teaching EMR that is a clone of an actual clinical care EMR, populated with panels of patients for students to manage with information gleaned from de-identified patient data.</p>
<p>Virtual hospitals</p> <p>A physical healthcare training environment, which includes simulated clinical spaces, such as operating and emergency rooms. When combined with the virtual reality simulators below, these facilities can replicate actual clinical environments in which teams of learners make decisions, perform procedures, and experience the workflow of complex care.</p>	<p>Virtual hospital facilities: Center for Advanced Medical Learning at the University of South Florida; University of California, Davis Center for Virtual Care.</p>

TECHNOLOGY AND DESCRIPTION	SPECIFIC EXAMPLES IN HEALTH PROFESSIONS EDUCATION*
<p>Part-task models and trainers</p> <p>Physical models that simulate a portion of the body or anatomy or train for specific clinical tasks (e.g., interventional cardiology, laparoscopic surgery). Many commercial products are available. Locally constructed or hybrid models can be made of plastic, explanted tissue (e.g., animal or human cadaver), plant (e.g., papaya), or other materials (e.g., rubber tubing, felt).</p>	<p>Explanted tissue: bovine colon used to simulate human colon¹¹¹</p> <p>Plant: banana used to simulate human spine¹¹²</p> <p>Rubber tubing used to simulate vas deferens¹¹³</p> <p>Commercial products: Simantha (http://www.medsimulation.com), Ultrasound Vascular Access Trainer (http://www.limbsandthings.com)</p>

TECHNOLOGY AND DESCRIPTION	SPECIFIC EXAMPLES IN HEALTH PROFESSIONS EDUCATION*
<p>Manikins</p> <p>Lifelike full-body and torso models of a complete human. Internal technical operations vary widely, ranging from no mechanical operation (static manikin) to manually operated circulation and breathing to computer-controlled pulse, breathing, and advanced patient monitoring. One simulator can often facilitate training and assessment of diverse competencies, including procedural skills, decision making, communication, patient safety, inter-professional team performance, crisis and emergency management, and the use of medical devices such as handheld ultrasound machines. Some models contain technology targeting specific skills such as physical exam, obstetrics, resuscitation, or anesthesia.</p>	<p>Helping Babies Breathe uses a manually operated baby simulator to train midwives in developing countries.¹¹⁴</p> <p>Commercial products: Resusci Anne (http://www.laerdal.com), iStan (http://www.caehealthcare.com), Noelle (http://www.gaumardscientific.com)</p>

TECHNOLOGY AND DESCRIPTION	SPECIFIC EXAMPLES IN HEALTH PROFESSIONS EDUCATION*
<p>Virtual reality (VR) simulators</p> <p>VR uses the computer to provide an immersive sensory experience that simulates a real or imagined physical place. VR systems accomplish this by stimulating the senses, most often sight and/or sound, but also touch (e.g., haptics) or smell, and by responding to authentic user inputs (e.g., hand or head movement, voice). VR typically combines realistic tangible controls (e.g., a standard endoscope control body) with computer-controlled visualizations, measurement, and analytics to create a fully customizable skill-training environment. Training tasks can vary from simple games intended to help users learn basic manipulations (e.g., moving a virtual ball around the screen) to recreations of a full surgical procedure.</p>	<p>Commercial products: LapSim (http://www.surgical-science.com), GI Mentor (simbionix.com/simulators/gi-mentor), EyeSi (http://www.vrmagic.com/simulators)</p>

TECHNOLOGY AND DESCRIPTION	SPECIFIC EXAMPLES IN HEALTH PROFESSIONS EDUCATION*
Technologies for assessment, evaluation, and administration	
<p>Computer-aided assessment</p> <p>These applications deliver quizzes, exams, and novel assessments to learners via computers, web browsers, or mobile devices. Computers offer numerous pragmatic advantages over the traditional paper or automatically scored paper forms, such as: automated grading, instant feedback, the ability to include multimedia and interactive questions, enhanced security, and automated analytics on learners and questions.</p>	<p>Commercial assessment and evaluation systems: ExamSoft (learn.examsoft.com/), NBME GEMS (http://www.nbme.org/Schools/gems), E*Value (http://www.e-value.net), New Innovations (http://www.new-innov.com)</p>
<p>Learning analytics</p> <p>Computer-based tools that collate and analyze data captured through other technologies (e.g., online learning, assessment, or portfolios) to answer complex questions about effective teaching and learning and render suggestions to optimize education for both individual students and educational programs.</p>	<p>Data on 8,000 students over 40 years were used to model how MCAT performance predicts medical school and residency success.¹¹⁵</p> <p>Commercial Learning Analytics Software: Civitas (http://www.civitaslearning.com), Epsilon Analytics (corp.epsilen.com), Knewton (http://www.knewton.com)</p>

TECHNOLOGY AND DESCRIPTION	SPECIFIC EXAMPLES IN HEALTH PROFESSIONS EDUCATION*
<p>Learner portfolios and coaching systems</p> <p>Systems that facilitate the storage, retrieval, and annotation of quantitative and qualitative information about learners' educational achievements, performance, and progress. Both learners and instructors can typically add, view, and annotate entries. Can be used to monitor progress (e.g., milestones), advise on next steps, and document competencies.</p>	<p>Nursing students used a mobile handheld electronic portfolio system to capture reflections on clinical cases at the point-of-care and provide real-time updates to remote preceptors.¹¹⁶</p> <p>Open-source portfolio systems: Mahara ePortfolio (mahara.org), OASIS (http://www.schillingconsulting.com), Sakai OSP (http://www.serensoft.com/eportfolios/osportfolio)</p> <p>Arizona State University uses an electronic dashboard to monitor the progress of all students (not health professions specific); those falling behind are provided personalized counseling (students.asu.edu/academic-success)</p>
<p>Curriculum mapping tools</p> <p>Tools that support "mapping" a curriculum (identifying redundancies, gaps, common themes, and other opportunities for improvement across classes and program years) and targeting specific objectives, competencies, and milestones.</p>	<p>University of California, San Francisco extended its LMS with a custom curriculum-mapping tool for HPE competencies, entitled Ilios (http://www.iliosproject.org).</p> <p>The Vanderbilt KnowledgeMap (knowledgemap.mc.vanderbilt.edu/research/) system performs real-time analysis of medical student clinical notes and maps them to the curriculum.</p>

TECHNOLOGY AND DESCRIPTION	SPECIFIC EXAMPLES IN HEALTH PROFESSIONS EDUCATION*
Technologies that integrate with clinical practice	
<p>Bedside clinical technologies</p> <p>Bedside technology devices are portable or handheld technologies that facilitate collecting clinical data in real-time from patients at the bedside. These devices collect a variety of data including imaging (ultrasound, thermal) and physiologic (blood pressure, ECG).</p>	<p>The University of South Carolina has a comprehensive curriculum on ultrasonography and issues handheld ultrasound devices to all of its medical students.¹¹⁷</p> <p>Commercial handheld clinical devices: Vscan Pocket Ultrasound (gehealthcare.com), SonoSite point of care Ultrasound (http://www.sonosite.com), AliveCor Heart Monitor for iPhone (http://www.alivecor.com)</p>
<p>Point-of-care learning</p> <p>Point-of-care systems include EMR, clinical decisions support systems, and computerized provider order entry systems. While most point-of-care systems are intended to support clinical decisions, some provide additional supports to enhance learning (i.e., retention of new knowledge with transfer to new settings).</p>	<p>Mayo Clinic is using EMR-integrated education to standardize clinical practice and automatically document practice-based learning by providers.¹⁵</p> <p>“Infobuttons” embedded within the EMR provided nurses with patient-specific education and links to medical evidence.¹¹⁸</p>

* These examples are intended for illustrative purposes only, and in most cases other equally meritorious examples could have been cited. We do not endorse any of these commercial or non-commercial products, nor do we claim them to be any more or less effective or noteworthy than other available products.

Box 1. Enduring truths

There will always be something new

Technologies will get cheaper, more powerful, and increasingly ubiquitous

Development and implementation will get easier

New and old technologies will progressively blend and blur

The fundamentals of learning will not change

Healthcare professionals care for humans, not computers

Box 2. Proposed actions requiring further discussion and evidence

Stop looking to technology as the key to educational transformation

Focus on fundamental principles of learning

Develop technical infrastructure

Develop faculty: Depth and diversity in local teaching expertise

Cultivate a culture of sharing

Expand intellectual infrastructure (evidence base)

Box 3. Elements of a suggested research agenda for educational technology in HPE

Develop the evidence and theoretical foundations that will help instructors identify the instructional approaches that will enhance course effectiveness (i.e., what works, for whom, in what context, for what objective?).

Better understand how to appraise and identify trustworthy content of sufficiently high educational quality.

Better understand how to streamline the development and sharing of new educational materials (e.g., authoring tools, templates, and sharing networks).

Develop models and processes that promote the integration, sequencing, blending, and blurring of existing content, resources, and modalities.

Manage the tension between the rapid progress of new technologies and the historically slower pace of academic healthcare and educational institutions. The use of emerging educational technologies requires a more agile response, but must avoid infringing on the core values and established priorities of their organizational cultures.

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COMMISSIONED PAPER

THE FUTURE OF HEALTH PROFESSIONS EDUCATION

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INTRODUCTION

When the United States faces a crisis of achievement, it turns its attention to education. In 1957, the United States was caught off guard when the Soviet Union launched the satellite Sputnik, beating the US in the race into space. This event was a shock that served to galvanize scientists and educators to collaboratively enact strategies to address what the public perceived as the failure of the American educational system to produce the scientists needed for the US to remain

pre-eminent in discovery. Dramatic changes in the structure and financing of high school, college, and graduate education in the science, technology, engineering, and math (STEM) fields followed, successfully establishing the United States as a world leader in scientific education and fundamental research.¹

Although there has been no single newsworthy event as dramatic as the launch of an object into space, the American healthcare professions now appear to be in the midst of our own Sputnik moment. While there are some who continue to extol the virtues of our healthcare system as the best in the world, most are coming to realize that many other nations are beating the United States in the race to achieve the highest quality, highest value healthcare system and the best population health. If the US envisions a transformation in health and health care, we must also envision a transformation in health professions education.

Over the past 15 years, the Institute of Medicine (IOM) has issued reports calling for an overhaul of the conduct of medical practice to address concerns about healthcare safety, quality health disparities, and interprofessional teamwork.²⁻⁵ With these concerns comes public scrutiny about the effectiveness of medical education. National reports chronicle deficiencies and disappointments in many aspects of medical education. These include but are not limited to inadequate curricula in skills required to address specific patient and population needs, such as shared decision making, cultural humility, pain management, advanced illness care, and geriatrics, as well as skills needed to adopt new models of care such as interprofessional collaboration, informatics, and continuous process improvement.⁶⁻¹⁰

Likewise, the past decade has seen scrutiny of nursing education. As noted in the IOM report on the *Future of Nursing*, much of nursing education has revolved around acute care rather than community settings that include aspects of primary care, public health, and long-term care.¹¹ Nursing education frequently has not incorporated the intricacies of care coordination and transitions. Nor has it promoted the skills needed to negotiate with the healthcare team, navigate the regulatory and access stipulations that determine patients' eligibility for enrollment in health and social service programs, or understand how these programs and health policies affect patients and health outcomes. Nursing curricula need to be reexamined and updated, and become adaptive enough to change with patients' changing needs and with improvements in science and technology.

Some have begun to question the cost, duration, and focus of medical education. They cite concerns, including that medical education is inefficient and that educational institutions are not fulfilling their social contract to educate health professionals capable of meeting the nation’s most pressing healthcare needs.¹²⁻¹⁵ This conversation has broadened to extend how this interaction between health professions impedes achieving healthcare goals.¹⁶

In response to these clarion calls and to the biomedical, technologic, and cultural advances that characterize 21st century health care, health professions educators and their academic institutions have recommended changes in curricular content (Table 1) and in educational methods (Table 2).^{6,7,17-21}

Table 1: Changes Recommended in the Curricular Content of Health Professions Education

New clinical knowledge and skills	<ul style="list-style-type: none"> • Patient engagement and shared decision making • Culturally sensitive care of diverse populations • Chronic disease and advanced illness care • Management of transitions of care • Panel and population management • Use of electronic health records and decision support tools • Use of telemedicine, email, and other forms of distance & asynchronous care • Leading and participating in interprofessional teams • Providing high-value, cost-conscious care • Management of mental illness and substance abuse • Management of acute and chronic pain • Geriatric, palliative, and end-of-life care • Continuous process improvement • Error prevention, mitigation, analysis, and disclosure
New or more heavily emphasized sciences	<ul style="list-style-type: none"> • Bioinformatics and clinical informatics • Genomics and personalized medicine • Social and behavioral sciences • Big data, population health, and precision medicine • Targeted therapeutics • Systems engineering sciences • Continuous process improvement

Table 2: Trends in Educational Methods for Health Professions Education

	HISTORICAL APPROACH	EMERGING APPROACH
All phases of education in all professions	Time-based advancement	Competency-based, milestone-assessed advancement
	Advancement based on multiple choice, knowledge-focused exams	Advancement based on performance in all competency domains
	Goals, objectives, and individual competencies	Entrustable professional activities
	Professional identity formation assumed	Professional identity formation nurtured
	Standard curriculum for all	Individualized pathways based on career interests and expertise
Undergraduate medical education	Discipline-based (e.g., biochemistry, physiology)	Systems-based, integrated courses
	Two years of foundational science followed by two years of clinical application	Integrated science and clinical application throughout curriculum
	Block rotations in single departments	Longitudinal clerkships with simultaneous involvement in all departments
	Large lectures as the dominant instructional methodology	Blended learning (technology supported + in-class activities) and small-group activities

	HISTORICAL APPROACH	EMERGING APPROACH
Graduate medical education	Focus on direct patient-care activities	Expected participation in continuous improvement of safety, quality, and patient experience
	Assessment by faculty physicians only	Assessment by other health professionals and patients/families
Continuing medical education	Required CME credits from any course chosen by physicians	Comprehensive, continuous maintenance of certification and maintenance of licensure programs
	Industry sponsorship common	Strict guidelines against industry-driven content and conflict of interest disclosures, and mitigation for individual speakers

Further, accreditors have implemented changes in their standards (Table 3).^{17,22} Certifying boards have moved from once-in-a lifetime certification to a more continuous model of lifelong learning and competency demonstration.²³ State licensing agencies are adopting more comprehensive requirements for licensure for medical professionals and, at the same time, expanding the scope of practice of non-physician care providers.^{24,25} All seek better strategies to respond to the challenge issued in the 2010 Report of the Lancet Commission on Education of Health Professionals for the 21st Century: Health professions education must be intentionally designed to meet the needs of our communities and countries.²⁶

Table 3: Expansion of Accreditation Requirements for Health Professions Education

Liaison Committee on Medical Education (LCME) for Undergraduate Medical Education	<ul style="list-style-type: none"> • Societal problems • Cultural competence/healthcare disparities/ personal bias • Experiences and instruction in interprofessional collaboration • Preparation of resident and non-faculty instructors for teaching roles • System of personal counseling and medical student wellbeing • Monitoring of student workload • Effective debt management and financial counseling of students
Accreditation Council on Graduate Medical Education (ACGME) Common Program Requirements	<ul style="list-style-type: none"> • Duty hours restrictions • Required guidelines and procedures for supervision of residents at different levels • Mandatory training in alertness management and fatigue mitigation • Institutional database of resident procedural competency • Continuous learning environment review • Resident participation in institutional safety and quality activities • Clinical competency committee for all programs to assess resident performance • Required semi-annual milestone reporting to the ACGME

**American
Association
of Nursing
Colleges: The
Essentials
of Master's
Education
for Advanced
Practice Nursing**

- Research and knowledge management
- Policy, organization, and financing of health care
- Ethics
- Professional role development
- Theoretic foundations of nursing practice
- Human diversity and social issues
- Health promotion and disease prevention
- Advanced assessment, physiology, pathophysiology, and pharmacology

Achieving this goal in the United States will require not only additions to curricula and adoption of new educational methods but also a change in the fundamental structure, strategy, and financing of health professions education. In our current reality, health professions education is constituted as a series of discrete and independent microsystems, each driven to sustain professional autonomy, all coexisting with the broader healthcare environment (Figure 1). In its place we must engineer a future ideal: A highly interdependent health professions education macrosystem, imbedded within a highly functioning healthcare system, driving toward the goal of optimal health and health care for all within our communities (Figure 2).

Figure 1: Current healthcare and health professions education environment: Independent, parallel systems interacting when convenient. The needs of the community are near but not central.

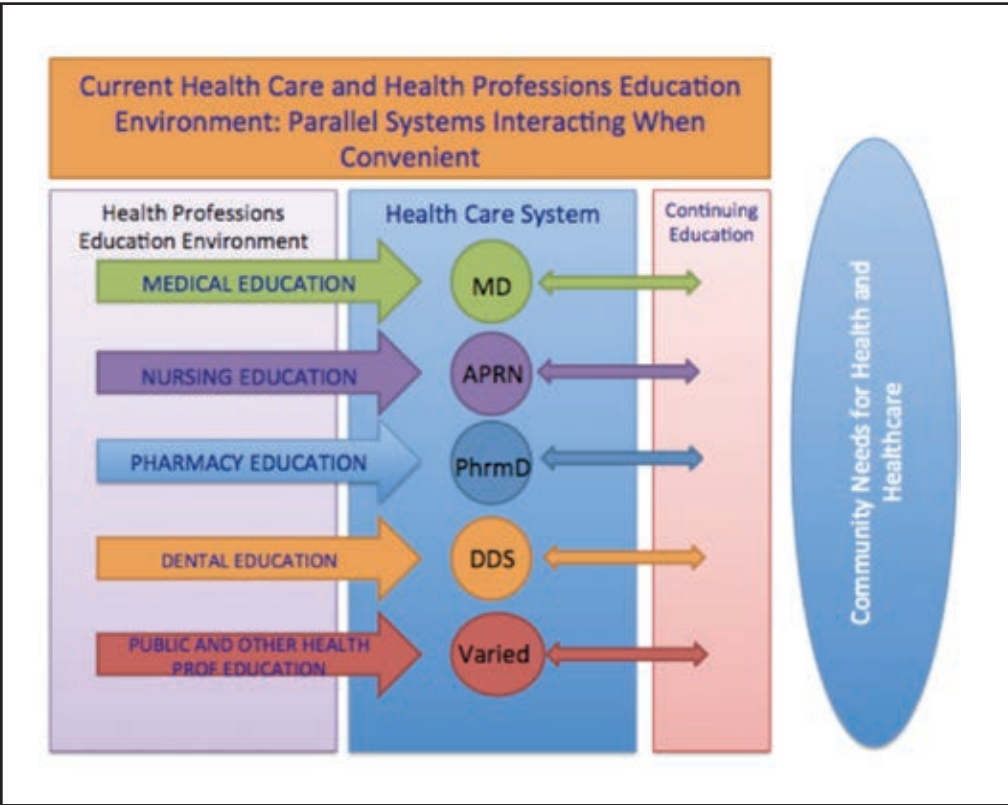
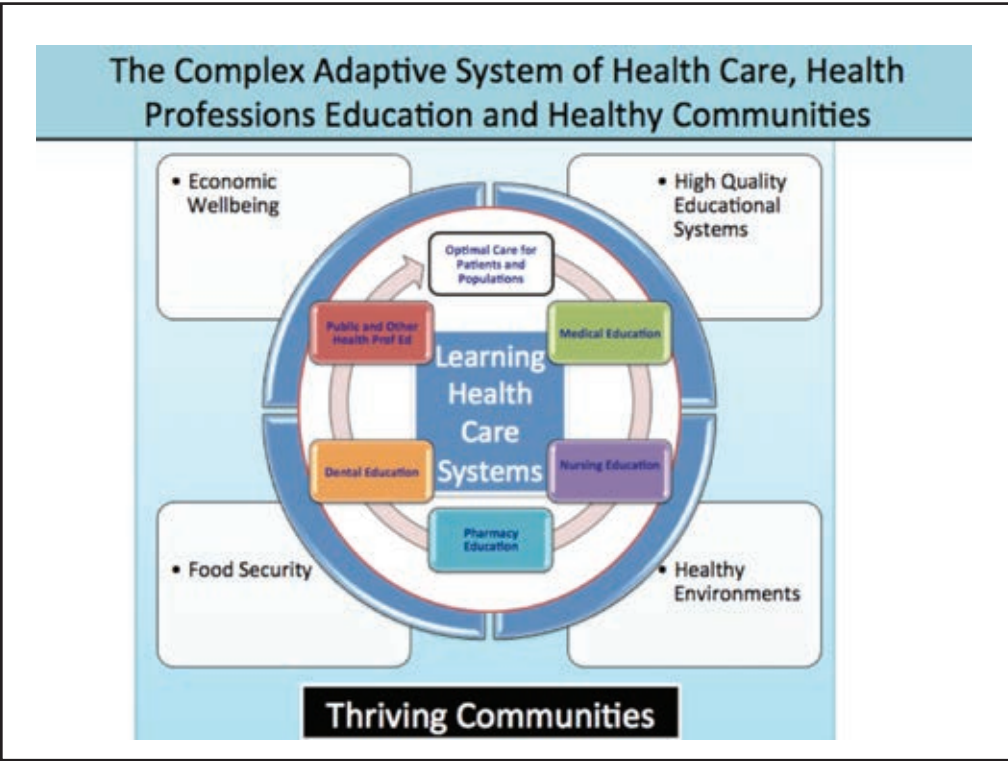


Figure 2: The future of health professions education: A community need-driven, complex system with interdependent educational and care delivery agents.



UNDERSTANDING THE CURRENT REALITIES OF HEALTH CARE AND HEALTH PROFESSIONS EDUCATION

We are in the midst of dramatic changes for healthcare delivery. The 2010 Patient Protection and Affordable Care Act is changing access and payment for health care. The aging population and advances in treatment have led to more people living with chronic conditions, some of which are disabling. Technology is changing the way we provide care, measure quality, and interact with our patients. Health promotion at a population level is garnering more attention and resources. Organizations such as the Robert Wood Johnson Foundation are leading the United States toward a “culture of health,” in which public and private decision making is driven by the goal of building healthy environments, supporting healthy lifestyles, and ensuring that all have access to the health care they need. This is a

huge turnaround from the world of fee-for-service, disease-focused care. All health professions must adapt to this new environment, starting with updating education to meet these realities.

In the context of secondary, tertiary, and quaternary care, there is no doubt that in today's healthcare environment, some people have access to outstanding, comprehensive, life-saving, scientifically advanced, patient-centered care delivered with compassion. Unfortunately, others either have no access to care or have access to care that is episodic, fragmented, not evidence-based, wasteful, dangerous, or fraught with inequities. The situation with primary care is even more dire. The causes of this current state are multifactorial and obviously include issues of healthcare economics, politics, and cultural norms. We must entertain the possibility that some of the responsibility for this performance failure lies in the ways in which we educate our health professionals.

We are fortunate in that there is much to be proud of in health professions education in the United States. Health professions schools are consistently able to attract highly accomplished students. Graduates from accredited health professions schools and training programs in the US are leading academic health centers, advancing scientific discovery, redesigning healthcare delivery, and responding to public health needs around the world. But while each individual graduate may be personally outstanding, the entry of these professionals into the workforce has not led to the healthcare system we need.¹⁴

However, if we look closely at the outcomes of health professions education, we see many problems that need to be corrected. We know that the highest-quality, lowest-cost healthcare systems in the world are based in easy access to primary care.²⁷ Despite this, graduates of medical education consistently choose subspecialty practice over primary care practice, and graduates of all health professions programs preferentially practice in urban and geographically oversubscribed areas rather than in the areas of greatest need.²⁸ We know that educational indebtedness can sway professionals to choose careers based on their potential earnings rather than their societal impact. Yet educational indebtedness in many health professions has escalated over the past ten years.^{29,30} We know that complex problems like persistent health disparities are best addressed by diverse teams and that students from groups typically underrepresented in medicine are more likely than their majority peers to practice in areas that are underserved.³¹⁻³³

Yet the socioeconomic, racial, and ethnic diversity of our health professions graduates, faculty, and leaders remains low.

We also know that managing complex chronic disease requires surrounding patients with highly functioning interprofessional teams. But we still educate our learners in predominantly mono-professional environments.³⁴ And we know that the numbers of nurses, pharmacists, physical therapists, and other health professionals with graduate and doctoral degrees has dramatically increased over the past 50 years.³⁵ Despite this, our medical education graduates have been slow to embrace models of care that are not physician-directed. These are just some of the healthcare challenges that health professions education has not been able to successfully solve using the common levers of curriculum and accreditation. Their persistence suggests the need for more significant, structural change.

AN ASPIRATIONAL VISION FOR THE FUTURE OF HEALTH CARE

In our vision for a modern healthcare system, all patients, regardless of where they live, would have ready access to comprehensive, first-contact care provided by professionals whom they trust, with seamless transitions to and from subspecialty care when needed. Health care at all sites, from non-traditional community settings to the most advanced medical centers, would be delivered by teams of health professionals, all of whom have demonstrated not only competencies in their own profession, but also common and collaborative competencies in interprofessional practice as a condition for both graduation from their training program and continued certification³⁴ (Table 4). In each professional role, diversity with respect to race, gender, ethnicity, sexual orientation, socioeconomic status, and other differences will be evident. Leadership of the teams would follow an adaptive model, where different professions step up to lead different initiatives, based on their content expertise and capacity for leadership. The teams would be expert in managing complex chronic disease, optimizing function, minimizing symptom burden, managing mental health needs, and providing transitional care that is attentive to the family caregivers and home environment.

Table 4: Interprofessional Education Common and Collaborative Competencies Domains

Common competencies domains for interprofessional collaborative care	<ul style="list-style-type: none"> • Provide patient-centered care • Employ evidence-based practice • Apply quality improvement • Ensure safety of care • Utilize informatics
Collaborative competencies domains for interprofessional collaborative care	<ul style="list-style-type: none"> • Shared values/ethics for collaborative practice • Effective interprofessional communication practices • Understand, respect, and leverage roles and responsibilities for collaborative practice • Know and utilize appropriate and effective models of teams, teamwork, and team leadership

In this vision, health professionals would be supported in a number of ways, including a culture and environment that provides for continuous learning, adoption of technology that is an adjunct to clinical assessment and decision making, and research that advances practice and science.^{36, 37} Work would be configured so that professionals and staff in these systems would feel supported and valued in their purpose-driven work and show no signs of burnout. Regardless of educational path or profession, all involved in health care would recognize the importance of, and participate as champions and collaborators in, initiatives designed to advance science and address the social determinants of health and illness.

A VISION FOR THE FUTURE OF HEALTH PROFESSIONS EDUCATION

In the US, we are shifting from the 20th century strategy of the omniscient solo provider overseeing isolated episodes of care to a 21st century strategy of integrated teams seamlessly offering coordinated, patient-centered care within and across a network of well-connected service settings, from home to medical center and back. Achieving this ideal healthcare system of the future means changing the ways in which we educate health professionals now.

In our view, **health professions education (HPE) of the future will be redesigned as a complex adaptive system, explicitly engineered to address the healthcare and health sciences needs of the nation.**³⁸ Periodic population health assessments will identify health, healthcare, and workforce needs. All institutions that educate health professionals, whether they are colleges, universities, or teaching hospitals, will be collectively incentivized and held accountable to educate and graduate the mix of professionals capable of addressing those measured population health needs. These professionals will practice in the array of specialties required and regions in which care is needed. They will demonstrate the competencies needed to support the care model that delivers the highest quality care and the discovery model that advances science. When an emerging epidemic such as HIV/AIDS appears, this system will be able to rapidly adapt its educational processes to prepare a workforce capable of meeting the new challenge.

Supporting this vision are six pillars of high-quality health professions education (Table 5).

- 1. HPE will be patient and population responsive.** Curricula will be continuously adapted to advances in science, changing demographics, and changes in the nature of illness so that graduates have measurable competency in the knowledge and skills needed to serve contemporary patients and population. All graduates will be expert in working with patients and families to optimize health and function throughout their lifespans. Professional identity formation will be explicitly addressed and will include not only a responsibility to advocate for vulnerable populations but a personal commitment to serve for at least part of their post-graduation careers in the areas of greatest need, reinforcing the concept of health professions as a calling rather than as simply a career.²⁰
- 2. HPE will be equitable.** All health professions will be celebrated and supported as critically important by communities, students, and funders. Potential students from all walks of life will be mentored to understand and prepare for entry into one of the many health professions. Educational and economic barriers to admission, program completion, and academic progress will be removed. Demographic diversity (race, gender, ethnicity, religion, socioeconomic class, sexual orientation, and other domains) of the health professions and health sciences workforce at all levels will approach that of the communities we serve.

3. **HPE will be effective.** Health professions education will be carried out using evidence-based learning strategies that prepare students for high-quality, patient-centered, interprofessional collaborative care and lifelong learning.^{20, 39} Faculty from all professions will be trained in educational methods and supported to teach core and common competencies for all professions.^{40, 41} Student learning experiences will include mentored, longitudinal workplace assignments in which they assume authentic and developmentally appropriate roles, contributing to ideal health outcomes.⁴² Valid and reliable assessment strategies, such as entrustable professional activities, will support uniform standards for performance of professionals in common competencies and shared roles, regardless of career path.^{34, 43-45}
4. **HPE will be efficient and flexible.** Career exploration and selection will take place during the most economical stage of education.⁴⁶ Reliable assessment strategies will be used to facilitate competency-based rather than time-based advancement.⁴³ Students with prior life experiences in one profession or one stage of a profession will be encouraged to demonstrate their workplace-acquired competency to shorten the time to degree in subsequent educational programs. Mid-career job shifts will be expected and supported through formal programs so that professionals can adapt to changes in their personal interests, life circumstances, and the healthcare environment.
5. **HPE will be driven by and enhanced by technology.** Technology-enhanced learning strategies with high-quality, brain-friendly digital learning objects will support both the initial phases of education as well as lifelong learning. Blended learning and asynchronous strategies will facilitate career transitions by enabling students to learn while working.^{11, 47} Simulation technologies will enable students to engage in deliberate practice as individuals and in interprofessional teams, tackling progressively challenging situations in a safe environment, free from concerns about harming patients.^{48, 49}
6. **HPE will be lifelong and continuous.** Educational institutions will collaborate with healthcare delivery systems to create exemplary environments for care and learning.³⁶ Electronic health records will be mined to provide data on key process indicators and critical outcomes of health care. These data will be analyzed in real time to identify gaps

in knowledge or skills in the individuals and teams providing the care. Mining of large data sets from population studies will be used to predict new diseases and suggest the need for new curricular approaches across all professions. Educational institutions will have sustaining educational relationships with their graduates, anticipating and meeting their learning needs for the duration of their professional careers. Relevant advances in science and care delivery will be pushed automatically to teams of professionals based on their practice profile and interests. All health professionals will welcome the opportunity to periodically update and demonstrate their competency in all domains of professional practice.

Table 5: Six Supporting Pillars for High-Quality Health Professions Education of the Future

PILLAR	VISION	RESULT
1. Patient and population responsive	Health professions (HP) curricula continuously adapt to advances in science, the changing nature of disease, the causes of suffering, and the desires and unique needs of patients and their communities.	The HP workforce is educated to address today’s health and health care challenges in a culturally sensitive manner.
2. Equitable	Structural inequities in health professions education are removed so that a career in the health professions is accessible to all interested students from all demographic groups.	The diversity of the HP workforce matches that of the nation, and HP education facilitates upward mobility for those from socioeconomic or educationally disadvantaged backgrounds.

PILLAR	VISION	RESULT
3. Effective	All institutions involved in health professions education apply the best evidence to educate their professionals; faculty are supported and expected to be as expert in education as they are in other aspects of their careers.	HP education systems reliably educate and assess learners to assure that they possess the competencies needed to function in their assigned roles.
4. Efficient and flexible	HPE is designed to facilitate career exploration during the most economical stages of education. Educational pathways leading to practice will be streamlined to facilitate entrance into service. On-the-job experience will allow students to shorten the time to degree in subsequent educational programs. Mid-career job shifts will be expected and supported through formal programs.	HP education system is high-value, cost-conscious, and flexible enough to adapt to the life circumstances and interests of health professionals.

PILLAR	VISION	RESULT
5. Driven and enhanced by technology	Technology will play a vital role in using data to identify gaps in knowledge and performance, pushing new information to practitioners before they realize they need it and supporting flexible learning.	HP education is tailored to the needs of teams and individuals and delivered in time to impact today's patients.
6. Lifelong and continuous	Educational institutions will collaborate to support learning in the workplace and to anticipate and meet the learning needs of their graduates for the duration of their professional careers. Graduates will expect to periodically demonstrate their competency in all domains of professional practice.	The competency of health professionals is measurably excellent throughout their careers.

THOUGHT EXPERIMENTS TO HELP ILLUMINATE THE REDESIGN OF HEALTH PROFESSIONS EDUCATION

Below, we present our vision for achieving this education redesign in a series of thought experiments. Each thought experiment targets one or more characteristics of the ideal health professions education system. Each involves changes in the ways in which education is structured, financed, and integrated into the delivery system. Each has themes that are relevant to all health professions. All are built on the foundation of existing programs that work. Some ideas are mildly disruptive and have the potential to produce evolutionary change. Others are tremendously disruptive but potentially game changing in their ability to quickly and deliberately

reengineer American health professions education to meet the health and healthcare needs of our country.

Thought Experiment 1: Designing a system to improve the effectiveness and patient responsiveness of health professions education.

Dean Howard from the School of Nursing, Dean Fitzgerald from the School of Pharmacy, and Dean Jain from the School of Medicine were inspired. They had just watched learners present about their experiences in a required interprofessional collaborative care curriculum, the result of a joint strategic initiative between the schools. The first group comprised a nurse practitioner student, a medical student, and a pharmacy student who completed a six-month rotation on the acute care for the elderly and palliative care unit. They were assigned to tackle the challenge of shared decision making at the end of life, and quickly found that working collaboratively improved the work and learning as each individual brought important views and unique competencies to their group. The nursing students were expert in patient assessment, the pharmacists identified important drug interactions that had been overlooked, and the medical student contributed complex diagnostic reasoning. They also heard enthusiastic support for the program from a group of faculty from each of their schools who worked to design and endorse joint entrustable professional activities (EPAs) for the common core competencies and interprofessional collaborative practice competencies. They used these EPAs and validated assessment tools to train faculty from all schools to assess the common core and interprofessional competencies of all learners.

In our current environment, all agree that we need to educate health professionals to work in interprofessional teams that provide measurably excellent, patient-centered, high-value care to diverse populations living with multiple complex chronic diseases. All also agree that this education should ideally occur in both the classroom and in mentored, workplace communities. Yet new competencies are often treated as add-ons to existing curricula. Interprofessional educational activities frequently take place only in the classroom or in simulation environments. Furthermore, health professions educational programs often compete for clinical placements, rather than collaborate to provide effective interprofessional training. Faculty members are either not available or not prepared to teach new subject

matter or effectively supervise teams with learners from different professions.⁵⁰

⁵¹ This shortage of faculty and clinical placements is particularly acute in nursing education, where it is a major barrier to training the ideally sized nursing workforce.

Ideal experiences in interprofessional education exist. The Macy Foundation Retooling for Quality and Safety Initiative fostered the development of classroom, simulation, and clinical interprofessional education experiences between nursing and medical students at six universities.⁵¹ Potentially more impactful is the Veterans Health Administration grant, which supports five institutions in the design and implementation of centers of excellence in primary care education. These programs imbed interprofessional education for residents and nurse practitioners in the clinical environment, using care model redesign and faculty and staff development as the cornerstones of successful programs.^{52, 53}

In our future system, health professions education institutions will be incentivized to collaborate and build shared curricula, both content and methodologies, on topics relevant to advancing health for our communities. Competencies linked to the current healthcare needs of our communities, including skills that focus on the patient experience, will become the core of all health professions curricula, rather than the add-ons to a historically constructed program. Required authentic, longitudinal workplace learning experiences with students participating in interprofessional teams will be routinely implemented as a best practice.⁵⁴

⁵⁵ Faculty will be incentivized to master new subject matter and educational strategies to supervise learners from different professions. Economic models of support for health professions schools will be designed to ensure that faculty from all schools will be supported to participate in classroom and workplace learning. Shared assessment tools will guarantee that all professionals who provide a common level of care have met a minimum standard of performance. Research into the effectiveness of different strategies of health professions education will be supported financially through the National Institutes of Health as critical to the health of the nation.

Thought Experiment 2: Designing a system to increase the equity of health professions education.

Roland was overjoyed. He had just been accepted into the Health Professions Corps, a joint venture by the federal and state government and the local Academic Health Care System. He will start exploring and training for careers in health professions from the beginning

of community college. As long as he meets his milestones, he is guaranteed to have a career in the health sciences. The Corps includes a co-op program, where he is paid to learn while working with the teams in the local medical center. That will allow him to quit the part-time job he has needed to meet expenses since his father died.

It is exciting to think about the options in front of him—he can choose a career in biomedical research, dentistry, nursing, pharmacy, public health, medicine, and more. And for any career he chooses, he also has options for the level of education. He could stop after two years and work as a technician in his chosen field. If he decides he wants to go further, he can apply his previous training to the next level. If he wants to pursue advanced degrees, scholarships are available in return for service in areas of need.

In our current environment, academic institutions attempt to increase the diversity of their student bodies and provide educational opportunities to individuals from diverse and/or disadvantaged backgrounds using a variety of strategies. All schools engage in informal, episodic outreach to K-12 and post-secondary schools. In medical, dental, and pharmacy education, formal post-baccalaureate programs are designed to help students from educationally disadvantaged backgrounds prepare to succeed in health professions education. Many health professions institutions use a form of holistic review to ensure that a student's academic achievements are considered in context and across a spectrum of competencies.⁵⁶ In nursing, groups such as the National Coalition of Ethnic Minority Nursing Associations and programs such as the American Nurses Association's Minority Fellowship program have been successful in advancing nursing education in minority populations.¹¹ All of these programs work; post-baccalaureate programs in particular have been shown to increase the diversity of medical school classes.⁵⁷

However, there are many challenges that limit the success of these programs.⁵⁸ Existing programs are small and randomly distributed, leaving the opportunity to achieve a career in the health professions up to chance. Institutional investment in these programs is often low and limited to supplementing soft money support. The post-baccalaureate strategy attempts to prepare students for career success after years of educational disadvantage rather than intervening early, when fundamentals of science, math, and critical thinking can become habits of mind. Rarely do pipeline interventions target all health careers: priority is given to preparing

students for medicine, and less commonly, pharmacy and dentistry. Finally, approaches that provide educational support alone fail to address the economic realities that require students from disadvantaged backgrounds to work while attempting to study, a situation that can prevent otherwise talented students from succeeding.

Academic medical centers are beginning to understand the importance of systematically addressing educational and employment disadvantages in communities not only to better prepare all students for careers in the health sciences but also to enhance the overall wellbeing of the community. In Durham, North Carolina, for example, Duke University has partnered with local industry to provide employment for all youth in the community. In a different approach, hospitals such as Barnes Jewish Hospital in St. Louis, Missouri, are embarking on initiatives to enhance early childhood education, thus increasing the likelihood that students can reach high levels of educational attainment.⁵⁹

In our future health professions education system, we strategically cultivate talent from all of our communities to achieve our goals of an equitable health professions educational system and workforce diversity. Institutions responsible for health professions education will work together with their colleagues in K-12 and post-secondary education to support comprehensive early intervention programs. These programs will be designed to expose students to the variety of health professions careers available and provide students and schools with learning support and encouragement. Through the use of co-op strategies, programs can mitigate the economic challenges that often stand in the way of success. With a systematic approach, every K-12 school and community college serving educationally and socially disadvantaged students will be connected to a consortium of health professions education institutions, thus optimizing opportunities for all students interested in and willing to work towards a career in health. Academic medical centers will embrace their roles as anchor institutions, using their economic and intellectual resources to ensure their communities thrive.

Thought Experiment 3: Designing a system to increase the efficiency of health professions education.

Dean Rodgers paused for a moment to reflect on how the world of medical education had changed during her 30-year career. One of the largest changes was the Medical Education Continuum (MEC) program. In this program, students are accepted into a medical education

continuum school, in which they would complete both their medical education and their initial residency training within the same academic healthcare consortium. A long-time advocate of diversifying the workforce, Dean Rodgers was particularly excited about how medical schools were prioritizing admission for students who had come through the Health Professions Corps. The experiences in the Health Professions Corps enabled students to develop an informed commitment to a specific specialty before they entered into their doctoral training.

In the initial pilots, the first advantage realized was that students were saving significant amounts of money and time by not having to travel for residency interviews. More significant beneficial effects were evident over time. Medical school officials and residency program directors began to cooperatively identify desired competencies and milestones for each of the critical transition points between the first year of medical school and the first year of practice. Faculty who knew that students would be staying in their system for residency became more thoughtful about both formative and summative assessments of the students and residents. The Academic Medical Center found it to be very useful in meeting workforce needs at their network hospitals—they could easily open or close residency slots depending on the needs of their communities. Furthermore, the investment they made in training a student and then a resident in the culture and strategies of their institution made it much easier to achieve their regional vision for high-quality health care.

In our current environment, the time to complete formal education has gradually lengthened as health professions education institutions add coursework and requirements to ensure that their graduates have the competencies needed to meet the increasingly complex care needs of patients. Recently, many have articulated economic, workforce, lifestyle, and pedagogical reasons in support of streamlining and potentially shortening the process of formal education and training in medicine. Despite this alignment of views, little progress has been made towards this goal. One structural barrier to achieving a more time-efficient model of medical education resides in the lack of coordinated control over the continuum of medical education. Each group in charge of one phase of medical education (medical school, residency, fellowship) supports maintaining (or increasing) the

length of their component of training while eliminating waste by shortening the other components of training.

Choosing a specialty before the third or fourth year in medical school is an anathema to physicians and medical educators. However, early career selection is the norm for nurse practitioners, who can select careers as certified nurse midwives, nurse anesthetists, or nurse practitioners with specialties in family health care, adult/geriatrics, pediatrics, community health, or psychiatric and mental health. Practitioners can continue on to more advanced degrees to prepare for research and teaching.¹¹ Bold but small pilots of combined MD/board certification trainings exist at New York University; the University of California, Davis; and through the Association of American Medical Colleges-sponsored Education in Pediatrics Across the Continuum, involving four medical schools.⁶⁰ These programs are attracting very talented students who are ready to commit to a career path that is more efficient and tailored to their career goals.

In our future system, specialty selection will occur before students embark upon the most expensive component of their education. The curricular experiences that result in a practice-ready specialist in all professions will be orchestrated as a continuum, with explicit competency milestones for transitions between stages of education articulated and agreed upon by all stakeholders. Faculty will approach the evaluation of all trainees as if they will be responsible for them for the duration of their education. While a given student may choose an educational pathway that is discontinuous, care will be taken to avoid interrupting educational processes to support large-scale migrations of students between different healthcare systems before they have completed their core training.

Thought Experiment 4: Designing a system to support efficient, flexible, lifelong, learning in health professions education.

Juan reflected back over the past two years with pride. He had successfully completed an associate degree in nursing (ADN) that allowed him to start earning an income to support his family. He also went on to complete an “RN to BSN” program. This program was a competency-based, blended-learning program sponsored by the local nursing school in collaboration with his health system. He began the program with a series of knowledge and skill exams in the local hospital’s simulation center. The results of this assessment dictated the coursework he needed to earn his degree. The online coursework and

the weekly online seminars with other classmates and the professors allowed him to stay on the job while he was learning. He felt very fortunate that the community health center at which he worked was a designated education unit (DEU).¹¹ This gave several of the BSN nurses and nurse practitioners (vetted for quality to be eligible as faculty) the time during work to supervise him as he learned new clinical skills.

It was easy to apply the new skills he was learning to the workplace. He drew upon his added credentials in quality and safety improvement to implement daily interprofessional huddles—well organized with medicine, nursing, pharmacy, and social work at the facility—that greatly improved the efficiency of workflow. In recognition of his excellent leadership of this effort, the clinic’s medical director asked him to chair a weekly team meeting to review outcome metrics for their patients. When review of electronic health records revealed that a large percentage of pregnant women did not receive adequate prenatal care, Juan used his training to conduct focus groups to collect data from patients. His team learned that many had difficulty getting to the clinic during regular hours. Adding clinic hours on the weekend proved to be a big success: not only did prenatal care improve but so did the vaccination rates among children.

The clinic was recently recognized as an exemplar for value-based care. As a result, the leaders of the clinic have asked Juan to pursue a doctor of nursing practice (DNP) degree, with the explicit goal of having him assume the leadership of the preventive care program for the practice. They will pay his tuition and a living stipend and he will be able to continue working at this great healthcare center.

In our current environment, educational programs are time- and course-based rather than competency-based. Regardless of past work or learning experiences, current competency, or future goals, students in formal educational programs will traverse almost identical pathways with the same required time to degree or certificate completion. Continuing education is also time-based: requirements are measured in terms of hours of classroom attendance or earned credit. Furthermore, continuing education is designed primarily to maintain competency of professionals after the end of formal education rather than to enhance career transitions. This structure is a major barrier to achieving the goals of transitioning the majority of

associate degree nurses to bachelors' degree nurses and masters' degree nurse practitioners to doctors of nursing practice over the next decade.¹¹

In our future system, competency-based assessment strategies will support individualized career pathways while maintaining standards of performance.⁴⁵ Roles and responsibilities in the clinical arena will be assigned based on an individual's demonstrated competency rather than on their terminal degree. The needs of highly educated professionals to continuously learn and improve themselves will be expected and supported. A range of programs from on-the-job to formal coursework and degree programs will be available to allow individuals to take on greater responsibility, follow a new interest, or manage a specialty-threatening disability (such as a tremor in a surgeon or arthritis in a bedside nurse). Mid-career education will be organized to recognize and reward past educational and workplace learning, using competency-based standards and assessment to facilitate the career transitions.

Thought Experiment 5: Designing a system to support lifelong, continuous, technology enhanced learning.

The team gathered together for the weekly professional performance optimization session. Their job today was to plan for continuing professional development for all of the members of their team: from the medical assistant to the physicians and advanced practice nurses who led the team. Four years ago, their practice joined a geographic consortium of teaching hospitals and health professions schools to create an accountable care and learning organization (ACLO). The academic medical center consortium at which most of the professionals trained and to whom they refer patients for tertiary and quaternary care provides telemedicine and e-consult support for difficult cases at no charge to the providers.

The electronic healthcare record system that links all of the practice sites and hospitals within the ACLO provides each professional with a performance dashboard that identifies the most common conditions they see, the management they have prescribed, the important healthcare outcomes in their population of patients, and any deviations from standards of care. When a possible gap in understanding is identified, the provider receives an email with a link to a learning module that can be shared with the entire practice. The ACLO also

provides each professional with their own learning management system and assigns him or her to a learning community of professionals with similar interests. Professionals can join a journal club, visit the simulation center to practice new skills, and use the same online curriculum that is provided to the current health professions students. When providers are due to renew their license or their certification, they download their competency portfolio from the learning management system and transmit it directly to their certifying boards.

In our current environment, continuing education is the responsibility of the individual. It exists outside of the practice and work environment. Professionals choose the programs in which they participate based on their interests and their assessment of their learning needs, despite evidence that the accuracy of self-assessment is generally poor.⁶¹ Most programs are lecture based and focused on knowledge.⁶² Mastery of the content is assumed by attendance and declared intent to change practice, rather than measured using reliable tools. Attempts by licensing and certification boards to require demonstration of competency with more valid and reliable tools, such as periodic high-stakes exams, have been met with enormous resistance from practicing professionals. These professionals raise concerns that preparation for these exams takes too much time away from patient care activities and that the content of the exams is not relevant to their practice environment.⁶³⁻⁶⁵

Continuing education programs are recognizing the limits of lecture-based activities and are striving for new methods that engage practicing professionals in active, skill-based, and reflective strategies that are known to increase the effectiveness of learning. New programs in continuing education are aligning continuing education strategies with workplace quality improvement and are leveraging simulation and project work to engage practicing professionals in more active and more effective learning.^{50, 66, 67}

In our future system, technology will facilitate the identification of educational needs, continuous learning, and documentation of competency. Data mining of health processes and outcomes in the electronic health record will be used to identify areas where urgent intervention to improve care is needed. Health professions schools will collaborate to develop high-quality digital learning objects to optimize the education of their students. Digitally stored videos, assessment tools, and simulation-based experiences that address enduring and emerging

competencies will be periodically pushed to graduates, based on their practice profiles and their own identified interests. From the start of their health professions education, each professional will store evidence of their learning activities and competency assessments in a cloud-based learning management portfolio. Maintenance of competency requirements will be met by downloading information from the electronic health record and these learning management systems. Learning will become an integral part of the weekly work of teams and individuals, with time and support provided to ensure that all within the workforce advance their competencies throughout their careers.

Thought Experiment 6: Designing a system to support all the pillars of an ideal health professions education system.

Josette was excited and just a little nervous about her new position as a primary care clinician in a small rural town, approximately 180 miles from the academic center where she completed her residency training. She had had the good fortune to enter medical school after the 2020 comprehensive health professions overhaul program began. Since then, in exchange for compulsory service, the government paid for all health professions education. Graduates could choose whichever career path they wanted: Any profession and any specialty within that profession. However, after they had completed training leading to their first board certification or credential, they were required to complete their service requirement as a generalist in their chosen field before embarking on any subspecialty training.

This requirement wasn't as burdensome as first envisioned. Because the continuum of health professions' education had been shortened, it took no longer to complete formal education and participate in the new service commitment than it took to finish formal education in the old system. Newly certified professionals were assigned to practice in one of the new comprehensive centers for education, health, and health care (CCEHHC), with infrastructure provided through a joint initiative between the regional academic medical center, local employers, and the state and federal governments.

The CCEHHC sponsors outreach programs for elementary and middle school. High School and community college students are eligible to join a health professions corps and work while they are learning

about different health professions. As a designated education unit, professionals are afforded time to teach and mentor either pre-health professions students or health professions students enrolled in their doctoral programs.

While professionals can leave after completing their service commitment, many with whom Josette interviewed had decided to stay within the practice because they found it so rewarding. Furthermore, the efforts that the practice had contributed in collaboration with the local public health and education officials had now made this a desirable location to live and raise a family.

In our current environment, individuals finance their own education in the health professions.⁶⁸ As a consequence, they are free to choose which specialty they will pursue and where they will practice. Existing financial strategies to address geographic areas without access to healthcare providers include the National Health Service Corps Scholarship and institutional, state, and federal loan repayment strategies for health professionals who agree to work in underserved areas. These strategies, in existence for decades, have not achieved the uniform geographic or specialty distribution needed because they attract and support only a small percent of health providers each year. The time-limited nature of the service commitment often means that a given area does not have a sustainable supply of healthcare providers. A prevailing focus on primary care specialties means that providers who practice in these communities are challenged to find specialty care, such as surgeons, psychiatrists, and neurologists, to help them manage their patients' complex needs. Given their transient commitment to their assigned region, health professionals have little incentive or ability to effect the changes in school systems and other social structures that could make the region a desirable place to live and raise a family.

Health professions institutions that have been founded with or have embraced a mission of social accountability are making progress in addressing healthcare deserts by intentionally recruiting students from areas of greatest need and supporting them to return to practice in their home communities.⁶⁹⁻⁷¹ Other institutions have worked to design and recruit students into specific tracks focused on the care of vulnerable populations.^{72, 73}

In our future system, a national service program requires all who have the privilege of embarking upon a career in the health professions to accept the responsibility of a period of practice in an area of unmet need. This strategy will simultaneously eliminate the problem of runaway educational debt as well as the misdistribution of health professionals. Competency-based advancement will allow practitioners to complete their training and enter their preferred practice in approximately the same time as is required in the current educational paradigm. Operational and economic support for the communities in need and learning support for the professionals is provided by academic-industry-governmental partnerships. Academic health systems and their educational partners embrace the value of working with their communities as anchor institutions, leveraging their intellectual, educational, and economic strength not only to provide health care but also to address the social determinants of health.^{59, 74-76}

SUMMARY

While some could call these thought experiment scenarios fanciful, it is likely that the professions felt the same way when Flexner recommended that medical education be conducted within the university; when the decision was made to increase the workforce of primary care providers through graduate training of clinical nurses; and indeed, when the federal government decided that the Sputnik debacle should be viewed as an opportunity to enhance graduate education in all scientific fields.

Building an ideal health professions education system that underpins the future ideal system of healthcare delivery will only be possible if we move from what Quinn and Quinn have articulated as comfort-driven goals to purpose-driven goals.⁷⁷ Comfort-driven goals lead to tactical, small-scale, unsustainable change and allow institutions to continue the status quo, maintaining control and autonomy. A focus on comfort-driven goals may be why some criticize health professions educational reform efforts as “revolution without change.”

Purpose-driven goals inspire action and commitment. Achieving these goals requires us to ask bigger questions. We must advance beyond questions that focus on tactics, such as “How do we shorten medical training?” Or “How do we get more health professionals to enter primary care careers?” Instead, we should be asking, “How can we ensure that every person who lives in the United States

can easily access the right type of health care when they need it, delivered by compassionate teams of skilled professionals?” and “How can we develop care delivery models that guarantee that professionals delight in serving their patients, engage in continuous learning, and find joy in their practice?”

Answering these purpose-driven questions will require engaging a wide variety of experts in planning a health professions educational redesign. Our leaders in national organizations and university- and community-based academic medical centers must join with practicing health professionals, economists, public health experts, labor experts, K-12 educators, legislators at the state and national levels, and patients. Their work will be to generate new ideas; identify incentives; address barriers that exist in culture, law, politics, and economics; devise accountability metrics and consequences; and cultivate the will to change. Within this tent of experts should be critics whose concerns must be heard and addressed.

The energy and enthusiasm for the needed revolution must come from within our professions. The desire to provide our communities with a healthcare system that is measurably the best in the world should be highly motivating to groups of leaders and professionals, all of whom have committed their careers to improving health and reducing suffering through patient care, education, and scientific discovery. Like the rocket scientists before us, we have the opportunity to galvanize our current patients, public partners, and future health professionals to advocate for and invest in a US health professions education system that advances the health and wellbeing of our nation.

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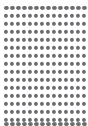
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HIGHLIGHTS FROM THE CONFERENCE DISCUSSION



On the following pages are highlights of the lively and thoughtful discussions that took place over the course of the two-and-a-half-day Macy conference “Enhancing Health Professions Education through Technology: Building a Continuously Learning Health System.” Participants at the conference engaged in intense discussions, both in small breakout groups and large plenary sessions, that ultimately resulted in consensus around a vision statement for the future of health professions education as well as a set of action-oriented recommendations intended to move us toward achieving the vision. Both the vision and recommendations are detailed in the “conference recommendations” chapter of this monograph.

During the first full day of the conference, the discussions focused around three commissioned papers, the complete texts of which are also included in this monograph. The papers laid the groundwork for and sparked dynamic conversation among participants, all of whom read them prior to the conference. During the second full day, discussion turned toward identifying and focusing on the major themes and issues that emerged from the previous day. Then, overnight on day two, conference organizers drafted a vision statement and set of recommendations based on the two days of discussions. The third day, a half-day, was devoted to achieving initial consensus around the draft vision statement and recommendations, which were then revised, refined, and finalized via conference calls and emails during the eight weeks immediately following the conference.

Opening Remarks and Introductions

Following a reception and dinner on Thursday evening, the 38 invited conferees as well as Macy staff and a handful of guests came together early on the first full day of the conference. George Thibault, MD, president of the Josiah Macy Jr. Foundation, opened the meeting by asking conferees to introduce themselves and describe their connection to the subject of the conference. Over the next hour, the conferees, who were seated at tables arranged in a large, open rectangle to facilitate group interaction, spoke briefly about the professional expertise and personal interests that connect them to health care, health professions education, and/or educational technology.

Conferees ranged from healthcare professionals as well as leaders of healthcare organizations and health professional education institutions to health professions students, innovation and technology professionals, education researchers and technology developers, funders, and patient advocates. In many cases, conferees have multiple connections to health care, health professions education, and/or educational technology. For example, one conferee is a practicing pediatric cardiologist as well as executive director of a virtual patient program used in most medical schools, while another is a nurse who also works with an online program that connects patients living with illness. Another conferee is a medical student, business student, and CEO of a medical education technology start-up company, while another is a speech pathologist whose company provides online continuing education to others in her field. A complete list of conferees and their affiliations appears in this monograph.

Following the introductions, Dr. Thibault provided a brief overview of the Macy Foundation's history of supporting innovations in health professions education, particularly interprofessional education. He explained that, in recent years, the Foundation has been focused on linking interprofessional education and clinical practice reforms, and including patients, families, and communities as equal partners in those efforts. In fact, linking education and clinical practice and partnering with patients were the subjects of the last two Macy conferences.

For this conference, Dr. Thibault explained, the planning committee identified a need to discuss and propose recommendations around enhancing health

professions through educational technologies—not all technologies that might benefit health care, but technologies related to teaching, learning, and assessment. He went on to describe the areas of discussion that he and the planning committee envisioned happening at the conference, including a consideration of the ways in which health professions education differs from other types of higher education—what sets it apart in ways that are both beneficial and also challenging?

He also suggested that the topic implies a need to improve or enhance health professions education, and that technology is a way to do that, but how? What are the parameters around that work and how do we define the scope of what we want to achieve? Will technology actually allow us to educate health professionals in a less costly and more efficient way? And who will and who should benefit from that? Could technology also help us further our diversity goals? Can it help us create partnerships with patients, families, and communities? Can it help us align and link health professions education and clinical practice? “These are the types of things that I hope we’ll tussle with,” said Dr. Thibault, “in the spirit of openness and acknowledging that this is a time for change, that we can and must do things better for our learners and for our patients.”

Dr. Thibault also explained the structure of the conference and how it came together. “We posed three questions to set up this conference, and those led to the commissioned papers we’re going to discuss next,” he said. Those questions were “What can we learn elsewhere from higher education about the use of technology in education? . . . [S]ince we’ve seen new technologies already beginning to be applied in health professions education, what do we know about what works and what doesn’t work? . . . And, finally, we want to be forward thinking . . . Where do we think health professions education should be going, and how should that influence our planning now?”

Before turning to the discussion of the commissioned papers, Dr. Thibault invited the co-chairs of the conference planning committee to speak. First, Marc Triola, MD, FACP, associate dean for education informatics at New York University School of Medicine, welcomed participants and asked them to consider the following quotation by President Johnson in 1967: “I believe the time has come to enlist the computer and the satellite as well as the television and the radio, to enlist them in the cause of education. Think of the lives this would change. The student in the small college could tap the resources of the great university. The country doctor could get help from a teaching hospital. Today, our problem is not making miracles

but managing miracles. We might well ponder a different question: what hath man wrought and how will man use his inventions?"

Dr. Triola then urged the conferees to seize the opportunity presented by this conference. "We have a tremendous obligation to the learners in our programs who are aspiring to be the best that they can be. These tools can help them, or potentially hurt or hinder them, if we use them incorrectly or inappropriately. We don't know the answers to these things and we're grappling with such great questions. But we have here, as a group, an opportunity to think very ambitiously, very broadly, and to be bold in our recommendations."

He turned the microphone over to conference co-chair Gail Stuart, PhD, RN, FAAN, dean of the Medical University of South Carolina College of Nursing. In her welcoming remarks, Dr. Stuart observed, "I believe that, right now, both the education of health professionals as well as the whole healthcare delivery system are in a time of flux. It's a time where things are becoming unfrozen, and as we know from change theory, that's an ideal time to look at how things can be improved." With these words, the opening speakers moved the gathered conferees into a plenary working session to consider the three commissioned papers.

Overview and Discussion of Commissioned Paper 1: ***Swirl: Trajectories for Digital Technology in Higher Education***

The first commissioned paper, "Swirl: Trajectories for Digital Technology in Higher Education," was summarized for the conferees by its author, Malcolm Brown, PhD, director of the EDUCAUSE Learning Initiative, and Marni Baker Stein, PhD, chief information officer at the University of Texas. The paper outlines three major trajectories—big data, personalization, and hybridization—that may impact the near future of higher education, which Dr. Brown described as being in "an unparalleled period of transition."

"Big data" or data analytics—terms that refer to the analysis and application of the ever-increasing amounts of data—may provide new insights into teaching and learning that will enable powerful new educational strategies. "Personalization" may allow learners to pull apart and reassemble traditional pedagogies, using digital and other resources, to create custom pathways for learning tailored to individual needs and interests. This process of disaggregation and re-aggregation of higher education is an important aspect of the "personalization" trajectory. In his paper, Dr. Brown compares this to "phenomena like student swirl, where a student builds

a multi-institutional pathway to a degree.” And finally, “hybridization,” or the adoption of hybrid learning models, may create new ecosystems for active learning that are technology-infused and provide “cross-contextual experiences like never before.”

Dr. Baker-Stein said that these trajectories are “causing a lot of creative tensions . . . and are encouraging us to look beyond the ‘course’ as the unit of analysis [and] think about fairly major changes in program and curriculum design.” She suggested that changes are needed in instructional staffing, curriculum governance, student services design, and “in the roles and responsibilities of the whole set of people—faculty and others—that surround an educational experience.” All of these considerations also imply additional changes would be needed in areas like facility design, accreditation, student financial aid, and more.

Following the brief overview of the paper, the floor was opened for comments and questions. Several conferees drew parallels between the higher education trajectories that Brown identified, particularly personalization, and trajectories that are being seen in other industries, such as the fast food, airline, online shopping, music, and newspaper industries. Also raised was the challenge of allocating resources and designing physical spaces for technology-based learning that we cannot yet envision—investments are made in buildings that are built to last, but technology is evolving rapidly.

A conferee raised a concern about the “tunnel vision” that students may experience with personalization, which allows them to make educational choices based on their interests and strengths, but leaves little room for exposure to new topic areas, experiences, and possible strengths because “they don’t know what they don’t know.” Building on this idea, another conferee asked how far health professions education should be willing to go with personalization. “We’ll need to decide,” she said, “whether we’re personalizing to address individual competency deficiencies or to fulfill students’ own interests as a priority over the needs of society.”

This point was picked up later in the discussion when a conferee suggested that a definition of personalization is needed to help further the conversation. It appeared that, in general, conferees were thinking about personalization in terms of the ability to adapt educational experiences to better fit with different student learning styles—rather than the ability of students to customize their degrees based on their particular interests.

Continuing the discussion, a conferee mentioned that the use of online and virtual technologies in health professions education is mirroring the expansion of patient “touch points” on the care delivery side—“We deliver care on the phone, and increasingly by video conference, and even email,” the conferee said. “We’re exploding the idea of the ambulatory care setting,” which “raises questions about faculty development and assessing student competence in these virtual care settings.”

Also raised was the idea that personalization works well on a small scale, in a course or a program, but how can it be brought to scale across health professions education more broadly and how do we know what works and what does not for the most students, and how do we use it to improve productivity? Along these lines, several conferees raised questions about how to free up time or create incentives for faculty, who are already stretched thin and often resistant to change, to integrate educational technologies effectively.

While most of the discussion centered on the concept of personalization, hybridization was also raised, with one conferee asking, “How do we get technology built into the education system that we currently have?” He went on to explain that he views personalization as a higher order challenge and that medical schools currently are not even using the more well-established virtual patient technology very effectively. He noted that there are a lot of barriers to integrating hybrid learning models into curricula. Dr. Brown expanded on this point, saying that courses designed to teach faculty how to use new technologies in their teaching usually have their priorities reversed, with the focus on the technology itself rather than on the educational goals that can be better achieved by using technology as a tool.

As the discussion wrapped up, presenters Baker-Stein and Brown were given an opportunity to reflect on the conversation about this paper. Dr. Baker-Stein said that she took from the discussion the need to continue exploring lessons learned from other industries, to be cautious and to fully examine both the positive and negative aspects of personalization, and to think carefully about the various challenges of integrating educational technologies into established pedagogical practice, including supporting the development of faculty. Dr. Brown affirmed that personalization is a powerful educational approach because “it is how we learn best, when things are personalized to us, to our needs.”

Overview and Discussion of Commissioned Paper 2: *Educational Technologies in Health Professions Education: Current State and Future Directions*

Authors David Cook, MD, MHPE, associate director of online learning at the Mayo Clinic, and Dr. Triola introduced the second commissioned paper, “Educational Technologies in Health Professions Education: Current State and Future Directions.” Dr. Triola began by mentioning the Gartner Hype Cycle that refers to the elevated expectations and excitement that accompany the release of new technologies, which may or may not live up to those expectations in the long run. According to Dr. Triola, “. . . so far, much of the hyped technology has yet to substantively transform education.” But he also believes that we are at a tipping point “where that will no longer be the case.”

He went on to describe the three qualities of technology that are most important to its successful adoption: flexibility, control, and analytics. Flexibility is most closely related to personalization—it is the opportunity afforded by technology to overcome barriers of time, place, pace, scale, and patient safety in health professions education. Analytics provide an opportunity to take advantage of big, rich data sets being collected electronically and “move away from anecdotal education to true educational epidemiology.” And control refers to the ability of educators to standardize course quality and content, optimizing information without redundancy and ensuring that student objectives are met.

Dr. Cook added two more important points. First, expensive new technologies should be evaluated and used based on their value. “We need to maximize the benefit and minimize the cost.” Second, we need to move beyond viewing technology as something special. “If we focus on the current or latest technologies, we will forever be losing ourselves and it will be harder and harder to keep up. Instead, we need to focus on the fundamentals of pedagogy, the fundamentals of how people learn.” He also mentioned the need to move beyond blended learning to what he calls “blurred learning,” where we no longer worry about the educational interface, we just use what works best.

Dr. Triola then stated that technology alone will not spur a transformation in health professions education, which also requires imagination and ambition on the part of teachers and learners. But, he said, the time is ripe to create a technology-enhanced transformation “at a scale and pace that are almost magical.” The other

necessary component, however, is evidence. Dr. Triola said that we need evidence “at the return-on-investment” level regarding the interplay between adult learning theory and emerging technologies. He also noted that there are opportunities to create a culture of sharing around evidence and best practices regarding educational technologies and that “we don’t have to re-invent the wheel.”

Dr. Cook followed up with three final points. First, we need to be careful to retain our focus on our relationships with our patients and colleagues. “There’s a danger as we focus on technology,” he said, “that we lose sight of the human part of health care.” Second, technology should reinforce the fundamentals of pedagogy, to really understand what makes for good, efficient learning. “I don’t think technology by itself is going to make learning more efficient,” he said. “And third, we need to focus on developing human capital. We need to train craftsmen on how to use these tools.” He said we need both generalists, who have a broad understanding of both pedagogy and how technologies can effectively support it, as well as specialists, who are experts in specific focus areas and specific technologies.

Following the authors’ brief overview of their paper, the floor was opened to questions and comments. One of the first commenters remarked that teaching has not always been supported or appropriately rewarded in health professions education. Another early commenter picked up on the author’s statements about needing more evidence regarding effective teaching and learning and how technology can support both. That commenter mentioned a “what works” website hosted by the US Department of Education that houses “high-quality” studies on effective pedagogy. The commenter said that one thing we know is that we learn best when we are out in the real world, practicing—which is something that technology can help facilitate. But two fundamental things that technology does not yet do, according to the commenter, are 1) teach learners how to communicate effectively, and 2) teach learners how to regulate emotions, such as managing stress. Although, later in the conversation, another commenter disagreed with this assessment, saying, “Video can do a great job in helping to assess how well you communicate in clinical encounters with standardized patients.”

Also mentioned during this exchange is the fact that technology does not and never will replace the role of human interaction—between practitioners and patients, teachers and learners, and between learners and patients—in health care. Technology does, however, hold the potential to free up people in these roles to

have more personal interactions and build stronger, more effective relationships with each other.

Another commenter mentioned that technology allows for the standardization of course quality. Traditionally, teachers have varied widely in their interpretations and approaches to the same topic areas and courses, but technology now allows for any teacher to be trained to lead students through a standardized course, which allows for more consistent outcomes. This led to a comment about the need to “teach teachers how to teach,” something that, historically, has not been done in the health professions. “ . . . [O]ne of the ways we’ve taught learners up until now is by people who we think should be able to teach because they’re a practicing nurse, or doctor, or other professional and, therefore, should teach others to be these things even though they’ve never been trained to teach.”

Faculty development in both effective teaching and integration of appropriate technologies as teaching tools was identified as a critical need by several commenters—many of whom also mentioned the opportunity to use technology to support faculty learning. And one person suggested that health professions education accreditors should consider developing national standards around not just professional qualifications but actual competence in teaching. A health professions student remarked that technology not only enables faculty members to become better teachers, but also enables students and peers to teach each other—to learn by teaching.

In addition to faculty development, another theme that ran through this particular discussion was that of sharing. Technology allows for open content, open educational assets, and also open curriculum and program design, although several noted that sharing may be a challenging concept for traditionally trained faculty members. Also mentioned was the idea that sharing requires consumption—whatever is shared must be consumed or it has no power to benefit learners or reduce costs. Along those lines, one of the health professions students asked faculty in the room to post any teaching videos to YouTube because “there are a lot of great materials being produced by different universities, but if they are locked into a learning management system that you need a password to get into, the students aren’t going to benefit.” He went on to mention that researchers are judged by their impact factor and “if you’re an educator producing great content, the number of views you get on YouTube is a great impact factor.”

In his wrap-up of the discussion, Dr. Cook reinforced the concept of technology as an enabler, a tool, that can support the needs for faculty development, for open sharing, and for getting back to the fundamentals of learning in re-imagining health professions education.

Overview and Discussion of Commissioned Paper 3: *The Future of Health Professions Education*

The third commissioned paper, “The Future of Health Professions Education,” was presented by two of its three authors from the University of California, San Francisco: Catherine Lucey, MD, vice dean for education at the medical school, and David Vlahov, PhD, RN, dean of the nursing school. Dr. Lucey spoke first and said the primary message of the paper is that “A high-performing healthcare system cannot exist without a high-performing health professions education system, and vice versa.” She continued, “The two are inter-related . . . and cannot continue to exist the way they are now, which can be described as an organically derived collective of similarly inclined professions and institutions.” She went on to explain that we must create incentives that force healthcare delivery and health professions education to work together, very deliberately, to achieve the health outcomes needed in our society.

She explained that the paper lays out the characteristics of a linked health professions education and healthcare delivery system that needs to be:

- Responsive to the healthcare needs of patients and populations;
- Equitable, representing the diversity of our general population;
- Effective and evidence-based;
- Efficient and flexible;
- Technology-enhanced; and
- Lifelong and continuous, with ongoing education seen as integral to the work.

Dr. Lucey also mentioned some provocative questions that were raised in the paper, including asking what would happen if health profession education institutions were held accountable for the health and wellbeing of their surrounding communities and/or for the quality and success of their graduates?

Dr. Vlahov followed up by briefly mentioning a Robert Wood Johnson Foundation initiative he is involved with that, when it is launched, will focus on creating a

culture of health in America. He believes it will have important implications for the ways society views health professions education and the healthcare system overall because it will seek to develop shared values around social cohesion, health, wellness, and prevention in communities. And he views technology as an important tool to help move health professions education and clinical practice in this same direction, which closely aligns with the future of health professions education described in the commissioned paper.

When the floor was opened to comments, many conferees noted that the paper's framing of a future for health professions education resonated with them. Many reiterated the need for health professions education and the healthcare system to be aligned around and driven by a shared purpose to optimize health and engage populations in that effort—and to enhance that effort through technology. Others mentioned the need for the systems to be adaptive and flexible and to be focused on developing the necessary mix of skills regardless of people's roles.

One conferee also picked up on the idea of health professions education needing to be lifelong and continuous, remarking that technology could help create more active, engaging, community-based educational experiences for pre-licensure students, developing in them a commitment to lifelong learning. Another conferee noted that medical students currently are being educated to function as a lifelong "crammers" (i.e., studying furiously right before an exam) rather than lifelong learners (i.e., continuously learning).

The same person noted the potential of both electronic health records (EHRs) and learning management systems as tools to improve health professions education. To illustrate his point, he said: "[Medical students are told], 'when you hear hoof beats, think horses (i.e, common diagnoses), not zebras (i.e., exotic diagnoses).' The problem is that during pre-clinical and clinical years, [students] are taken on safari, not to the barn, and they see all these zebras and not horses. But if you actually look at EHRs, it's mostly horses," implying that EHRs are an untapped resource that could be used to educate new learners about common diagnoses.

Another commenter raised the idea of costs as the driver of disruptive innovation, saying that technology could be a way to reduce the costs of health professions education in addition to helping to develop a healthcare workforce with the right skills mix and expertise to optimize population health. One of the last comments made focused on the possibility of creating a framework for a healthcare ecosystem

in which everyone—regardless of role—signs the same social contract to create good health.

The authors then summarized the conversation, with Dr. Lucey asking conferees to consider a final point: “If we really think these issues that we’ve laid on the table as needing to be addressed are imperatives, then we would stop talking about whether or not they’re feasible and just start getting to work—and I think technology may be able to help us do that.”

Following the presentation and initial discussions of the commissioned papers, conferees broke into small groups to discuss the papers more thoroughly, with the goal of identifying major themes around which actionable recommendations could be organized.

Discussion of Themes from Day One

Following the small-group discussions, everyone came back together for brief overviews of their conversations, which Conference Co-chairs Marc Triola and Gail Stuart then summarized, continuing the process of identifying the major themes of the conference.

According to Dr. Triola, personalization, as described in Dr. Brown’s paper, was a primary theme that ran throughout the day as well as through the small-group discussions. “We need to fundamentally define what we mean by personalization,” he said, “because it obviously is something that we all feel has tremendous merit and potential power, but we’re not all using it in the same way.” He went on to discuss the significance of personalization—that there are many unanswered questions about the extent to which health professions students should be allowed to craft their own paths, and balancing that with the needs of the communities into which they will be graduating and practicing their profession. Personalization also creates new challenges around supporting and mentoring students who are following customized pathways.

Another topic that came up several times across the small-group discussions was the concept of disaggregation and re-aggregation, which Dr. Triola described as a tremendous opportunity for students who, in theory, could “put together like Lego™ pieces the best of the best from every school, but this is also viewed as a significant threat to the future of traditional universities with their packaged curricula.” The power to disrupt traditional education lies, Dr. Triola said, with

professional licensing bodies and with employers; they are the ones who decide “what we’re looking for in terms of credentials and competencies.”

Creating incentives for healthcare professionals around teaching in general and developing their teaching skills in particular were also topics of discussion in the small groups, as was the idea of supporting faculty in the use and integration of educational technologies in teaching. Similarly, health professions learners must be equally supported and challenged in the use of emerging technologies, so that they “can continue to navigate the changing health system rather than become victims of it.”

Another important theme that ran through the small-group discussions was that of data and analytics—specifically mining the student data collected from the use of educational technologies to evaluate, refine, or redesign curricula and to assess student learning. It also could be used to empower learners, who could use data collected over time to gain insights into themselves as learners that would help them make educational decisions.

Additional themes included the importance of access, diversity, and democracy in terms of new curricular content and who is creating this content, and also in terms of data and how data are used and who decides. Also running through the discussions was the overriding concept of linking health professions education and healthcare delivery. Dr. Triola stated, “Both are changing rapidly and coupling them makes perfect sense, but it is very difficult to do.” He went on to explain that it will only become more difficult over time, so it is a challenge we must face “head on” now.

Conference Co-chair Gail Stuart agreed with Dr. Triola’s summary, but added the need for a culture shift at every level as a significant theme. She observed, “I heard the groups asking, ‘how do we change the culture of health professions education—from leadership to faculty to students?’” Another conferee picked up on this idea and said that the change must come from all directions, the top, the middle, and the bottom. And another suggested that the needed cultural shift will only happen if a financial argument can be made for why it is necessary and beneficial for the schools or if the students begin demanding more educational value for their tuition dollars. This brought the discussion back to the need for data and measurement, to understand the impact of educational technologies as well as efforts to link health professions education and clinical practice.

At the end of the day, the Macy Foundation's George Thibault wrapped up the discussion. "I have a sense that we have consensus around some big and important themes," he said. "This group has a strong sense of the need for change and we have an agreement that the reason a health professions education enterprise exists is to improve the health of the public, and that we could be doing a better job of this. And that technology can help us do that better job."

DAY 2: SATURDAY, APRIL 11, 2015

The second day of the conference began with a brief recap of day one and an overview of the agenda and goals for the day ahead. The conferees then met in small groups, as assigned by the conference planning committee, to discuss the key themes from the previous day and begin the process of developing recommendations for action. The small groups were organized around the different types of stakeholders—both individuals and organizations—to whom the conference recommendations would likely be targeted.

The five breakout groups were titled:

1. Implications for programs in health professions education: curriculum design, time allocation, etc.
2. Implications for faculty development
3. Implications for accreditation and regulation
4. Implications for the healthcare system
5. Implications for technology developers

Reports from Small-Group Discussions

That afternoon, the conferees reassembled to hear reports and draft recommendations from the five small-group discussions, which are summarized briefly below.

Group 1: Implications for programs in health professions education: curriculum design, time allocation, etc.

A summary of Group 1's discussion was presented by UCSF's Catherine Lucey, who said, "We were conscious as we went through this exercise of trying to always move

toward revolution . . . to lay out the platform for subsequent revolution . . . because we want revolutionary change in a way that's meaningful and impactful for both our learners and our society."

The group's first recommendation was that leaders of health professions education programs should be held accountable for employing current population data to continuously adapt their educational programs, which must be interprofessional, to address the pressing health and healthcare needs of society. It should be considered "unacceptable," she said, for health professions education to do anything other than construct interprofessional educational programs to address society's needs.

Her group's second recommendation was that leaders of health professions education programs should convene and agree upon what the group termed a "curricular taxonomy cascade knowledge map." Such a map would use a certain framework (known as a cascade of progressive specificity) to plot out a standardized agreement around the purpose, goals, and activities of health professions education. It would begin by identifying the needs of society that drive health professions education, translating that into professional activities that would help ensure that health professionals meet those societal needs, down to the competencies that educational programs would need to ensure in their learners, down to individual milestones and learning activities that are compatible with success.

This group also said that health professions education leaders should agree to share and make publicly available modularized, digital learning objects to support critical competency development in all health professionals. Its hope was that a national organization, such as the National Library of Medicine, would agree to curate a shared resource like this, which the group believed has the potential to transform health professions education. The resource would allow the sharing and scaling of new and emerging content related to quality and safety, to informatics, and to use of technology in patient care, precision medicine, genomic medicine, etc. This resource would also make it easier to create new health professions schools, particularly in under-resourced regions. It also would allow for exposure and access to health professions education curricula earlier, in undergraduate programs and even in high schools, to help expand the pipeline of students and increase general health literacy in communities.

A fourth recommendation was that leaders of health professions education should convene to develop technology-enhanced strategies for formative and summative learner assessment, with learners being defined broadly as all health professions learners from those in pre-licensure programs through those in continuing medical education and faculty development programs. Such a system would enable the tracking of clinical outcomes across entire careers and support the concept of lifelong learning and the creation of longitudinal learning portfolios. Further, it would represent a shift from episodic maintenance of certification to continuous competency demonstration.

The group also made a recommendation regarding the need to identify mechanisms for interoperability between electronic health record systems, learning management systems, and learners' individual learning portfolios as a way to drive continuous quality improvement of educational programs. The group acknowledged the need, if all these things are to be accomplished, for transformative partnerships between academia, industry, government, payers, and healthcare systems.

Group 2: Implications for faculty development

Group 2's draft recommendations regarding faculty development were presented by Jeff Cooper, PhD, founder and executive director of the Center for Medical Simulation. He said group members began their discussion by agreeing to some introductory statements about faculty development. Specifically, they agreed about the need to make faculty development a major priority for health professions education reform for the purpose of supporting rapid changes in healthcare delivery that seek improved quality and patient outcomes. The group also agreed that this priority includes supporting the integration of educational technologies in health professions education.

Further, the group defined faculty broadly as "any person involved in the education and training of healthcare professionals" (with some unresolved debate among group members about whether or not this includes patients as teachers). The group also differentiated between faculty development and faculty training, which are often used interchangeably. Faculty development is concerned with an individual's career advancement, while training is devoted to gaining proficiency in specific tasks and learning objectives.

After this preliminary discussion, the group developed five draft recommendations regarding faculty development. The first recommendation was that health professions education institutions should explicitly state requirements for faculty and learner competence in educational technologies. The group believed that development of specific expectations around the use of educational technologies would speed movement in this direction. A second recommendation suggested the development of best practices and metrics for the use of educational technologies, as well as a requirement that faculty be educated about these best practices. This would provide an opportunity for faculty to see how technology, used effectively, is not an add-on requirement but is a tool that can support their teaching and free them up to pursue other roles and endeavors.

A third recommendation was that all healthcare institutions should commit to faculty development in teaching, learning, and technology. This includes removing barriers to and creating incentives for participation. Incentives, for example, could tie faculty development to guidelines for promotion. The group's fourth recommendation was that institutions should create an infrastructure for the effective use of data to optimize faculty teaching practice, students' learning and clinical practice, and the overall success of the organization. This would require developing clarity around which data to use and how to use them, as well as dashboards and other tools to help use data. "In other words," Cooper said, "we have to be able to manage our data in order for faculty to be able use those data effectively."

The group's final recommendation was that faculty should be encouraged, through rewards and incentives, to leverage technology and innovate in health professions education.

Group 3: Implications for accreditation and regulation

According to presenter Jan Bellack, PhD, RN, FAAN, president and professor at the MGH Institute of Health Professions, the first topic of discussion within Group 3 was the difference between accreditation and regulation, to ensure that everyone at the table was starting with a similar understanding of the two. Accreditation is a voluntary peer review process that is generally managed by professional organizations or other independent certifying bodies, while regulation is a matter of policy and law and is overseen and controlled by federal or state governments.

The group also identified several reasons why professional organizations and governments would be interested in the recommendations that come from this

conference. First, the ultimate purpose of this effort is to create a healthcare system that better serves patients, and technology can help facilitate that goal. Second, technology can go a long way toward mitigating challenging issues with the accreditation and regulation processes—enabling the processes, such as maintenance of certification or licensure, to be updated more easily and to remain relevant to the realities of practicing professionals as the health system evolves. A third reason would be that as higher education—and health professions education in particular—become more personalized, there will need to be some redefining of standards and measurements, and technology can assist with that process. Finally, technology will facilitate the process of linking health professions education to patient safety and quality outcomes.

Bellack then presented the group's recommendations. The first suggested that accrediting and regulating agencies should promote, rather than stifle, creativity and innovation in health professions education and clinical practice. Specifically, the group said that these bodies should allow for disaggregation, re-aggregation, and personalization in meaningful ways in health professions education. Another recommendation for accreditors and regulators was to develop systems to promote educational technologies, and to use those systems to identify gaps in, and leverage opportunities to improve, education. The fourth recommendation was to ensure appropriate human and technical infrastructure to support the integration of educational technologies in ways that align with institutional missions, goals, and needs.

Also recommended, similar to a recommendation made by Group 1, was the idea of creating a national education data warehouse that enables real sharing of information. This group also put forth a recommendation that education technologies should be used to simplify and support accrediting and regulatory requirements in order to facilitate benefits such as reciprocity across states and accrediting organizations. The final recommendation made by this group was that accreditors and regulators need to accept technology-enabled learning as legitimate and appropriate educational activities.

Group 4: Implications for the healthcare system

John Glaser, PhD, senior vice president of Cerner Corporation, provided an overview of Group 4's discussion about implications for the healthcare system. He began by offering some context for the group members' discussion, reminding conferees that the healthcare system represents practitioners who are experiencing

a time of extraordinary change on multiple levels. For health system CEOs, this change means there is a tremendous need for practitioners to learn across disciplines and schools and systems, and while it is important for new students to be engaged in education within the health systems within which they will one day be practicing, it is equally if not more important for those who are learning in place as they also deliver care and contend with change.

Given this context, the group's first recommendation is to convene stakeholders—from health system leadership, health professions education, professional societies, patients, technology professionals, and more—to collectively develop strategies for educating our health professionals to deliver care in this rapidly changing environment. This means education that goes beyond the core knowledge and skills in each discipline, but also includes population health, quality improvement and patient safety, understanding risk, working in teams, and more. Technology is a necessary component to help ensure that the teaching of all these things can be done in a way that is efficient and effective for those practitioners who are also busy caring for patients every day. Also important is the use of technology to ensure that new practitioners, those just coming into the healthcare delivery system from the education system, are ready to go on day one, that their orientation and training can be provided before they actually walk in on their first day.

Another recommendation was to use technology to create an interprofessional inventory system that maps educational opportunities to educational needs. For example, a system that crosses disciplines and institutions to match learners who have skill development needs with open training slots or other opportunities appropriate to those needs. The next recommendation focused on the need for better ways to deliver content to busy learners, such as using technology to deliver highly targeted materials to staff and trainees in brief increments of time. One opportunity for doing this might be through electronic health records systems, which, as mentioned repeatedly throughout the conference, hold tremendous potential to be modified for educational purposes. Another recommendation was to use the data already being generated by health systems for training purposes, using practice variation data, for example, to educate learners around best practices. The group's final recommendation was to create electronic systems that allow practitioners and patients to interact around shared care plans, which would facilitate their ability to work together and for everyone involved to both learn and teach.

Group 5: Implications for technology developers

The members of Group 5, whose recommendations were presented by Rishi Desai, MD, MPH, who leads Khan Academy Medicine, used their discussion time to describe, for technology developers, the crucial characteristics of an educational technology intended to enhance health professions education and help link it to the healthcare system. They began with a process recommendation: technology developed or recommended for use in health professions education should engage all stakeholders from the beginning to ensure that a good product is developed and deployed.

The group then recommended the following characteristics for educational technologies:

1. Competency-based – the technology should help learners gain mastery of skills and information.
2. Feedback – the tool should offer meaningful and timely feedback. This could be in the form of immediate assessment of an individual skills unit or a broader analytics map offered via a dashboard that informs learners about their progress.
3. Cognitive neuroscience – the tool should integrate what we know about how learning works.
4. Assessment tools – the technology should recognize that assessment is an integral part of learning.
5. Clinical data integration – the technology should integrate learners' data from across the educational continuum (pre-licensure to continuing education and lifelong learning) and should also be able to be incorporated into EHRs.
6. Atomic content – the technology should be designed so that content is not static, but rather allows users to mix and re-mix the content according to their needs.
7. Interoperability – the technology should plan for and allow the sharing of data across a variety of platforms.

Several additional characteristics also were discussed, including flexibility, accessibility, user interface, and more, with the point being that a good technology product—one that will be well used and thoroughly integrated to the point that it enhances health professions education—should be carefully and thoughtfully designed, developed, and deployed.

Plenary Discussion on Conference Themes and Initial Breakout Group Recommendations

After each small group summarized their discussion and presented ideas for recommendations, the floor was opened for plenary discussion. At this point, Macy's George Thibault reminded the conferees that the remainder of the conference would be focused on further developing and reaching consensus—though not necessarily unanimity—around a set of recommendations. He reminded conferees about the need to keep the focus on technology as a tool to enhance health professions education.

Thibault also mentioned the need to hone in on the big themes around which the recommendations could be based, including personalization and hybridization, both of which had come up repeatedly during discussions on day one, but were not evident in the initial recommendations that emerged from the most recent small-group discussions. Several conferees agreed with this and made suggestions for ways that these two topics could be made more explicit in the recommendations. Others mentioned additional themes that had dominated the previous day's discussions, but were not evident in the initial recommendations, such as the concept of scalability, or technology making education affordable and accessible for more learners.

Other conferees spoke to the need for context setting around the final recommendations, including a vision statement about the future of health professions education or a value proposition that convinces stakeholders why the recommendations should be heeded. It was suggested that several of the big themes, including personalization, should be identified as trends or changes that are necessitating the recommendations.

One conferee also reiterated a point that had been raised multiple times: the need to define personalization in the recommendations document. She worried it might be a loaded word that could be easily misunderstood. She went on to suggest that, in this discussion, it means education that is "tailored, timely, actionable, effective, and engaging." Dr. Thibault replied, "Perhaps 'individualized' is a better word, but the concept is that not everybody is going to go through the educational program at the same pace or have the same experiences. It's going to be tailored to their learning styles and needs." Another conferee mentioned the US Department of Education's definition of personalization, which encompasses individualization as

well as the concept of differentiation, both of which are more limited in the scope of variability allowed. In personalization, essentially everything can be altered, allowing for complete flexibility in different learning objectives, content, and pace. Another conferee suggested that the discussion had lost its focus on what was important: regardless of how learners get there, the goal is achieving competence, and the challenge is assessing that competence and how technology can help.

Changing topics, the conferees discussed a suggestion for a recommendation to reduce technology costs by choosing less expensive but equally effective technologies over more expensive and often newer technologies. This was followed up by a comment about the need to explore ways that technology can be used to improve both the effectiveness and efficiency—or costs—of teaching in clinical settings.

The conversation then swung back to the need to lay out a compelling vision for the future of health professions education, committing to fulfilling the social contract to meet society's healthcare needs and identifying technology as an important vehicle for achieving the vision. Another conferee raised the Institute of Medicine's concept of a learning healthcare system¹, which, among other attributes, uses data to continuously improve patient care. Another conferee suggested a "continuously learning" health system, which incorporates both education and health care, while another raised the idea of "educational homes" for learners, similar to the notion of medical homes for patients being created under the Affordable Care Act.

Interjected into the discussions about the vision for a continuously learning health system, adaptive health system, or educational homes—all of which would embrace personalization of learning—was the notion that technology could also allow us to democratize health professions education, making it possible for health professions learners in under-resourced areas to acquire clinical competencies through a standardized educational program. This concept would have little room for personalization because its goal would be to push the same educational program out broadly to large numbers of geographically dispersed students.

1 Institute of Medicine. (2012). Best Care at Lower Cost: The Path to Continuously Learning Health Care in America. Consensus report of the Committee on the Learning Healthcare System in America. Available online: <http://iom.nationalacademies.org/Reports/2012/Best-Care-at-Lower-Cost-The-Path-to-Continuously-Learning-Health-Care-in-America.aspx#sthash.Y9z9oelm.dpuf>

The conversation continued along these lines for a while longer until Dr. Thibault wrapped it up, saying, “At this point, the conference planning committee becomes a writing committee, and we are going to take all of this incredibly valuable information—the reports from the breakout groups, this discussion, our notes from yesterday—and synthesize it into a rough first draft of a conclusions and recommendations document that will be the focus of tomorrow’s discussion.”

DAY 3: SUNDAY, APRIL 12, 2015

The final day of the conference was devoted to reviewing and providing feedback on the draft recommendations document, which had been drafted and distributed to conferees by writing committee members on Saturday night.

Conference Conclusions and Recommendations

At the start of the morning discussion, conferees were generous with their praise of the draft document, congratulating the writing committee on producing a comprehensive document in such a short amount of time. Many suggestions followed for improvement, including in the context, tone, and organization of the document. For example, a primary message that echoed throughout the morning was the need to be explicit about technology—what do we mean by technology? The document should define technology without jargon and provide examples, demystifying it for readers, most of whom will be health professions educators and administrators and not technology developers.

There also was a general consensus that the document needed a more positive tone overall and to do a better job of framing the issues and conveying a sense of urgency around the need to address them. Considerable discussion occurred around defining who are teachers and who are learners. A general consensus was reached that everyone who has a role in health and health care is both a teacher and a learner, including those more traditionally identified as faculty members, students, and patients. Building on this was a discussion around the need to clarify the necessary linking of health professions education and healthcare delivery, putting a “stake in the ground” and declaring that what we need is a continuously learning health system that recognizes the lifelong educational continuum and the dual-roles of participants.

The conversation continued throughout the morning, with conferees making numerous substantive comments to strengthen the recommendations. They also suggested reordering the recommendations, clarifying specific points and making certain messages more explicit, consolidating topic areas and eliminating redundancies, creating more consistency across the document in terms of scope and structure, and other specific ways to improve the draft.

Following discussion of the draft recommendations document, the conference ended with closing remarks from Macy's George Thibault, who acknowledged that the topic of this conference was particularly challenging because of its broad scope, and that there is still work to be done to incorporate all of the excellent discussions into a set of recommendations. "We have been talking about a fundamental change in the way we think about and will approach health professions education in the future," he said. "This is both exciting and unsettling. This meeting was intellectually challenging and very fulfilling because of you, because of this great group of people and the commitment that you gave to us to do this work. Thank you, and I predict we will all remember this time we spent together."

The writing committee was charged with revising the recommendations based on the feedback provided by conferees. Two additional iterations of the draft were distributed to all conferees in the weeks following the conference and revisions were made based on feedback to those versions. The final, consensus document appears in this monograph.

After participating in this conference, Tom Aretz, MD, vice president for global programs at Partners HealthCare International, was motivated to draft a brief paper on the intersection between health professions education, the healthcare delivery system, and technology. An excerpt from the paper is included in the appendix of this monograph.





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BIOGRAPHIES OF PARTICIPANTS

H. Thomas Aretz, MD, is Vice President for Global Programs at Partners HealthCare International (PHI), the international arm of the Partners HealthCare System (PHS) in Boston, Massachusetts, founded by the Massachusetts General Hospital (MGH) and the Brigham and Women's Hospital. He has been involved in international programs since 1996, working in over 30 countries and focusing largely on the design and implementation of academic programs and institutions, such as universities of health sciences, medical schools, and academic medical centers and systems. He is a native of Germany and received his medical degree from Harvard Medical School, where he is Associate Professor of Pathology. He holds a clinical appointment at the MGH, where he completed his residency and fellowship training in anatomic, clinical and cardiovascular pathology. He was the course director of a major integrated medical school course at Harvard from 1992 to 2005 and is Program and Course Director for the Harvard Macy Institute. He has served on many academic and hospital (IRB Chairman) committees and industrial boards, and has lectured and published extensively. He is the recipient of multiple teaching awards at Harvard Medical School and the MGH and has been recognized with international prizes for his efforts to improve medical education around the world.

John Baker founded Desire2Learn (D2L) in 1999 at the age of 22 while attending the University of Waterloo. He saw that online digital tools could open the door to entirely new and more effective models of education and create learning experiences that are personal, engaging, and inspiring. Mr. Baker's vision for D2L is to transform the way the world learns, improving outcomes for learners everywhere.

He was recognized in 2013 as an EY Entrepreneur of the Year within Ontario, received the Young Alumni Achievement Medal from the University of Waterloo in 2010, and was inducted into the Waterloo Region Hall of Fame as an Intrepid Entrepreneur in 2009.

A strong believer in community involvement, Mr. Baker devotes both his personal and business efforts to supporting young entrepreneurs who are developing and applying technology to improve society worldwide. Mr. Baker was appointed to the Governing Council of the Social Sciences and Humanities Research Council of Canada, is Chair of the Board of Communitech, and is a board member of Canada's National Ballet School, among other organizations.

Mr. Baker graduated from the University of Waterloo with an Honours BAsC in Systems Design Engineering, with First Class Honours and an option in Management Sciences.

Marni Baker Stein, PhD, Chief Innovation Officer at the University of Texas System's Institute for Transformational Learning (ITL), is an authority on next generation program and curricular development, delivery, and assessment; student lifecycle management, and student-centered, outcomes-focused instructional design.

Before joining the ITL, she was Senior Associate Dean of Columbia University's School of Continuing Education, where she oversaw the school's academic portfolio, and was responsible for the development, design, and evaluation of all online and hybrid programs. Prior to that, Dr. Stein has led the development of graduate, undergraduate, and non-degree programming delivered through a wide variety of innovative packages, including dual language, executive, online, and hybrid formats for educational institutions in the United States (US) and abroad, including University of Pennsylvania; University of California, Santa Barbara; Pennsylvania State University; State University of New York (SUNY) Buffalo (Latvia); and the United States Information Agency (Turkey, Japan).

Frequently invited to speak on technology-enhanced curricular and pedagogical innovation, Dr. Stein is an accomplished educational researcher. Her scholarship focuses on social and knowledge networking behaviors in online courses and the impact of design, instructional strategies, and platform technology upon student engagement in e-learning. Dr. Stein has a PhD in Teaching, Learning, and Curriculum from the University of Pennsylvania.

Janis (Jan) P. Bellack, PhD, RN, FAAN, is President and John Hilton Knowles Professor at the MGH Institute of Health Professions in Boston. Previously, she served for seven years as Vice President for Academic Affairs/Provost and Professor of Nursing and Health Sciences at Massachusetts College of Pharmacy and Health

Sciences, Boston, and prior to that served as Associate Provost for Education and Professor of Nursing, Health Professions, and Graduate Studies at the Medical University of South Carolina in Charleston.

Dr. Bellack is a senior fellow at the University of California, San Francisco (UCSF) Center for the Health Professions, and served as consultant and member of the National Program Faculty for the UCSF-based RWJ Executive Nurse Fellows Program from 1998–2010. She currently serves on the RWJ National Advisory Committee for the Evaluating Innovations in Nursing Education program. She also serves as a member of the governing boards of Partners Healthcare International, the Center for Medical Simulation (Boston), and the Association of Independent Colleges and Universities of Massachusetts (AICUM).

Dr. Bellack is recognized for her work in curriculum development; program evaluation; accreditation in nursing and the health professions; health professions leadership and workforce development; and interprofessional education. She has received more than \$9 million in external funding to support health professions education and research, and has directed or co-directed a variety of federal and foundation grants. Dr. Bellack has co-authored two editions of a nursing textbook, and published numerous articles and book chapters in the professional literature. She has consulted internationally in the Philippines, China, South Africa, and Ireland. In 2012, Dr. Bellack was appointed editor-in-chief of the *Journal of Nursing Education*, the top-ranked peer-reviewed nursing education journal, having served previously as the Journal's associate editor for 14 years.

Dr. Bellack holds earned degrees from the University of Virginia, University of Florida, and University of Kentucky. She is a fellow of the American Academy of Nursing, and has been honored as Outstanding Alumnus of the University of Florida College of Nursing, inducted into the Alumni Hall of Fame at the University of Kentucky, and named Distinguished Alumna of the Year by the University of Virginia School of Nursing.

Norman B. Berman, MD, is Professor of Pediatrics at Geisel School of Medicine at Dartmouth; Co-founder, Executive Director and Co-editor-in-Chief of MedU. Dr. Berman graduated from the University of Florida and University of South Florida College of Medicine. He served as a pediatric intern and resident at the University of New Mexico, and then was Chief Resident in Pediatrics, and a Pediatric Research Fellow and the University of New Mexico. He completed a Pediatric Cardiology

Fellowship at the Cincinnati Children's Hospital Medical Center in 1993. Dr. Berman is a Pediatric Cardiologist and served as Section Chief of Pediatric Cardiology at Dartmouth-Hitchcock Medical Center from 2008–2014, and was the Pediatric Clerkship Director at Dartmouth Medical School from 1996–2006.

Dr. Berman's academic work is in technology-enhanced learning in medical education—more specifically, the use of virtual patients. A federal grant in 2000, with a Dartmouth colleague, led to the development of the Computer-assisted Learning In Pediatrics Program (CLIPP). He then co-founded and directs MedU, which continues to maintain the CLIPP cases, and has developed virtual patient courses for internal medicine, family medicine, and radiology. Additional courses cover topics in high-value care and substance use disorders, and a new course will address trauma-informed care. Current research is focused on assessment of clinical reasoning and learning analytics based on large virtual patient data sets.

David Blumenthal, MD, MPP, is president of The Commonwealth Fund, a national philanthropy engaged in independent research on health and social policy issues.

Dr. Blumenthal is formerly the Samuel O. Thier Professor of Medicine at Harvard Medical School and Chief Health Information and Innovation Officer at Partners Healthcare System in Boston. From 2009 to 2011, he served as the National Coordinator for Health Information Technology, with the charge to build an interoperable, private, and secure nationwide health information system and to support the widespread, meaningful use of health IT. He succeeded in putting in place one of the largest publicly funded infrastructure investments the nation has ever made in such a short time period, in health care or any other field.

Previously, Dr. Blumenthal was a practicing primary care physician, Director of the Institute for Health Policy, and Professor of Medicine and Health Policy at Massachusetts General Hospital/Partners Healthcare System and Harvard Medical School. He is the author of more than 250 books and scholarly publications, including most recently, *Heart of Power: Health and Politics in the Oval Office*. He is a member of the Institute of Medicine and serves on the editorial boards of the *New England Journal of Medicine* and the *Journal of Delivery Science and Innovation*. He has also served on the staff of the US Senate Subcommittee on Health and Scientific Research; is the founding chairman of AcademyHealth, the national organization of health services researchers; and a trustee of the University of Pennsylvania Health System.

Dr. Blumenthal received his undergraduate, medical, and public policy degrees from Harvard University and completed his residency in internal medicine at Massachusetts General Hospital. With his colleagues from Harvard Medical School, he authored the seminal studies on the adoption and use of health information technology in the United States. He has held several leadership positions in medicine, government, and academia, including Senior Vice President at Boston's Brigham and Women's Hospital and Executive Director of the Center for Health Policy and Management and Lecturer on public policy at the Kennedy School of Government. He served previously on the board of the University of Chicago Health System and is recipient of the Distinguished Investigator Award from AcademyHealth, an Honorary Doctor of Humane Letters from Rush University, and Honorary Doctors of Science from Claremont Graduate University and SUNY Downstate.

Benjamin K. Chu, MD, MPH, MACP, was named group president for Kaiser Permanente's Southern California and Georgia Regions in October 2014. He directs health plan and hospital operations for 14 hospitals and 237 medical offices to serve more than 4 million members in both locations.

Dr. Chu joined Kaiser Permanente as its regional president of Southern California in February 2005. In January 2011, he was given the added responsibility of overseeing the Hawaii region as a group president responsible for both the Southern California and Hawaii regions. In July 2013, he was named executive vice president for Kaiser Foundation Hospitals and Kaiser Foundation Health Plan Inc. and appointed to the National Executive Team, which supports the chairman and CEO in setting and ensuring achievement of both the short- and long-term strategies and performance of the Hospitals and Health Plan organizations.

Before coming to Kaiser Permanente, Dr. Chu served for three years as president of New York City's Health and Hospitals Corporation (HHC), the largest public hospital system in the country. A primary care internist by training, Dr. Chu possesses extensive health care experience as a clinician, administrator, and policy advocate. He was senior vice president for Medical and Professional Affairs for HHC in New York from 1990 to 1994. During that period, he also served as acting commissioner of Health for the New York City Department of Health.

Dr. Chu also has experience as an academic health center leader. He was senior associate dean at Columbia University College of Physicians and Surgeons from July

2000–February 2002. He also served at the New York University School of Medicine and Medical Center as associate dean and vice president for Clinical Affairs from April 1994–May 2000. He was a 1989–1990 Robert Wood Johnson Policy Fellow serving as legislative assistant for health for New Jersey Senator Bill Bradley.

At both Kaiser Permanente and New York City, Dr. Chu has been a strong proponent of the use of the electronic health record as a powerful tool for improving quality and outcomes for patient care.

Dr. Chu currently serves as chair of the board of directors for The Commonwealth Fund in New York and is a member of the Advisory Committee to the director, Centers for Disease Control and Prevention. He is a past chair of the American Hospital Association Board of Trustees.

Dr. Chu earned his medical degree at New York University, his master's degree in public health from Columbia University, and a bachelor's degree in psychology from Yale University.

David A. Cook, MD, MHPE, received a BS in chemistry from Utah State University and an MD from the Johns Hopkins University School of Medicine before coming to the Mayo Clinic, where he completed residency in Internal Medicine, a fellowship in General Internal Medicine, and joined the staff in 2004. He subsequently completed a master's degree in health professions education through the University of Illinois at Chicago – Department of Medical Education. He is currently Professor of Medicine and Medical Education in the Mayo Clinic College of Medicine, Consultant in the Division of General Internal Medicine, Associate Director for Mayo Clinic Online Learning, and the Research Chair for the Mayo Multidisciplinary Simulation Center. He is an associate editor/editorial board member for the journal *Advances in Health Sciences Education*. Prior to this he served five years as a deputy editor for the *Journal of General Internal Medicine*. Dr. Cook's research interests include the theory and design of online learning and other educational technologies, the quality of medical education research methods and reporting, clinical reasoning, and assessment of clinical performance. He has developed and studied multiple online courses for residents and medical students, conducted several systematic reviews, presented at numerous national and international conferences, and published over 145 journal articles and book chapters on medical education topics. He also serves as a local leader in the Church of Jesus Christ

of Latter-Day Saints. He and his wife Jennifer are the parents of five incredibly wonderful children.

Jeffrey B. Cooper, PhD, is the founder and Executive Director of the Center for Medical Simulation, which is dedicated to the use of simulation in health care as a means to improve the process of education and training and to avoid risk to patients. He is also Professor of Anaesthesia at Harvard Medical School and Massachusetts General Hospital.

Dr. Cooper is one of the pioneers in what is now called patient safety. He did landmark research in medical errors in the 1970's, is a co-founder of the Anesthesia Patient Safety Foundation (APSF) and on the Board of Governors of the National Patient Safety Foundation.

Dr. Cooper has been awarded several honors for his work in patient safety, including the 2003 John M. Eisenberg Award for Lifetime Achievement in Patient Safety from the National Quality Forum and the Joint Commission on Accreditation of Healthcare Organizations and the 2004 Lifetime Achievement Award from the American Academy of Clinical Engineering. The Department of Anesthesia and Critical Care of the MGH established the Jeffrey B. Cooper Patient Safety award in his honor. He received the Distinguished Service Award of the American Society of Anesthesiologists in 2013, the first non-MD to receive the honor. In 2014, he was awarded the JS Gravenstein Award for lifetime achievement by the Society for Technology in Anesthesia.

Rishi Desai, MD, MPH, is a pediatric infectious disease physician with a public health background who currently leads Khan Academy Medicine. Khan Academy is an online, nonprofit, educational platform that reaches ~12 million unique users per month and offers a free world-class education to anyone, anywhere.

Dr. Desai had an accelerated education, completing high school and receiving his BS in microbiology from UCLA by the age of 18. He completed his medical training at UCSF and went on to work at medical centers including those affiliated with Harvard University, Boston University, University of Southern California, and Stanford University. He returned to UCLA to earn his MPH in epidemiology, and then spent two years at the Centers for Disease Control and Prevention as an Epidemic Intelligence Service Officer investigating disease outbreaks, before beginning his work with Khan Academy Medicine.

K. Anders Ericsson, PhD, is presently Conradi Eminent Scholar and Professor of Psychology at Florida State University. After his PhD in Sweden, he collaborated with the Nobel Prize winner in Economics Herbert A. Simon on verbal reports of thinking, leading to their classic book *Protocol Analysis: Verbal Reports as Data* (1984). Currently he studies the measurement of expert performance in domains such as music, chess, nursing, law enforcement, and sports, and how expert performers attain their superior performance by acquiring complex cognitive mechanisms and physiological adaptations through extended deliberate practice. He has edited several books on expertise: the influential *Cambridge Handbook of Expertise and Expert Performance* consisted of over 40 chapters and 900 pages and the recent *Development of Professional Expertise* appeared in 2009.

Dr. Ericsson has published articles in prestigious journals, such as *Science*, *Psychological Review*, *Psychological Bulletin*, *Current Biology*, and *Trends of Cognitive Science*. He is a fellow of the Center for Advanced Study in the Behavioral Sciences, of the American Psychological Association and the Association for Psychological Science, and a member of Royal Swedish Academy of Engineering Sciences. His research has been featured in cover stories in *Scientific American*, *Time*, *Fortune*, *Wall Street Journal*, and the *New York Times*. He has been invited to give keynote presentations at conferences of surgeons, musicians, teachers, clinical psychologists, athletes, and coaches, as well as professional sports organizations, such as the Philadelphia Eagles (American football) and Manchester City (soccer).

Erica Frank, MD, MPH, is Professor and Canada Research Chair in Preventive Medicine and Population Health in the Faculty of Medicine at the University of British Columbia in Vancouver, Canada. Dr. Frank is also the founder (in 2001) and President of www.NextGenU.org, the world's first free university (now in use in 128 countries), founder of the Healthy Doc = Healthy Patient initiative (establishing and building on the strong and consistent relationship between physicians' personal and clinical practices), and past President (2008) of Physicians for Social Responsibility. She is residency- (Yale) and fellowship- (Stanford/NIH) trained and Board-certified in preventive medicine.

Shiv Gaglani is the co-founder and Chief Executive Officer of Osmosis, which makes a popular web- and mobile-learning platform (www.osmosis.org) used by more than 20,000 medical students and a growing number of medical schools. In this capacity he leads a team of more than a dozen people to develop and distribute tools that make learning both efficient and enjoyable. Mr. Gaglani has

also spearheaded relationships with organizations such as the American College of Physicians, Elsevier Publishing, Medscape/WebMD, the University of Pennsylvania Graduate School of Education, and the Robert Wood Johnson Foundation.

Mr. Gaglani's primary passion is developing innovative and scalable solutions in the fields of health care and education. To this end he curated the Smartphone Physical, which debuted at TEDMED (www.quantifiedcare.com), and the Patient Promise (www.thepatientpromise.org), a growing movement aimed at improving the clinician-patient relationship through partnership in pursuing healthy lifestyle behaviors. Mr. Gaglani is also an avid writer whose articles and papers have been featured in *Fast Company*, *Quartz*, *Entrepreneur*, *Huffington Post*, *The Health Care Blog*, *Baltimore Sun*, *Medgadget*, *CardioSource World News*, *Emergency Physicians Monthly*, *Academic Medicine*, *Innovations in Global Medical & Health Education*, and the *Annals of Internal Medicine*. He has written two educational books, *Success with Science* (www.successwithscience.org) and *Standing out on the SAT & ACT* (k12.osmosis.org).

After graduating magna cum laude from Harvard College in 2010 with degrees in engineering and health policy, he began his MD/MBA degree at the Johns Hopkins School of Medicine and Harvard Business School (expected graduation: 2018).

In his free time he enjoys running, cycling, chess, scuba diving, playing with his dogs, and flying.

Deborah C. German, MD, a physician, educator, and administrator, is Vice President for Medical Affairs at the University of Central Florida (UCF) and the Founding Dean of UCF's College of Medicine. After receiving her MD from Harvard Medical School, she was Resident in Medicine at Rochester, Fellow and faculty member at Duke, Associate Dean for Students and Senior Associate Dean of Medical Education at Vanderbilt, President and CEO of Saint Thomas Hospital, and Association of American Medical Colleges (AAMC) Petersdorf Scholar-in-Residence. As Vice President and Founding Dean at UCF, she is working with a team of over 2,200 full-time, part-time and volunteer faculty, and staff members to develop a premier 21st century research-based medical school and a patient-centered clinical enterprise. Recognizing the central role of the College of Medicine in Lake Nona, she takes an active leadership role in facilitating partnerships and expanding the reach of Medical City. Her leadership in College of Medicine, Lake Nona, and the community has been recognized through both local and national awards.

Jean Giddens, PhD, RN, FAAN, is Dean and Professor at the School of Nursing, Virginia Commonwealth University in Richmond, VA, and is an alumna of the Robert Wood Johnson Executive Nurse Fellows program, 2011 Cohort. In her role as Dean, Dr. Giddens is responsible for the delivery of quality academic programs for students, fostering nursing research, community engagement, alumni and development, and the management of fiscal, physical, and human resource management, including the development of faculty and staff. Prior to the Dean position at Virginia Commonwealth University, Dr. Giddens served for several years in senior administrative leadership at the University of New Mexico College of Nursing. Dr. Giddens has a wide range of teaching experiences that include associate degree, baccalaureate degree, and graduate degree programs in New Mexico, Texas, Colorado, and Virginia. She is an expert in concept-based curriculum development and evaluation as well as innovative strategies for teaching and learning. Dr. Giddens has been actively engaged with the Future of Nursing Campaign for Action through her involvement with academic progression in nursing, and with state action coalitions in New Mexico and in Virginia. Dr. Giddens is the author of multiple journal articles, nursing textbooks, and electronic media and serves as an education consultant to nursing programs throughout the country. Dr. Giddens earned a Bachelor of Science in Nursing from the University of Kansas, a Master of Science in Nursing from the University of Texas at El Paso, and a PhD in Education and Human Resource Studies from Colorado State University.

John P. Glaser, PhD, currently serves as Senior Vice President and member of the executive cabinet for Cerner Corporation. Formerly, he was Chief Executive Officer of the Health Services Business Unit of Siemens Healthcare, where he is responsible for heading Siemens' global healthcare IT business. Cerner acquired Siemens Health Services in February 2015.

Prior to joining Siemens, Dr. Glaser was Vice President and Chief Information Officer, Partners HealthCare, Inc. Previously, he served as Vice President, Information Systems, at Brigham and Women's Hospital.

Among his many industry affiliations, Dr. Glaser was the founding chairman of the College of Healthcare Information Management Executives (CHIME), past president of the Healthcare Information & Management Systems Society (HIMSS), and has served on the boards of the eHealth Initiative, the National Alliance for Health Information Technology, and the American Medical Informatics Association (AMIA). Additionally, Dr. Glaser is a fellow of HIMSS, CHIME, and the American College of

Medical Informatics. He is also a former Senior Advisor to the Office of the National Coordinator for Health Information Technology (ONC).

Dr. Glaser has published more than 150 articles and three books on the strategic application of information technology in health care, including the most widely used textbook on the topic. He is on the faculty of the Wharton School at the University of Pennsylvania, the Medical University of South Carolina, and the Harvard School of Public Health.

Dr. Glaser holds a PhD in Healthcare Information Systems from the University of Minnesota.

Vivek Goel, MD, CM, MSc, SM, FRCPC, was appointed Vice President, Research and Innovation, of the University of Toronto in December 2014. Dr. Goel is a distinguished scholar with an extensive background in teaching, research, and university administration. He obtained his medical degree from McGill University and completed post-graduate medical training in Community Medicine at the University of Toronto. Dr. Goel obtained an MSc in Community Health from University of Toronto and an MSc in Biostatistics from Harvard University's School of Public Health. His research has focused on health services evaluation. He was a founding scientist at the Institute for Clinical Evaluative Sciences (ICES), where he continues as an Adjunct Senior Scientist.

Dr. Goel joined the University of Toronto in 1991 as Assistant Professor in the Department of Preventive Medicine and Biostatistics. He was chair of the Department of Health Administration in the Faculty of Medicine from 1999 until 2001, then served as Vice-Provost, Faculty and subsequently was the University's Vice President and Provost from 2004 until 2008. He was founding President and CEO of Public Health Ontario from 2008 until 2014, where he was highly successful in building an academic public health services agency that provided scientific and technical to front-line practitioners. Prior to rejoining University of Toronto, he served as Chief Academic Strategist with Coursera, a global platform that connects universities and learners with online courses.

Louis M. Gomez, PhD, is Professor of Urban Schooling and Information Studies, and holds the MacArthur Chair in Digital Media and Learning in the Graduate School of Education and Information Studies at the University of California, Los Angeles where he is also currently the Department Chair of Education. Dr.

Gomez is also a senior fellow at the Carnegie Foundation for the Advancement of Teaching. Dr. Gomez has focused his research and design efforts towards helping to support community formation in schools, collaboratively designing new approaches to teaching, learning and assessment, and infusing state-of-the-art computing and networking technologies into traditionally underserved schools. Most recently, he has turned his attention to problem-solving research and development carried out in diverse networks and organized around high-leverage problems associated with the day-to-day work of teaching and learning. His work transcends traditional divisions between applied and basic research and has aimed to have practical impact on urban schools. He holds a bachelor's degree in psychology from SUNY Stony Brook and a doctorate in cognitive psychology from UC Berkeley.

Peter Goodwin, MBA, is Chief Operating Officer and Treasurer of Josiah Macy Jr. Foundation. In this role, Mr. Goodwin oversees the Foundation's investments, finances, communications, and operations, and serves as secretary to the Foundation's Board of Directors.

Mr. Goodwin has spent 30 years working as a professional in the nonprofit sector. After serving as a hospital administrator at Beth Israel Medical Center in New York City, he joined the Robert Wood Johnson Foundation (RWJF) as a financial analyst in 1984. With more than two decades of experience at RWJF, he served as financial officer, and in the senior leadership positions of Vice President for Financial Monitoring, Chief Financial Officer and Treasurer, and Vice President for National Program Affairs. He also planned and directed the renovation and expansion of RWJF's headquarters in Princeton.

During his tenure at RWJF, he championed and implemented a number of quality improvement activities in the areas of accounting, information technology, grantee audits, mission-related investing, and grant competitions. As a 15-year member of RWJF's executive team, he provided regular trusted advice to two CEOs and heads of Fortune 500 companies, university presidents, nonprofit leaders and senior government officials.

Mr. Goodwin holds a bachelor's degree from Boston College and an MBA from The City University of New York, Baruch College. He is active in both national and local leadership roles in the nonprofit sector. He served for two terms on the Board of Directors of Grantmakers in Health, during which he also served as Chair of the Finance and Investment Committee. For the last fifteen years he has served as Chair

of the Board of Directors of the Sikora Center, Camden, New Jersey. Sikora Center is an outpatient treatment facility for substance-abusing women. He currently serves as a member of the Board of Directors of Garden State bioEnterprises, which produces commercial-grade algae by-products for the pharmaceutical, nutraceutical, and agricultural industries. Mr. Goodwin is a fellow in Leadership New Jersey, a statewide program to identify and connect leaders in government and the nonprofit and business communities.

Maryellen E. Gusic, MD, Chief Medical Education Officer, leads AAMC efforts to advance medical education and inspire learners to serve the public, promote health, and improve care. In this role, Dr. Gusic and her team focus on initiatives to advance competency-based medical education, interprofessional education across the continuum, and programs that support learners, educators, and educational leaders and administrators.

Prior to joining the AAMC, Dr. Gusic was Executive Associate Dean for Educational Affairs at Indiana University School of Medicine, in addition to serving as Dolores and John Read Professor of Medical Education and Professor of Pediatrics. She also has served in medical education and faculty development leadership roles at Penn State College of Medicine.

On the national level, Dr. Gusic has been a site surveyor for the Liaison Committee on Medical Education and served on committees of the National Board of Medical Examiners and the Accreditation Council for Graduate Medical Education. She also has been active in the AAMC's medical education community, serving as chair of the AAMC Task Force on Educator Evaluation and the Research in Medical Education Program Planning Committee. A leader in her specialty, Dr. Gusic is president-elect of the Academic Pediatric Association and has served as senior education editor for the journal *Academic Pediatrics*.

A board-certified pediatrician, Dr. Gusic is a graduate of the University of Pennsylvania School of Medicine. She completed her residency training at Boston Children's Hospital.

Ryan Haynes, PhD, has been developing educational software for the past 15 years. He graduated summa cum laude from Georgia Tech (2006) with a degree in biomedical engineering and then completed his Masters in Nanotechnology Enterprise and PhD in Neuroscience (NIH Oxford-Cambridge GPP Program) at

the University of Cambridge as a Marshall Scholar, giving him both a solid first-hand experience in STEM education and also an appreciation for the neuroscience behind learning. He has written online textbooks on linear algebra and computer science, as well as led the development of an open-source 3D anatomy viewer (osmosis.org/anatomy). While in medical school at Johns Hopkins, Dr. Haynes co-founded Osmosis (osmosis.org) and has successfully led the technical and product team to develop, test, and launch the company's first product in medical education over the past 18 months. Dr. Haynes's key expertise is in designing and building educational tools and pursuing his passion for understanding the underlying theories of how the brain learns.

K. Ranga Rama Krishnan, MB ChB, has served as Dean of the Duke-NUS Graduate Medical School Singapore (Duke-NUS) since 2008. Prior to his Singapore move, Dr. Krishnan was Professor and Chairman of the Department of Psychiatry and Behavioral Sciences, Duke University Medical Center, Durham, North Carolina for eleven years. His department of psychiatry had more than 490 faculty members, conducted over 270 human-subject studies a year and a similar number of *in vitro* and *in vivo* animal studies, and received approximately \$40 million of research funding annually. A key decision-maker in the Singapore biomedical sciences community, Dr. Krishnan has been Chairman of the National Medical Research Council (NMRC) since 2013. In early 2014 he was appointed Chairman of the NMRC Singapore Translational Research Investigator Award (STaR) Panel. He is also Chairman of the Board of Directors of the Singapore Clinical Research Institute at the Ministry of Health (MOH).

In addition, Dr. Krishnan holds memberships on the board of the Health Sciences Authority, and Singapore Health Services Pte Ltd (SingHealth). He is also a member of several committees: the Applied Study in Polytechnic and ITE Review (ASPIRE) Committee; the Biomedical Sciences Review Panel; and the Biomedical Sciences Executive Committee, National Research Foundation (NRF).

Dr. Krishnan earned his medical degree and completed a rotating internship at Madras Medical College in Madras (now Chennai), India. He completed his residency and held a fellowship in neurobiology at the Duke University Medical Center. He continued his tenure at Duke holding various appointments in psychiatry and neurobiology as he rose through the ranks. During this time, he also created a translational research center for depression in the elderly, the only such center in the United States funded by the National Institutes of Health.

Dr. Krishnan is an elected member of the Institute of Medicine—the world’s foremost national resource for independent, scientifically informed analysis and recommendations on human health issues. As a further recognition of his contributions to biomedical science, Dr. Krishnan received the 2007 Distinguished Scientist Award from the American Association for Geriatric Psychiatry. In 2008, Dr. Krishnan was the recipient of the C. Charles Burlingame Award, which recognized his outstanding leadership and lifetime achievement in psychiatric research and education. More recently, Dr. Krishnan was presented with the Award for Research in Geriatric Psychiatry by The American College of Psychiatrists in 2010.

He has also received multiple awards—the Rafaelsen Award from the Collegium Internationale Neuro-Psychopharmacologicum, the Laughlin Award from the American College of Psychiatry, the Distinguished Investigator Award from the National Alliance for Research on Schizophrenia and Depression, and the Klerman Award from Depression and Bipolar Support Alliance. He has over 400 peer-reviewed publications and numerous books and book chapters. Dr. Krishnan serves or has served on many editorial boards of scientific journals and on multiple research review panels for the National Institutes of Health.

In Singapore, Dr. Krishnan shares his knowledge on teaching and learning in a well-regarded commentary series in the TODAY newspaper, the nation’s second widest read daily. He highlights salient issues that are facing educators, administrators, parents, and students, from his standpoint in pedagogical work, psychology, and the neuroscience of learning. His opinion-editorials have been engaging readers and educators since April 2013.

Gerri Lamb, PhD, RN, FAAN, is Associate Professor at Arizona State University College of Nursing and Health Innovation and the Herberger Institute for Design and the Arts. She directs the Interprofessional Primary Care Project funded by the Josiah Macy Jr. Foundation to implement and evaluate an interprofessional primary care curriculum across four professional healthcare programs and two universities. Dr. Lamb teaches several graduate level interprofessional courses in nursing, healthcare delivery systems, and healthcare design. She co-chairs and serves on numerous interprofessional initiatives focused on teamwork, care coordination, and performance measurement at the National Quality Forum, the National Committee for Quality Assurance (NCQA), the American Board of Internal Medicine, and the American Academy of Nursing. She is chair-elect for the American Interprofessional Health Collaborative (AIHC) and a co-facilitator of the Arizona Interprofessional

Innovations Incubator for the National Center on Interprofessional Practice and Education.

Mary Y. Lee, MD, MS, FACP, is Professor of Medicine at Tufts University School of Medicine, and Special Advisor for Education Innovation at Tufts Medical Center. She is currently concluding six months as the 2014–2015 Kimitaka Kaga Visiting Professor at University of Tokyo's International Research Center for Medical Education. Most recently, Dr. Lee served 12 years as Associate Provost across Tufts University's ten schools and three campuses. Broad responsibilities involved interdisciplinary educational and global health initiatives, including open education with partners in Asia and Africa. As former Dean for Educational Affairs at Tufts' School of Medicine, she initiated e-learning and faculty development in the 1990's, and led major curriculum redesign. Over the past three decades, she has focused on how innovations in leadership training, technology integration, and open access can transform professional education and global health. Under her leadership, major initiatives have included Academic Leadership Development, TUSK (an open-source enterprise system for health sciences education used in 15 countries), Center for Enhancement of Learning and Teaching, Tufts OpenCourseWare, USAID One Health Core Competency Development (for pandemic training in Southeast Asia and Africa), and the implementation of e-learning at Christian Medical College, Vellore, India.

Dr. Lee practiced internal medicine for over 20 years at Tufts Medical Center where she remains on the Board of Governors; she is a fellow (FACP) and laureate of the American College of Physicians. She received her BA and MD from Tufts University, and trained at Tufts Medical Center. Dr. Lee holds degrees in Health Services Research (MS) and Asian Studies (MA) from Stanford University. In recognition of her many contributions she has received numerous school and university awards, and has a biannual Medical Education Day named in her honor. She lives in Belmont, Massachusetts, with her husband, Paul W. Lee, and enjoys traveling, gardening, and painting. Their son, Greg, lives in San Francisco, California, and their daughter, Samantha, lives in New York City.

Catherine R. Lucey, MD, a board-certified internist and geriatrician, is Vice Dean for Education at the University of California, San Francisco School of Medicine. Previously, she was the interim Dean, College of Medicine, Vice Dean for Education at The Ohio State University (OSU) College of Medicine and Associate Vice President for Health Sciences Education for the OSU Office of Health Sciences. She

is past Chair of the Board of Directors of the American Board of Internal Medicine. She currently serves on the Board of Directors of the AAMC, as well as on the AAMC's Holistic Review Advisory Committee.

Dr. Lucey was Clinical Instructor at Harvard University School of Medicine, Assistant Professor of Medicine at the University of Texas, San Antonio, and Associate Professor of Medicine at the George Washington University School of Medicine and the Uniformed Services University of the Health Sciences, before joining Ohio State as Associate Professor of Medicine in 2002. She was promoted to Professor of Internal Medicine in 2005. She has won numerous teaching awards and has given more than 200 invited presentations at national meetings and academic institutions across the country. Her areas of expertise include professionalism, clinical reasoning, educational technology, and leadership. Her recent massive open online course (MOOC) on clinical problem solving attracted thousands of students and faculty around the world. She is a coauthor of the book *Understanding Medical Professionalism* (McGraw Hill).

A fellow of the American College of Physicians, Dr. Lucey also is a prior council member for both the Society of General Internal Medicine and the Association of Program Directors in Internal Medicine. She served on the AAMC MR5 Committee, charged with redesigning the MCAT.

Dr. Lucey earned her medical degree from the Northwestern University School of Medicine, and completed her residency in internal medicine at the University of California, San Francisco before serving as Chief Resident in Internal Medicine at the San Francisco General Hospital.

Mary (Beth) E. Mancini, RN, PhD, NE-BC, FAHA, ANEF, FAAN, is Professor, Associate Dean and Chair for Undergraduate Nursing Programs at The University of Texas at Arlington College of Nursing and Health Innovation, where she holds the Baylor Health Care System Professorship for Healthcare Research. Prior to moving to an academic role, Dr. Mancini held progressive management positions, including 18 years as Senior Vice President and Chief Nursing Officer at Parkland Health & Hospital System in Dallas.

In recognition of her contributions to the fields, Dr. Mancini has been inducted as a fellow in the American Academy of Nursing, a fellow of the American Heart Association, and a fellow in the National League for Nursing's Academy of Nurse

Educators. She has served as a Visiting Scholar in Innovation and Simulation at The University of Pennsylvania School of Nursing and was recognized with a Regent's Outstanding Teaching Award from The University of Texas System.

Dr. Mancini's research interests include interprofessional collaborative practice and the development of high-performing healthcare teams through the use of simulation. Her professional activities include having served as President of the Society for Simulation in Healthcare; member of the Institute of Medicine's Global Forum on Innovations in Health Professions Education; and past member of the Royal College of Physicians and Surgeons of Canada's Simulation Task Force, Sigma Theta Tau International's Simulation and Emerging Technologies Content Advisory Group, and the World Health Organization's Initiative on Training and Simulation and Patient Safety.

Dr. Mancini has more than 90 publications and has made presentations at local, national, and international conferences on such topics as simulation in health care, patient safety, basic and advanced life support education, emergency and critical care nursing, and the transformative redesign of health professions education.

Haru Okuda, MD, is National Medical Director for the Department of Veterans Affairs Simulation Learning Education and Research Network (SimLEARN) program. Dr. Okuda leads a staff of clinical simulationists and educators in conducting research, developing curricula and best practices, and coordinating acquisitions of clinical simulation training systems in support of healthcare providers at VA medical centers.

Before joining VA, Dr. Okuda served as Director and Assistant Vice President of the Institute for Medical Simulation and Advanced Learning for the New York City Health and Hospitals Corporation (HHC), the largest municipal healthcare system in the United States. He oversaw the construction of a 10,000 square foot, \$10 million simulation center; coordinated the development and implementation of simulation programs in areas such as central line placement, obstetrical emergencies, and code team training; and worked to link simulation training with patient safety outcomes for the organization. Dr. Okuda was also Associate Clinical Professor of Emergency Medicine at the Mount Sinai School of Medicine, as well as the former Associate Residency Director in Emergency Medicine and Director of Simulation for the medical school.

Dr. Okuda is the current co-chair of the educational program Simwars for this year's International Meeting on Simulation in Healthcare. Simwars is an interdisciplinary simulation competition between healthcare providers that has been held at a number of national meetings. He is also immediate past chair of the Emergency Medicine Special Interest Group for the Society for Simulation in Healthcare, and vice-chair of the Simulation Academy for the Society for Academic Emergency Medicine.

With numerous publications in the areas of simulation, patient safety, and education, Dr. Okuda recently published the textbook *Emergency Medicine Oral Boards Review Illustrated*. In 2010, he was recognized by Crain's New York Business Magazine as a member of its current "40 Under 40" cohort, as well as by Becker's Hospital Review as a "rising star" on its list of 25 healthcare leaders under age 40.

Dr. Okuda received his Bachelor of Science Degree in Neuroscience from Brown University and his Medical Degree from New York Medical College, and completed his residency in emergency medicine at the Mount Sinai School of Medicine. He is completing a clinical quality fellowship with the Greater New York Hospital Association/United Hospital Fund. He is certified by the American Board of Emergency Medicine.

Sally Okun, RN, MMHS, is Vice President for Advocacy, Policy, and Patient Safety at PatientsLikeMe, an online patient-powered research network. She is responsible for bringing patient voice and insight to diverse advocacy and health policy discussions at the national and global level, and is the company's liaison with government and regulatory agencies. Ms. Okun joined the company in 2008 as the manager of Health Data Integrity and Patient Safety overseeing the site's medical ontology and the development of the PatientsLikeMe Drug Safety and Pharmacovigilance Platform.

Ms. Okun participates in numerous collaborative efforts of the Institute of Medicine's (IOM) Roundtable on Value and Science-Driven Health Care and is a member of the Committee on Core Metrics for Better Health at Lower Cost. She serves on the Advisory Panel on Patient Engagement for the Patient-Centered Outcomes Research Institute (PCORI); the Scientific Advisory Committee for the Reagan-Udall Foundation's Innovation in Medical Evidence Development and Surveillance (IMEDS) Program; the Program Advisory Board of the Schwartz Center for Compassionate Health Care; and was co-chair of the National Quality Forum's

Person-centered Care and Outcomes Committee. Ms. Okun is a frequent speaker at clinical, advocacy, and policy events and in April 2013 was the first nurse invited to give a TEDMED talk at Kennedy Center.

Ms. Okun, a registered nurse, practiced as a palliative and end-of-life care specialist mainly in community-based settings and contributed to numerous clinical, research, and educational projects in this specialty area. She received her master's degree at The Heller School for Social Policy & Management at Brandeis University; completed study of Palliative Care and Ethics at Memorial Sloan-Kettering Cancer Center; and was a 2010 National Library of Medicine Fellow in Biomedical Informatics and a 2014 Salzburg Global Fellow.

Charles G. Prober, MD, is Senior Associate Dean for Medical Education at Stanford School of Medicine. He is Professor of Pediatrics, Microbiology, and Immunology and Co-Director of the Stanford Center for Clinical and Translational Education and Research. He is an expert in pediatric infectious diseases with an academic career focused on the epidemiology, pathophysiology, prevention, and treatment of infections in children. Much of his research has focused on viral infections, especially those caused by herpes simplex virus (HSV). He has conducted a number of seminal studies concerned with the epidemiology of HSV-2 infections in pregnant women, their partners, and neonates as well as investigations of the immunologic response to HSV infections. Antiviral therapy is another area of specific expertise. Dr. Prober has published extensively in peer-reviewed journals and is editor of *Principles and Practice of Pediatric Infectious Diseases*, one of the major textbooks in the field of pediatric infectious diseases.

Dr. Prober has been involved in medical education throughout his career. He has directed a number of undergraduate and graduate student courses in the classroom and at the bedside, served as Associate Chair for Education for the Department of Pediatrics, and lectured locally, nationally, and internationally on infectious diseases and medical education. As Senior Associate Dean, he oversees undergraduate, graduate, and postgraduate medical education at Stanford Medicine.

Stephen C. Schoenbaum, MD, MPH, is Special Advisor to the President of the Josiah Macy Jr. Foundation. He has extensive experience as a clinician, epidemiologist, and manager. From 2000–2010, he was Executive Vice President for Programs at The Commonwealth Fund and Executive Director of its Commission

on High Performance Health Systems. Prior to that, he was Medical Director and then President of Harvard Pilgrim Health Care of New England, a mixed model HMP delivery system in Providence, RI.

He is currently a lecturer at the Department of Population Medicine at Harvard Medical School, a department he helped to found, and the author of over 150 professional publications. He is Vice Chairman of the board of the Picker Institute; former president of the Board of the American College of Physician Executives; chair of the International Advisory Committee to the Joyce and Irving Goldman Medical School, Ben Gurion University, Beer Sheva, Israel; and an honorary fellow of the Royal College of Physicians.

William Stead, MD, is Associate Vice Chancellor for Health Affairs and Chief Strategy Officer at Vanderbilt University Medical Center (VUMC). He leads strategy development for VUMC, facilitating structured decision making to achieve strategic goals, curation of methods to drive transformation, and concept development to nurture system innovation.

Dr. Stead received his BA, MD, and residency training in Internal Medicine and Nephrology from Duke University. He came to VUMC in 1991 and guided development of the Department of Biomedical Informatics (informatics research and education); Eskin Biomedical Library (knowledge management); Center for Better Health (accelerating change) and operational units providing information technology infrastructure to support education, research, and healthcare programs throughout the Medical Center. He aligned organizational structure and informatics architecture to bring cutting-edge research in natural language processing, data mining, data privacy, and complex process visualization into clinical practice. The resulting enterprise-wide electronic health record, clinical communication/decision support tools, and population-scale research resources support his current focus on system-based care and research leading toward personalized medicine and population health management.

He is a member of the Council of the Institute of Medicine, the Division Committee on Engineering and Physical Sciences of the National Research Council, and the National Committee for Vital and Health Statistics.

Gail W. Stuart, PhD, RN, FAAN, is Dean and a tenured Distinguished University Professor in the College of Nursing and Professor in the College of Medicine in

the Department of Psychiatry and Behavioral Sciences at the Medical University of South Carolina (MUSC). The MUSC College of Nursing was ranked number one in online graduate nursing education by US News & World Report in 2015. The College is known for educational innovation and optimizing the integration of technology in education, research, and clinical practice.

Dr. Stuart received her Bachelor of Science Degree in Nursing from Georgetown University, her Master of Science Degree in Psychiatric Nursing from the University of Maryland, and her Doctorate in Behavioral Sciences from Johns Hopkins University, School of Hygiene and Public Health. She has taught in undergraduate, graduate, and doctoral programs in nursing and serves on numerous academic, corporate, and government boards. She has represented nursing on a variety of National Institute of Mental Health and National Institute of Nursing Research policy and research panels.

She is best known for her significant contributions to psychiatric mental health nursing. As a prolific writer, she has published numerous articles, chapters, textbooks, and media productions. Most notable among these is her textbook *Principles and Practice of Psychiatric Nursing*, now in its 10th edition, which has been honored with four Book of the Year Awards from the *American Journal of Nursing* and has been translated into five languages. She has received many awards, including the American Nurses Association Distinguished Contribution to Psychiatric Nursing Award, the Psychiatric Nurse of the Year Award from the American Psychiatric Nurses Association, and the Hildegard Peplau Award from the American Nurses Association. Dr. Stuart is a fellow in the American Academy of Nursing, a past president of the American College of Mental Health Administration, and a past president of the American Psychiatric Nurses Association.

Dr. Stuart's work also has focused on the healthcare workforce. She is currently President of the Annapolis Coalition on the Behavioral Health Workforce and on the National Advisory Board of SAMHSA. She has been a van Ameringen Fellow at the Beck Institute of Cognitive Therapy and Research and was a Visiting Professor at King's College, Institute of Psychiatry, at the Maudsley in London.

George E. Thibault, MD, became the seventh president of the Josiah Macy Jr. Foundation in January 2008. Immediately prior to that, he served as Vice President of Clinical Affairs at Partners Healthcare System in Boston and Director of the Academy at Harvard Medical School (HMS). He was the first Daniel D. Federman

Professor of Medicine and Medical Education at HMS and is now the Federman Professor, Emeritus.

Dr. Thibault previously served as Chief Medical Officer at Brigham and Women's Hospital and as Chief of Medicine at the Harvard affiliated Brockton/West Roxbury VA Hospital. He was Associate Chief of Medicine and Director of the Internal Medical Residency Program at the Massachusetts General Hospital (MGH). At the MGH he also served as Director of the Medical ICU and the founding Director of the Medical Practice Evaluation Unit.

For nearly four decades at HMS, Dr. Thibault played leadership roles in many aspects of undergraduate and graduate medical education. He played a central role in the New Pathway Curriculum reform and was a leader in the new Integrated Curriculum reform at HMS. He was the founding director of the Academy at HMS, which was created to recognize outstanding teachers and to promote innovations in medical education. Throughout his career he has been recognized for his roles in teaching and mentoring medical students, residents, fellows, and junior faculty. In addition to his teaching, his research has focused on the evaluation of practices and outcomes of medical intensive care and variations in the use of cardiac technologies.

Dr. Thibault is chairman of the board of the MGH Institute of Health Professions and chairman of the board of the New York Academy of Medicine. He serves on the boards of the New York Academy of Sciences, the Institute on Medicine as a Profession, and the Lebanese American University. He serves on the President's White House Fellows Commission and for twelve years he chaired the Special Medical Advisory Group for the Department of Veteran's Affairs. He is past president of the Harvard Medical Alumni Association and past chair of Alumni Relations at HMS. He is a member of the Institute of Medicine of the National Academy of Sciences.

Dr. Thibault graduated summa cum laude from Georgetown University in 1965 and magna cum laude from Harvard Medical School in 1969. He completed his internship and residency in Medicine and fellowship in Cardiology at Massachusetts General Hospital. He also trained in Cardiology at the National Heart and Lung Institute in Bethesda and at Guys Hospital in London, and served as Chief Resident in Medicine at MGH.

Dr. Thibault has been the recipient of numerous awards and honors from Georgetown (Ryan Prize in Philosophy, Alumni Prize, and Cohongaroton Speaker) and Harvard (Alpha Omega Alpha, Henry Asbury Christian Award and Society of Fellows). He has been a visiting Scholar both at the Institute of Medicine and Harvard's Kennedy School of Government and a visiting Professor of Medicine at numerous medical schools in the US and abroad.

Marc M. Triola, MD, FACP, is Associate Dean for Educational Informatics and Associate Professor of Medicine at NYU School of Medicine, and the founding Director of the NYU Langone Medical Center Institute for Innovations in Medical Education (IIME). Dr. Triola's research experience and expertise focuses on the disruptive effects of the present revolution in education driven by technological advances, big data, and learning analytics. Dr. Triola has worked to create a 'learning ecosystem' that includes inter-connected computer-based e-learning tools and new ways to effectively integrate growing amounts of electronic data in educational research. He has also extensively studied the use of virtual patients, and the assessment of change in knowledge and attitudes resulting from computer-assisted instruction.

Dr. Triola and IIME have been funded by the NIH, the IAIMS program, the NSF Advanced Learning Technologies Program, the Josiah Macy Jr. Foundation, the US Department of Education, and the AMA Accelerating Change program. He chairs numerous committees at the state and national level focused on the future of health professions educational technology development and research. He recently gave a TED Talk at TEDMED 2012 and published his first textbook, *Biostatistics for the Biological and Health Sciences*.

Sandrijn van Schaik, MD, PhD, is Associate Professor of Pediatrics at the University of California, San Francisco (UCSF), with a subspecialty appointment in Pediatric Critical Care Medicine. Dr. van Schaik fulfills several administrative and leadership roles in medical education: she is the Education Director of the UCSF Kanbar Center for Simulation, Clinical Skills and Telemedicine Education, serves as Fellowship Director for Pediatric Critical Care Medicine, and is in charge of faculty development for the new UCSF School of Medicine "Bridges" curriculum. Her research focuses on interprofessional teamwork and communication, and a current area of focus is interprofessional feedback. She completed the Teaching Scholars Program as well as a Medical Education Research Fellowship at UCSF and was a scholar in the Macy Faculty Scholars Program from 2012–2014. She is a member of

several national organizations and committees, including the planning committee for the Annual Medical Education meeting of the AAMC.

David Vlahov, PhD, RN, FAAN, is Dean and Professor at the University of California, San Francisco School of Nursing. He brings experience in interprofessional and interdisciplinary education and research. He served on the faculty as Professor of Epidemiology at the Johns Hopkins and Columbia Universities; and was Adjunct Professor in the medical schools at Cornell, Mount Sinai, and New York University and the College of Nursing at New York University. He has also served as co-Director of the Robert Wood Johnson Foundation Health and Society Scholars program. He brings research expertise in epidemiology, infectious diseases, substance abuse, and mental health. Dr. Vlahov conducted studies of urban populations in Baltimore for over 20 years, including several longitudinal cohort studies for which he received the NIH MERIT Award. More recently, Dr. Vlahov led epidemiologic studies in Harlem and the Bronx, which have served as a platform for subsequent individual- and community-level intervention studies and community-based participatory research (involving partnerships with residents, community-based organizations, academic/public health departments) to address social determinants of health. This work has contributed information on racial/ethnic disparities in health and approaches to address such disparities. Uniting these interests, Dr. Vlahov initiated the International Society for Urban Health (www.isuh.org), serving as its first President. He was a Visiting Professor at the Medical School in Belo Horizonte, Brazil, to develop their programs in urban health, and has been an expert consultant to the WHO's Urban Health Center in Kobe, Japan. He served on the New York City Board of Health. Dr. Vlahov is the editor-in-chief of the *Journal of Urban Health*, has edited three books on urban health, and published over 640 scholarly papers. He is a member of the Institute of Medicine and a fellow of the American Academy of Nursing.

Warren Wiechmann, MD, MBA, currently serves as Associate Dean of the Division of Instructional Technologies at the University of California, Irvine School of Medicine. He is responsible for directing the school's iMedEd Initiative—a comprehensive digital overhaul of the medical school curriculum that uses technologies such as the iPad and Google Glass as the catalysts for curricular innovation and reform.

Dr. Wiechmann's IT roots as a graphic designer and web applications developer pre-date his career in medicine, and he has been fortunate enough to have had

opportunities throughout his career to utilize this skill set. Dr. Wiechmann has used his programming background to enhance different facets of the medical student and resident experience, from the creation of the school's first student intranet and online scheduling website to a comprehensive patient-tracking and management system for the UC Irvine Department of Emergency Medicine.

Since the launch of the iMedEd Initiative in 2010, Dr. Wiechmann has focused his academic interests on technology integration into education and clinical care, leveraging technology for patient education, personalized proactive health, the role of social media in medicine, and digital literacy for students and physicians. Dr. Wiechmann is the course director for the school's Health 2.0 and Digital Literacy Elective and the Director of a new Multimedia Design and Instructional Technologies Fellowship through the Department of Emergency Medicine. He has been an invited speaker at SXSWedu, TEDx, MedicineX, and is an Apple Distinguished Educator.

Stacy L. Williams, PhD, is Chief Operations Officer of Allied Health Media LLC, a leader in online continuing education for allied health professionals. Dr. Williams is a licensed speech-language pathologist in the state of Ohio, a certified simulation healthcare educator and an adjunct assistant professor at Case Western Reserve University in the Communication Sciences Department. Dr. Williams was the founder and Director of the Virtual Immersion Center for Simulation Research at Case Western Reserve University and the Website Technology Director for the Ohio Speech Language Hearing Association.

Dr. Williams earned her doctoral degree in communication sciences and disorders from the University of Cincinnati. She has experience as a clinical speech-language pathologist specializing in pediatric speech-language disorders, school-based issues, and AAC/technology, and as a researcher and lecturer in the area of pediatric language development and disorders. Dr. Williams is one of the virtual simulation pioneers for speech-language pathology, launching the first immersive simulation-training center specializing in communication and science disorders (CSD) for students and patients alike. In 2006, her innovative work was granted a patent that resulted in a new virtual simulation technology—SimuCase™. SimuCase™ is an online simulation tool used to evaluate students' clinical decision making skills and performance for assessing communication disorders and is currently in use at 80 universities around the country. Dr. Williams has presented on the topics of virtual world technology, immersive virtual reality systems, augmented

reality in education, simulation-based education, and serious gaming applications for the speech-language pathology profession at state, national, and international meetings.

Dr. Williams is the author of several research articles and abstracts in a variety of peer-reviewed publications, including the *American Journal of Distance Education*, the American Speech Language Hearing Association *Perspectives on School-Based Issues*, the American Speech Language Hearing Association *Perspectives on Telepractice*, and the Apple Learning Interchange. She was invited to present her research findings at the Higher Education Leadership Summit at Stanford University. Awards and recognition include OSLHA Honors for Fellow of the Association; J. Bruce Jackson, M.D. Award for Excellence in Undergraduate Mentoring; Thompson Hine LLP, Woman of Excellence Award for recognition in research, scholarship, and accomplishments; Northern Ohio Live Award of Achievement for Science and Technology; and the Singular Publishing Scholarship by the Council of Academic Programs for Excellence in Innovative Instructional Technology in Communication Sciences and Disorders.



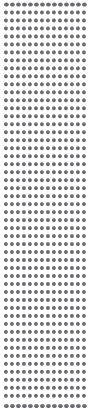
APPENDIX

THE METAPHOR OF AN EDUCATIONAL JOURNEY— WHAT CAN WE LEARN FROM TRAVELING?

H. THOMAS ARETZ, MD
PARTNERS HEALTHCARE INTERNATIONAL

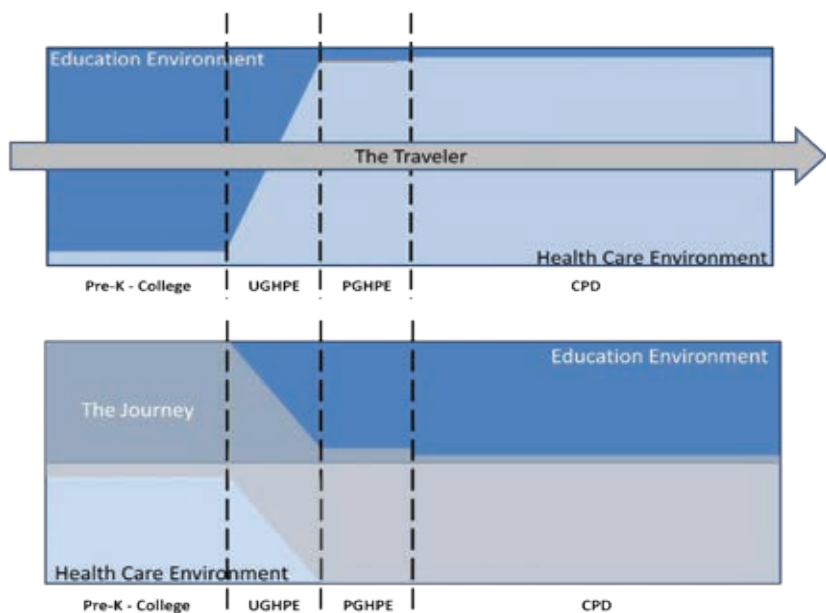
Technology has revolutionized travel in all aspects: how we get exposed to the possibilities; how we weigh our options; how we decide on a destination; how we prepare for the journey; how we book it; how we experience the journey; how we customize it; how we capture it; how we remember it, etc. Yet traveling may also serve as a useful metaphor for the educational process: many of us still use human guides (faculty)¹ while we travel, and depending on our pocket book or needs, they can be personal (private tutor, mentor, coach, home “schooler”, etc.); cohort-based, such as group guides (classroom teachers); or virtual, such as audio tours (podcasts, video, etc.).

Travel can take place in large organizational contexts, such as cruises with fixed routes, interspersed with personal excursions of proscribed length (universities with required curricula with certain times for electives), or it can be unplanned and spontaneous, following one’s own interests, whims, passions, and available resources (personal learning plans). It can support personal learning such as ecotours or educational travel (professional development); it can fulfill lifelong dreams (career goals and personal fulfillment); it can widen our horizons (interdisciplinary and interprofessional experiences); it can bring family, friends, or strangers closer together, by design or incidentally (team building); it can be arduous and challenge us to the edge of our capabilities, such as climbing a mountain (stretch assignments, career goals); or it can “merely” provide contentment and inner peace (personal satisfaction). Whatever the purpose or the unintended consequences, technology can aid and support those goals.



The question is, as the journey takes the traveler through the two seemingly disparate worlds of formal education and the healthcare environment, how can technology support learning, performance, personal satisfaction, professional development, and, ultimately and most importantly, the health of our patients and communities? Figure 1 tries to capture the learner’s journey in two slightly different ways.

Figure 1: The Learner’s Journey



During much of formal education up to undergraduate health professional education (UGHPE), the learner’s direct exposure to the healthcare environment is mostly on a personal level (i.e., personal experiences as a patient; sick family members and friends). The learner acquires insights into health care through the formal education environment’s offerings in the sciences, health education classes, etc. The major transition happens during the UGHPE period, as students move from one world into the other, often in a very abrupt manner. From the postgraduate (PGHPE) phase onward, with the exception of some advanced degrees in the health professions, most health professions learning takes place in the healthcare system, with some input from the formal education environment, often in the form of continuing professional development (CPD).

Some examples of the parallels to various stages of a trip may help illustrate my point about technology in health professions education.

- Deciding where to go (thinking about medicine as a career): Before technology was available, deciding where to go was based on reading or hearing about the places, seeing pictures, talking to people that had been there, etc.—unless of course you were Christopher Columbus or any other explorer. With technology, virtual tours, detailed maps, and the synthesized reviews of thousands who have already been there are available to travelers. But still, curiosity and motivation are still an absolute must.
- Clearly, comparable resources are available to potential future health professionals. Given the enormous amount of material available in modern media, the decision to go into health care as a career should not be an uninformed one at this point in time. Obviously, separating fact from fiction is still a challenge and may require an informed counselor.
- Planning the trip (looking at colleges/schools)
- Booking (applying)
- Preparing (required and elective courses; healthcare experiences; volunteering; advanced degrees; etc.)
- The trip (UGHPE, PGHPE, work)

Without belaboring the point, the type of technology we use to help the process of planning a trip, provide advanced information, obtain just-in-time information, track our progress (GPS), document our experiences (photos, blogs, etc.), evaluate our performance (health data on an iPhone, miles covered on a bike trip, etc.) and describe what we learned (reflections, trip reports, etc.) all have parallels in the education world.

The role of travel agencies, travel companies, and guides has changed dramatically in light of new technologies. Companies must provide services that add significant value and guides must be able to provide specific information not easily gotten from other sources, or utilize the travelers' information and contextualize it. They also must accept that travelers will come with more information, and that at times, the best they can do is help get the latest information together with the traveler. This has not been an easy transition for many guides, who were used to being the sole source of information, and find themselves now in situations when they are learning from the traveler. The parallels to faculty development are fairly clear.

A journey may also require documentation at various stages, such as passports (transcripts), exit visas (diplomas, exams, degrees), and entrance visa (qualifying exams, etc.), with the greatest amount of requirements and regulations existing as one moves from the education environment into the healthcare environment (Figure 2). As we know, some countries have employed technology to make this easy (global entry, electronic visas) while others make the process as arduous as possible.

Clearly there are no official exams when one travels and there are no strict performance metrics as there are in medicine, but one can imagine that with increasing technology, these will become increasingly sophisticated in the healthcare and education environments. The question is how the two systems would interact. Figures 2, 3, and 4 consider various aspects of that interaction.

In Figure 2, the traditional educational pathway to advanced degrees is an evolving pathway that allows the Healthcare Professional (HCP) to enter the healthcare system, where he or she is faced with multiple career choices. Each will require additional learning, which for the most part takes place in the healthcare system and some of which is mandated by regulatory agencies or internal policies.

Figure 2: Educational Pathways and Healthcare Careers:
The Tale of Two Systems

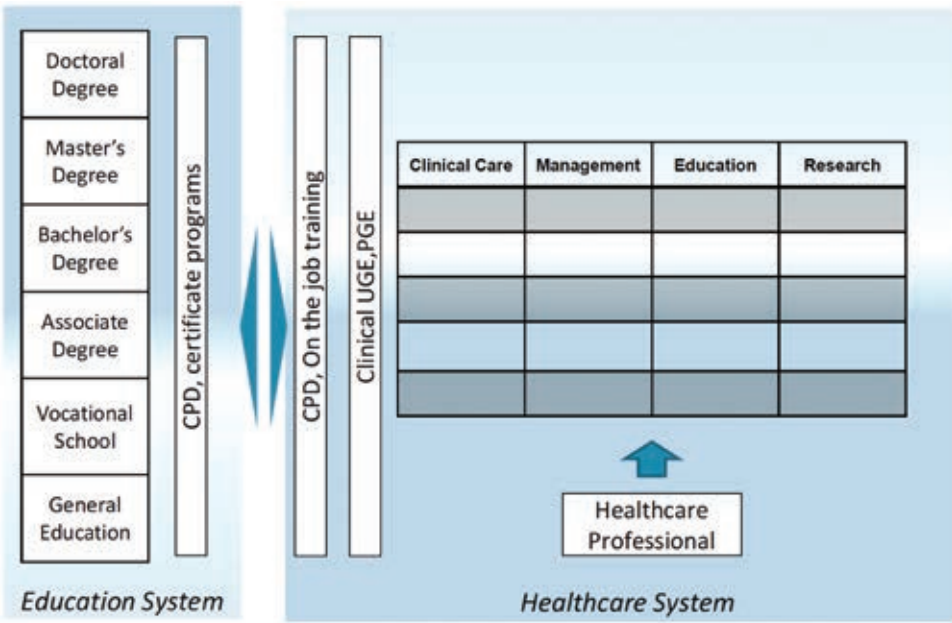
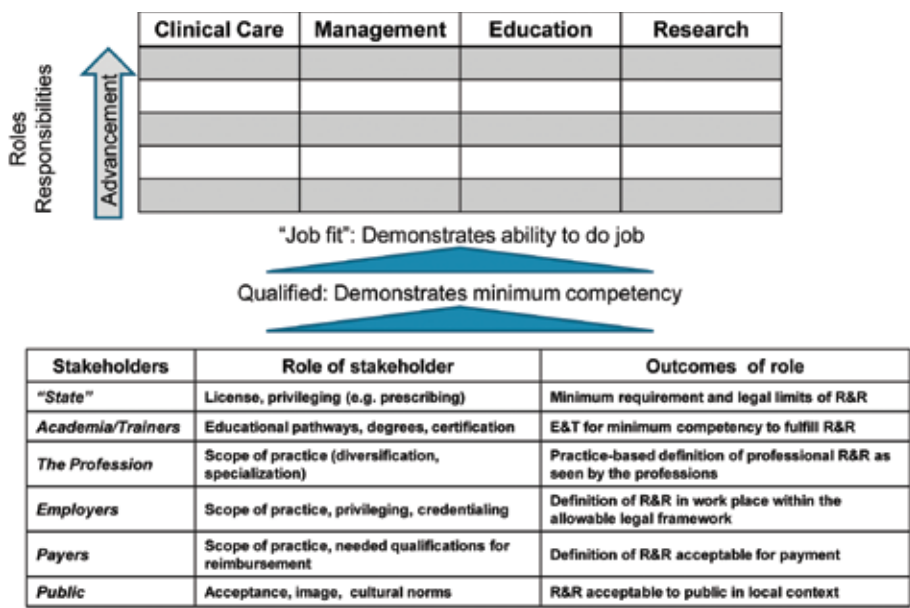


Figure 3 illustrates the number of stakeholders that regulate or influence the healthcare professions and their education and training (“R&R” stands for “roles and responsibilities”). This is one of the major issues in healthcare documentation of appropriate learning. It emphasizes the need for a single (electronic) professional portfolio that satisfies licensing, credentialing and maintenance of certification (MoC) processes.

Figure 3: Healthcare Career Model and Stakeholders



Finally the role of academic medical centers (AMCs) as a consequence is multifold (Figure 4). Not only are the AMCs “borrowed” by the educational system to produce qualified HCPs, but the AMCs themselves have to constantly educate and train their employees to be the “best thing now”, while also being the “breeding ground²” for the future workforce (“the next best thing”).

These are tall orders, and technology, prudently applied and coupled with human efforts, can and will be of great help.

Figure 4: Education and Training Tasks in Academic Medical Systems



ENDNOTES

- 1. The items in parentheses are meant to illustrate educational equivalencies.
- 2. As quoted from Prof. Geert Blijhams, the former CEO of University Medical Center Utrecht.







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