Improving Health Professional Education and Practice Through Technology: Proceedings of a Workshop

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IMPROVING HEALTH PROFESSIONAL EDUCATION AND PRACTICE THROUGH TECHNOLOGY

PROCEEDINGS OF A WORKSHOP

Patricia A. Cuff and Erin Hammers Forstag, *Rapporteurs*

Global Forum on Innovation in Health Professional Education

Board on Global Health

Health and Medicine Division

The National Academies of
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Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the content of the proceedings nor did they see the final draft before its release. The review of this proceedings was overseen by **Claire Pomeroy,** Albert and Mary Lasker Foundation. She was responsible for making certain that an independent examination of this proceedings was carried out in accordance with standards of the National Academies and that all review comments were carefully considered. Responsibility for the final content rests entirely with the rapporteurs and the National Academies.

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Introduction

Highlights

- There are a number of mismatches in the health care system. The education and training of health care professionals does not always match the real-world demand. (Sheikh)
- Technology can help bridge the gaps in health education and health care by connecting, supporting, informing, and empowering students and providers. (Jeffries)

A pressing challenge in the modern health care system is the gap between education and clinical practice, said Malcolm Cox, member of the Global Forum on Innovation in Health Professional Education (the Forum). Emerging technologies have the potential to bridge this gap by creating the kind of team-based learning environments and clinical approaches that are increasingly necessary in the modern health care system both in the United States and around the world. To explore these technologies and their potential for improving education and practice, the Forum hosted a workshop titled Improving Health Professional Education and Practice Through Technology. The 1.5-day workshop, held in Washington, DC, on November 16 and 17, 2017, was attended by participants from 19 different health professions, from countries including Australia, Canada, Qatar, Switzerland, and the United States. The objective of the workshop was:

> Explore effective use of technologies as tools for bridging identified gaps within and between health professions education and practice in order to optimize learning, performance, and access in high-, middle-, and low-income areas while ensuring the well-being of the formal and informal health workforce.[1]

The full Statement of Task is in Appendix A.

USING TECHNOLOGY TO ADDRESS CURRENT CHALLENGES

Pamela Jeffries, a member of the planning committee, welcomed participants to the event and gave a brief overview of some of the current challenges in health care and how technology may address these challenges and improve both education and clinical practice. The workshop, said Jeffries, confronts a major problem in the preparation of health professionals: the gap between academia and clinical practice. Jeffries explained that while health professional students are learning new knowledge, skills, and attitudes while in their educational environments, it is not clear that what they are learning matches the demand for what is needed in practice.

Javaid Sheikh, dean of the Weill Cornell Medical College in Qatar, expanded on this with a reminder: "What looks good on paper . . . does not always succeed in real life." The health care market should theoretically respond to demand, resulting in a good match between the health needs of the population and the preparedness and supply of health professionals, Sheikh continued. However, in real life, there are a number of mismatches in the market that result in inefficiencies, underserved populations, and expensive care. The true population health needs are not reflected in the demand for care, in part because of perverse incentives that prioritize curative care over preventive care, which is often not reimbursed. As described in a previous forum workshop on the financial economics of health professions education (NASEM, 2017), the demand for care does not match perfectly with the supply of care, owing to a saturated labor market and the fact that health professionals tend to aggregate in certain geographic regions and specialties, said Sheikh. Health professions education and training do not necessarily align with the needs of the population or the demands of the market (see Figure 1-1).

To remedy these mismatches, said Jeffries, it will be necessary to transform health professions education in order to more closely match the skills and knowledge needed in the real world. She asked, "Are we limited in how

[1] The informal health workforce, sometimes called the "shadow workforce," includes caregivers who did not go through formal health professional training such as family members who provide care for loved ones (Phillips et al., 2016).

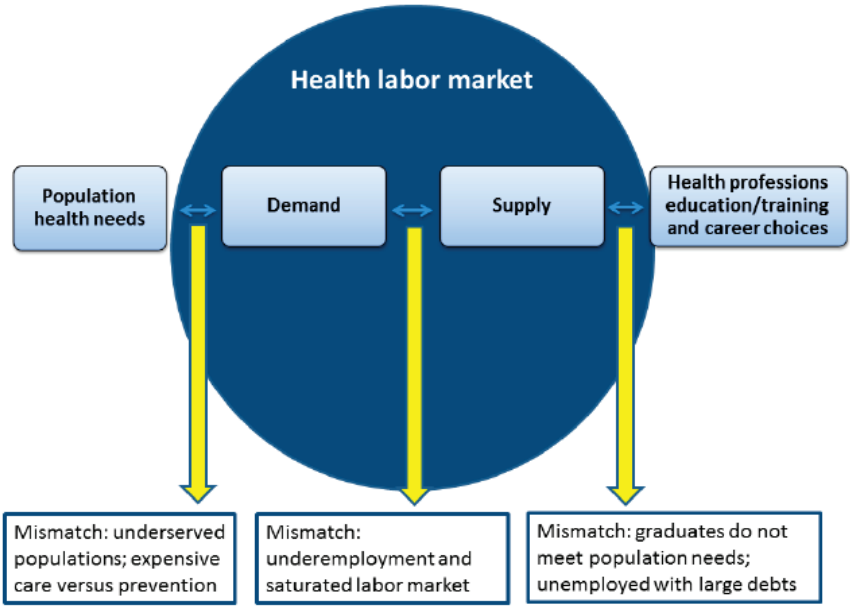

FIGURE 1-1 Mismatches that result in market failures in a model for financing health professions education.
SOURCES: Presented by Sheikh, November 16, 2017. From NASEM, 2017.

we teach in academic settings because of obstacles that prevent us from replicating real practice? Or are there opportunities in simulation to teach students the full scope of practice in a controlled, but realistic environment?" To address these questions, the workshop explored ways to bridge the gap using technology and innovative approaches through presentations and discussions about existing, emerging, and futuristic technologies from multiple disciplines and multiple countries. The hope, said Jeffries, is that the use of these technologies can help to "overcome challenges to improve the education of our practitioners and ultimately improve our health care quality and patient outcomes." To set the stage, Jeffries described five issues in health professions education and health care that technology has the potential to improve: the new generation of learners, clinical education, faculty shortage, changes in health care, and cost.

New Generation of Learners

Students joining the health professions are no longer digital immigrants, but digital natives, said Jeffries. These learners understand technology better than any generation before them—and better than their faculty—and typically have numerous devices at their fingertips ready to retrieve information, communicate, and explore across borders. They also have certain expectations coming into their learning environment; evidence has shown that current learners expect their faculty to use technology in education and to incorporate the technologies needed for their profession (McKnight et al., 2016). Current learners are able to use certain technologies as a platform for learning, particularly in underserved areas where geographically it may be a challenge to attend classes, have clinical experiences, or embark on a learning experience without the assistance of technology. For example, said Jeffries, midwives in Bangladesh are learning new ways to implement mother–baby care through videos, social media, and other technologies. Technological platforms are no longer a novelty for students, but an expectation, as demonstrated through their way of living, being, and learning.

Clinical Education

There are many challenges in clinical education that educators, practitioners, and leaders all have to navigate, said Jeffries. Typically, health professional students are assigned to clinical sites, and their clinical practice is conducted in parallel with their didactic courses. Securing appropriate clinical sites for all health professional students is a major challenge. The American Association of Colleges of Nurses reported that 64,000 qualified applicants eligible for baccalaureate and graduate nursing education were not admitted to programs because of the lack of clinical sites, faculty shortage, and a lack of preceptors needed for graduate clinical education (AACN, 2017). In a recent survey of medical schools, half reported concerns about the availability of residency positions for their students after graduate school, and 85 percent indicated concerns about finding clinical sites and qualified clinical preceptors (AAMC, 2018). Jeffries asked, "How can technology help to remedy these challenges with our admissions and acceptance of needed qualified students entering our health professions?" She noted that while technology may be an important part of the answer to this problem, the implementation "isn't as easy as one would think," owing to legal and policy issues that must be considered. For example, getting state authorization for online distance education learning can be challenging, as requirements and rules differ from state to state.

Faculty Shortage

The shortage of qualified nursing faculty is another major challenge in preparing health professionals, Jeffries said. Existing nursing faculty are aging: the average age of a doctorally prepared professor is 62 years old and the average of a doctorally prepared associate professor is 58 years old (AACN, 2017). As current health professionals retire, and the population ages and requires more health care, the pipeline of health professionals must keep up with demand. In medicine, one-third of physicians are over the age of 55 (AAMC, 2016). Without an adequate number of faculty to teach, the output of prepared health professionals will continue to not meet the demand of a growing population. However, through the use of technologies, said Jeffries, there is the potential for supporting a larger group of faculty to teach health professions; using experienced, retired faculty in some aspect; and making content scalable and accessible. For example, massive, open online courses could be one tool to help to deliver, scale up, and extend content to health professions students across the globe. Jeffries said that the idea of providing open source materials and information is a very nontraditional concept in higher education, but one that has great potential.

Changes in Health Care

The health care environment is changing, said Jeffries, with shifts from acute care to chronic care, with the demand for global aspects of care, and with the never-ending need to prepare for unique types of medical challenges (e.g., the Ebola epidemic) that require just-in-time learning. It is essential that practitioners be prepared to deliver high-quality patient care, whether in an acute care environment or a primary care setting such as a rural community clinic in an underserved area, said Jeffries. Health care practitioners must understand population health, social determinants, and have the knowledge and skills to work with diverse communities in diverse areas. Just-in-time learning requires that health professionals be nimble and ready to deploy new knowledge, best practices, and new interventions when necessary. "How can technology prepare our health professions students, interns, residents, and practicing providers for this new world?" asked Jeffries. "How can the use of technologies help prepare our practitioners for these environments, challenges, and to care for populations and communities in addition to individual clients?"

Cost

As with any venture, said Jeffries, the cost and financial implications must be considered. While new technologies are often costly to develop and

disseminate, there is the potential for cost savings as well. Using technology to disseminate education to health professionals could be a way to teach thousands of health care providers across the globe while eliminating barriers to access, reducing costs, and ensuring consistency in quality and delivery. However, those who do not have access to the Internet or technologies may be left behind, said Jeffries, furthering the financial divide.

CONCLUSION

Jeffries told participants that the workshop was centered around the idea that technology is only a platform or a tool to use for education, not an end unto itself. Technology is embedded in everyday life, including health professions education, communication, and as a way to access information. Rural communities are dependent on the use of technology, such as the use of mobile phones to connect and educate health professionals in rural African regions. Technology can help to connect, empower, and support health professionals, wherever they may practice. "Harnessing the power of technologies allows us to make an impact in communities by creating a culture of health, supporting education, giving support for addictions, or just notifying about annual flu shots," said Jeffries.

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2

Technology in Education

Highlights

- When technology is combined with solid pedagogy, it can transform education and enable students to take ownership over their learning. (McKnight)
- Education is shifting from a didactic, top-down model to one in which students are self-directed learners who use technology to gain knowledge, interact, and collaborate. (Siemens)
- Technology can be used for sharing and building on existing knowledge, which can lead to creative and innovative solutions to problems. (Casserly)
- As faculty move away from their traditional role as gatekeepers of information, it gives them the opportunity to focus on teaching, critical thinking, and problem solving. (Nemire and Thibault)

The presentations in this session cover three different aspects of health professions education and how technology is transforming these systems. First, Katherine McKnight, senior manager at the Research Triangle Institute's Center for Evaluation and Study of Educational Equity, talked about the kindergarten through 12th grade (K–12) system, which lays a foundation of knowledge and skills for more specific health professions education. George Siemens, associate director of the Technology Enhanced Knowledge Research Institute at Athabasca University in Canada, discussed technology

in health professions education, and how it is changing the traditional roles of student and teacher. Finally, Catherine Casserly, formerly vice president of Learning Networks at EdCast, told participants about the use of technology to diffuse knowledge, and how tools such as open-access educational resources are transforming how knowledge is built and shared around the world.

TECHNOLOGY IN K–12 EDUCATION

"Great technology can't replace poor teaching," said McKnight, noting that integrating technology into education is not as easy as simply adding laptops or apps to the classroom. However, when solid pedagogy is aligned with how humans learn, technology can transform education and facilitate a learner-centered approach, she said. McKnight said that education is undergoing a transformation from a teacher-centered "sit and get" approach to a learner-centered active learning approach. An active learning approach involves a few key features, said McKnight. First, the educator seeks to personalize the learning so it is challenging and relevant to the student's interests. Personalizing learning materials so they are challenging but not overwhelming is called targeting the "zone of proximal development." Educating a classroom full of students using the zone of proximal development is nearly "impossible to do without technology," said McKnight.

The second feature of active learning is enabling personal choice and control of the learner. Rather than instructing the student, the teacher facilitates his or her learning through an inquiry-driven approach that follows the student's interests. Third, using multiple pathways to knowledge is essential to active learning; the teacher uses various sources of information and different methods of learning, rather than simply covering material in a textbook. Fourth, active learning requires that students be enabled and encouraged to be responsible for their own learning and to learn the answers to the questions that interest them. The fifth and final feature involves an active learning approach using collaborative learning. Humans are social beings, said McKnight, and learning is a social enterprise.

McKnight told workshop participants about a study she and her colleagues performed in seven K–12 school districts that were "known for pushing the envelope in terms of integrating technology into learning" (McKnight et al., 2016). The researchers observed classrooms, talked with teachers and students, and reviewed lesson plans to see how teachers were leveraging technology to enhance learning. The study found that integrating technology affected five domains: access, communication and feedback, teacher time, teacher and student roles, and purpose and audience for student work. These changes, in turn, increased student engagement and deepened and improved student learning (see Figure 2-1).

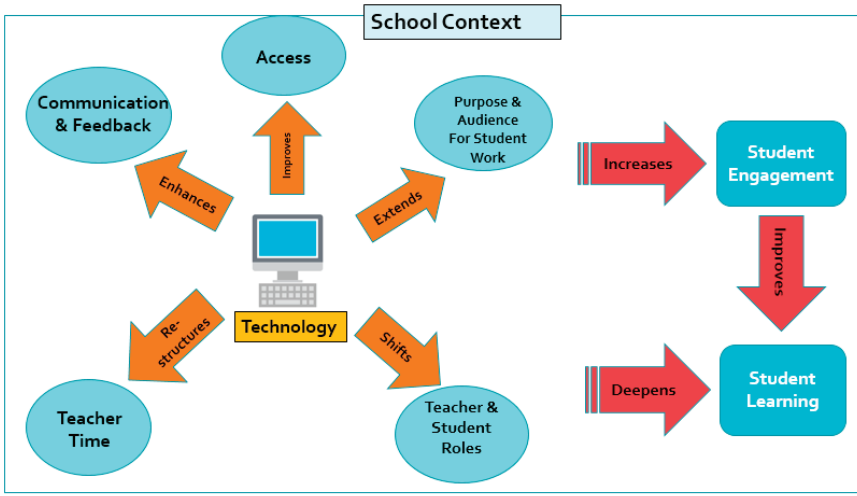

FIGURE 2-1 How technology affects K–12 education.
SOURCES: Presented by McKnight, November 16, 2017. Reprinted with permission of Taylor & Francis Ltd. (McKnight, 2016).

McKnight discussed each of these domains and the effect that technology had on them. First, students had improved access to a wider variety of educational resources, and they could select video, reading, and other materials that were interesting and appropriate for the individual student. McKnight said that textbooks tend to be outdated by the time they are printed—particularly in the fields of science and technology—and that using other resources provides a richer and deeper array of information. Students who have unique challenges in learning are able to use technology to find accessible material. For example, a student who struggles with reading—and therefore cannot read the science assignment—can use a technology that will read the text to them so they can learn the material.

Communication and feedback were also improved by technology, said McKnight. Technology allows students and teachers to communicate with anyone at any time; for example, students in a rural area can "beam in" a teacher from across the world to teach subjects they would not normally have access to. In addition, technology enables immediate feedback to students, which is "critical for learners," said McKnight. Online quizzes, assessments, and feedback-oriented tasks allows students to immediately discover and disabuse misconceptions or misunderstandings as well as track their learning progress.

The integration of technology into education helped teachers use their

time more efficiently. Teachers used technology to keep track of students' absences, to monitor their progress on homework, and to provide immediate feedback. The time this freed up could be used for planning, integrating technology, and instructional time. McKnight said that one of the best predictors of quality learning is the proportion of classroom time spent on instruction; using technology to allow for more instructional time is an enormous benefit to students.

The study found that technology was being used to extend the audience and the relevance and authenticity of the students' learning tasks. McKnight said that teachers and students were using technology to share student work with others, and that this sharing encouraged students to take ownership of their learning. For example, students who wrote blog posts and discovered that people around the world were reading the posts became invested in checking their spelling and grammar and in writing material that would interest others. This type of ownership and engagement is "foundational for learning," said McKnight.

Finally, technology facilitated a restructuring of teacher and student roles, in which students shifted from passive to active learners and teachers shifted from the "sage on the stage" to the "guide on the side." The "flipped classroom" model for education serves as a good example of this shift in teacher and student roles, allowing students to drive their own education, while teachers teach students *how* to learn, rather than simply conveying information. McKnight said that this is an area in which technology can be the "biggest game changer," although she noted that the role change can be difficult for some teachers to accept.

In response to a question from the audience, McKnight emphasized that integration of technology into the classroom does not mean that K–12 teachers are teaching students *how* to use technology—in fact, she noted that students are likely to know more about technology than their teachers. Rather, teachers are using the technology in order to further the general aims of education. Aligning the capabilities of the technology with what students are expected to know and be able to do is "the Holy Grail," McKnight concluded.

TECHNOLOGY IN HIGHER EDUCATION

Siemens started with a story about when Red River College in Winnipeg, Manitoba, brought laptops into the classroom in the late 1990s. Siemens said that the switch had very little effect on teaching—professors simply put old transparencies into PowerPoint, but those same computers changed the students' experience dramatically. Students used the laptops to message with each other, and used messaging to discuss the answers to online tests. This experience demonstrated to Siemens that technology has an uneven

effect on a population, based on their existing expertise and comfort with technology and their intent of how to use the technology. Since that time, Siemens has focused his research on the question: "How do technologies influence how we create networks, and develop and share knowledge?"

In recent years, there has been a fundamental shift in the population of health professions students, said Siemens, and this shift has affected how technology is used in education. Students are not a homogenous group—a student may be a recently graduated 18-year-old, a health professional with a long career who is returning to learn new skills, or a professional from another field who is changing course mid-career. Students come from all around the world, and the average entrance age is increasing (OECD, 2013). Many students and faculty are now digital natives, who are comfortable with and accustomed to using technology in every aspect of their lives. Owing in part to these changes, higher education is moving away from the traditional didactic model (see Figure 2-2) into a more complex and interconnected model of learning (see Figure 2-3).

There is increasing emphasis on self-regulated, self-selected, and self-directed learning, said Siemens, and on the use of social media, massive open online courses (MOOCs), and community knowledge spaces. Students and faculty are growing more comfortable with online and distance learning. Siemens said that nearly half of professors have taught online courses, and as the percentage of professors teaching online rises, so does the percentage of professors who believe that online outcomes can be at least as good as face-to-face learning (Inside Higher Ed, 2017). However, Siemens also noted a need for faculty to be trained on how to teach and interact in the digital

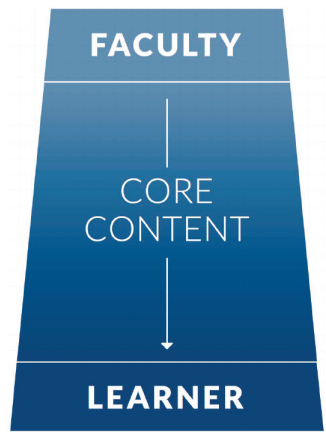

FIGURE 2-2 Traditional model of education.
SOURCE: Presented by Siemens, November 16, 2017.

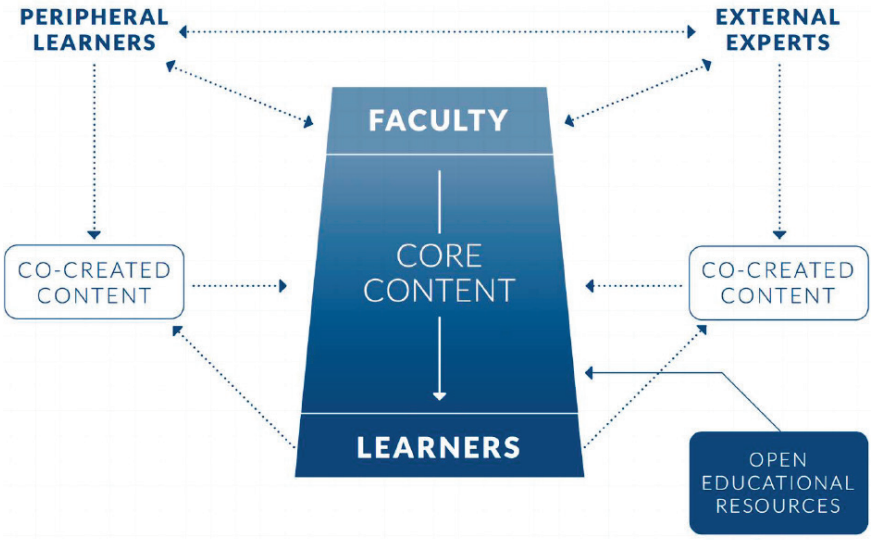

FIGURE 2-3 New interconnected model of education.
SOURCE: Presented by Siemens, November 16, 2017.

environment, and he commented on the lack of digital pedagogical models to draw on. Courses cannot seamlessly be shifted from in person to digital without an investment of resources to design the course appropriately.

Students and professionals are accustomed to taking ownership of their education by seeking out TED Talks, MOOCs, and other self-directed learning, said Siemens. For example, 59 percent of employed data scientists have learned skills on their own or via a MOOC, in addition to or instead of taking traditional classes (Jansen and Konings, 2017). These shifts have resulted in faculty becoming "a node among an overall knowledge network" rather than the sole source of knowledge, said Siemens. As part of this change, faculty need to be prepared for a role change; when professors are no longer the sole source of information, they must be prepared to serve as facilitators, collaborators, and communicators.

Another way in which technology has affected health professions education, said Siemens, is the advent of technology that can perform tasks better than humans. For example, it has been shown that artificial intelligence systems can more accurately and consistently diagnose the presence of cancerous tissue in a mammogram than a human being (Bahl et al., 2018). If this is the case, asked Siemens, why should universities be teaching students how to perform these types of tasks? It is ineffective to bring up to scale through humans what should be brought up to scale through technology or vice versa. Instead, technology can help free up humans to do what they

do best. For example, humans have the capacity for combinatorial creativity, focusing on collaboratively developing knowledge and understanding the implications of connections. Siemens said that his organization, along with Smart Sparrow and Arizona State University, are working together to change science instruction away from a model of learning facts toward a model of learning as a system of exploration, relationship building, and creativity. This type of approach, said Siemens, can help to break down the silos within science and health care, and to improve the ability to answer questions and solve problems by connecting people and knowledge from multiple disciplines and fields of thought.

Moving forward in this new world of online learning, personalized education, and interconnected and creative problem solving will require overcoming some challenges, said Siemens. First, educational institutions need to understand the diverse and complex student population, and what their needs, interests, and aptitudes are. Second, institutions need to provide scaffolded support for students, and design curricula in a way that supports learners in their individual journeys. Siemens noted that certain groups may be in particular need of assistance. For example, adding technology and digital learning to education may negatively affect students of lower socioeconomic status because they may not have access to or know how to use certain technologies, and they may lack access to a social network that can help them. Third, systematic integration among technology, education, and health care systems is needed in order to move forward in a meaningful and sustainable way. Fourth, said Siemens, there are the inevitable technological limitations. Particularly in a global context, many people lack access to technologies or fast Internet. However, Siemens said, "We should not lower our expectations of what is possible because there are some technology limitations." To demonstrate this point, he gave an example of people who have been displaced and are living in refugee camps using social media and MOOCs to further their education.

TECHNOLOGY TO DIFFUSE KNOWLEDGE

Before speaking about using technology for knowledge diffusion, Casserly emphasized that the most important aspect of technology is that it is focused on the needs of the user. Whether the technology is used for education, knowledge diffusion, or health care practice, a user-centered design helps ensure the technology meets a need and gets adopted. Casserly noted that many devices and technologies are developed that only work effectively for a small percentage of the population. She specifically urged participants to think about the needs of populations in different parts of the world when developing new ideas.

Casserly said that knowledge has often been "recreated again and

again," particularly in the pre-Internet era. Instead, Casserly said the focus should be on sharing information and building on knowledge that already exists: "If we share, we all gain." There are limited time and resources, she said, and these should be spent distributing and teaching the knowledge rather than recreating content. In addition, resources and knowledge are often locked "behind walls"—there are fee structures and permissions required to access information, which creates barriers to learning rather than facilitating diffusion of ideas. A key goal of health professions education should be to promote innovation and collaboration—two things that cannot be accomplished when knowledge is "locked up."

One way to share knowledge is through open educational resources and Casserly gave workshop participants an overview of this topic. Open resources, said Casserly, are content that have free and unfettered access, and free copyright permissions. This permits people to access, use, adapt, and redistribute content—including teaching, learning, and research materials—at no cost. Open resources can either be in the public domain or be available through an open license. Open licensing—such as Creative Commons—allows creators of content to share their work on their own terms, with attribution. For example, a creator may allow users to adapt the content and redistribute it, but may not allow commercial use. This type of licensing is available for both individuals and institutions and allows content to be translated and reproduced.

Casserly highlighted two platforms as exemplars for knowledge distribution. One is called EdCast, a Silicon Valley startup that focuses on facilitating peer-to-peer learning and personalized education. EdCast has designed its product to be accessible on mobile phones, since many people have smartphones but may not have access to a computer. Another platform is called Osmosis, which was created to spread health information around the globe. Osmosis offers open access to nearly 500 videos on various health topics, including schizophrenia, hepatitis, and tuberculosis. Health professionals around the world use these videos to supplement and inform their classroom learning.

Allowing open access to high-quality educational resources, said Casserly, encourages people to repurpose and reuse content to develop "creative and innovative solutions." This type of innovation demonstrates the "power of the Web that we should all be harnessing." Casserly concluded with a few principles of success regarding technology and knowledge diffusion. First, content should be free and open so resources can be used to innovate and collaborate, rather than to recreate content. Second, designs should be inclusive and user centered, considering the user's situation, opportunities, and constraints. Third, technologies should harness the power of the community and encourage collaboration and peer-to-peer learning and sharing.

DISCUSSION

Preparing Faculty for New Roles

Drawing on both McKnight and Siemens's comments about how integrating technology into education can result in a shifting of teachers' and students' roles, Loretta Nunez asked how faculty can learn the new roles and the new competencies that will be required. She noted that particularly in higher education, professors have traditionally been hired based on their content knowledge, which may not be as important under a new system. McKnight concurred, saying that the incentive structures in higher education reward content knowledge and research ability, rather than teaching skill. Shifting these incentives at an institutional as well as individual level will be necessary to ensure that faculty are prepared to inhabit their new roles. In K–12 schools, teachers are largely incentivized based on student test scores. While this is not a perfect measure, test scores do convey some evaluation of what a student has learned. Eventually, she said, professors should also be evaluated based on what students have learned and what they can do, but it is unclear how higher education will accomplish this. McKnight identified methods that could potentially help teachers learn how to educate based on evidence. For example, the science of e-learning looks at how people learn in a virtual environment. It could be applied along with dual channel learning theory—use of multiple senses for maximizing learning—to improve education and student engagement in the learning process.

George Thibault, a forum member and president of the Josiah Macy Jr. Foundation, said, "When we think about faculty development in this domain, we often think about teaching the faculty about the technology and how to use it." However, he said, when technological innovations mean that the primary goal of faculty is no longer transmitting knowledge, faculty development can take an entirely different course. Faculty can focus on developing high-quality assessments and ensuring that learners are comprehending and developing new skills. Ruth Nemire added that in this new world, the "human values" are really what is going to be valued in faculty, including teaching, critical thinking, and problem solving.

Ensuring Competencies in Learner-Based Education

Patricia Hinton Walker, forum representative of the Uniformed Services University of the Health Sciences, asked McKnight how competencies and progression can be assessed in a learner-driven education model. McKnight responded that in order to assess competency, we need to understand exactly what mastery of the content looks like: What does the learner need to know and be able to do? Once this is understood, learning trajectories are

mapped out, with smaller competency markers along the way. She said that using this competency-based system means that instead of students passing or failing a specific grade level, students are assessed on whether they have mastered a specific content area (e.g., algebra), whether they do so in 4th grade or 10th grade. This system harkens back to the "one-room school house where every kid was learning their own content at their own pace." Once a student has mastered the knowledge, skills, and abilities, they move on. The difficulty comes in defining these competencies and trajectories, said McKnight. In some content areas—math and reading—these competencies are well-defined, whereas in other parts of education like science and the arts, it is more of a challenge.

Economic Implications of Open Access

Hinton Walker asked panelists about the economic implications of open access. She noted that institutions must somehow generate money in order to pay faculty, and wondered how providing free access to content affects this reality. Siemens responded that he believes that curriculum should not be a value point. If a lecture can be recorded and shared digitally with thousands of people, the ease of duplication "eliminates the opportunity for economic resources to be generated." Siemens reiterated his earlier point about using technology to let humans do what humans do best, and said that if content can be learned via free and open digital access to lectures—instead of lectures being viewed as income generation—it opens up the opportunity for classroom time to be used for engaging dialogue and discussion. MOOCs, such as the Massachusetts Institute of Technology's open courses, have demonstrated that content does not have to be a value point for a university. Furthermore, Siemens believes that content that is developed using public funds should be free to access. It is "ludicrous" that public funds are used to create knowledge (e.g., taxpayer-funded research) that is then given to a journal and sold back to the public at a cost. Bringing a global perspective into the conversation, Siemens noted that most higher education institutions in the world do not use the same economic models that the United States and the United Kingdom use, and therefore do not face the same economic pressures to generate income from content.

Casserly agreed with Siemens that content should not be seen as a source of income, and said that platforms such as Osmosis use value-added services to pay for the cost of providing open access to content. For example, students can pay for a content deck that is personalized for the student's needs and sent directly to their mobile phone. Casserly added that "the unique value proposition of higher education" is not content, but interaction, synergy, and collaboration. Making content freely available furthers these aims of education. The model of open access can also affect

the traditional model of "publish or perish" tenure decisions, said one workshop participant. Casserly responded that she has seen a recent shift in norms in academic institutions; institutions are beginning to recognize the "power of knowledge diffusion as part of their mission" and are changing incentive structures to allow faculty's open access work to be considered as part of the promotion and tenure process. The economic model of the future for academic institutions, said Casserly, is in flux and will likely be quite different in the future. She said that institutions increasingly serve a wide variety of students, and serve students over the life of their careers, so the economic model may need to be more flexible and more differentiated than it is currently.

Crowdsourcing

Brenda Zierler, a forum member representing the American Academy of Nursing, asked panel members about the use of crowdsourcing to develop and assess knowledge and create content. Siemens responded that in his opinion, crowdsourcing can play different roles in different settings. He said that creation of content and curriculum is best done with an expert-oriented approach, whereas crowdsourcing can be quite useful for solving problems. Siemens relayed his concerns about the "diminishment of the idea of expertise" in society, where "all opinions are equal and all opinions are valid." While crowdsourcing is valuable, he said that it is not a solution to all problems, particularly knowledge creation. Casserly added that when expert-created content is made open, it provides the opportunity for other experts to build on the content—in effect, crowdsourcing by experts.

Christoph Pimmer, senior researcher and lecturer at the University of Applied Sciences and Arts in Northwestern Switzerland, relayed his experience in rural African communities (see Chapter 3) and said that the local health workers used crowdsourcing principles to solve patient-oriented problems, particularly complex cases, in that they consulted larger groups of colleagues by using mobile social media. By connecting health workers, this kind of crowdsourcing can work very well. However, he said, the results of crowdsourcing "can only be as good as the crowd being sourced." There is a danger for misinformation and rumors to spread in this environment, so ensuring that participants are educated—and perhaps moderated by experienced professionals—is critical to success.

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3

Bridging the Education-to-Practice Gap

Highlights

- Using technology to teach health professions in rural communities allows students to learn within the context of a real-world environment. (Worley)
- Mobile social media can be an effective tool to better connect rural health care providers and to facilitate knowledge sharing in settings that are marked by poor access to knowledge resources, professional isolation, and attrition. (Pimmer)
- Busy health care professionals want trainings that are fast, fun, and interactive; technology can be used to provide these types of trainings. (Walker)

Leveraging existing technologies, as discussed in Chapter 2, is one element in the transformation of health professions systems. Specifically, the gap between education and practice can be addressed by means of digital media. Pimmer introduced the session by describing the education-to-practice gap and the variety of forms it takes. He said there are three main situations in which the gap is most evident: in placements during school, in the first job after graduation, and in the training-practice transfer of continued professional education and training. Students who are experiencing the workplace for the first time often learn that what they were taught in the classroom does not correlate well with the realities of the practice setting.

They may find their education has not prepared them appropriately for the work they are expected to do and may need extra support to stay engaged. The first 6 to 9 months are a particularly "critical phase" that affects the professional development, retention, and career success of young health professionals. In addition, the third gap exists where health professionals find that their continuing professional development training does not translate into day-to-day practice (see Figure 3-1).

This chapter covers three different uses of technology, used at three different stages of a health professional's career. First, Paul Worley, National Rural Health Commissioner for Australia, talked about how Flinders University has used technology to support and train health professions students in remote and rural areas of Australia. By training students in these real-world environments, students become aware of the challenges, are better integrated into communities, and are better prepared to practice once they graduate. Second, Pimmer addressed the challenge that health care providers face when first entering practice in rural and underserved areas, and how social media can be used to support and empower such providers. Third, Cynthia Walker, vice president at Medtronic, discussed the use of two technologies—augmented reality and interactive video—to engage, immerse, and train practicing health care providers on new procedures.

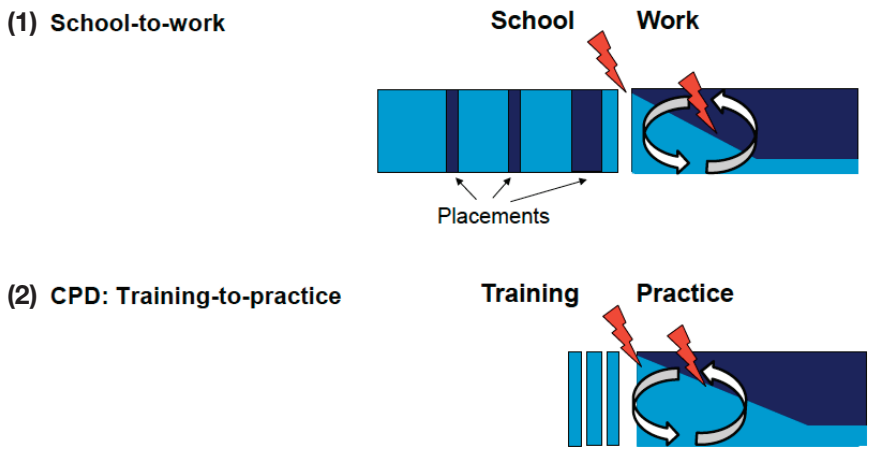

FIGURE 3-1 The education-to-practice gap: two phases.
NOTE: CPD = continuing professional development.
SOURCE: Presented by Pimmer, November 17, 2017.

BRIDGING THE GAP THROUGH EDUCATION IN RURAL COMMUNITIES

Paul Worley, former dean of medicine at Flinders University and now National Rural Health Commissioner for Australia, spoke to participants about his work in Australia on bridging the education-to-practice gap. Worley painted a picture of the challenges facing Flinders University medical school in 1997: the area it served was a landmass four times the size of Texas with only 2 million people, there were severe doctor shortages outside the capital city, and life expectancy was similar to sub-Saharan Africa in some areas. Worley said that improving this situation required engaging in teaching and research in the underresourced regions, recruiting students from these areas, sending students to work in regions with low human health resources, and establishing a flourishing academic culture in the health sector. However, the full academic infrastructure of the university could not be replicated in each small town, so a solution involving distance learning was needed, said Worley. The Flinders University department that focuses on distance learning existed long before smartphones, widespread Internet access, or video conferencing. Instead, at first they used low-tech approaches such as photocopies, faxes, and videotapes to reach students. The distance learning program began with students in a small geographic region, fairly close to the capital city of Adelaide, but it eventually spread over the entire 3,000 miles between Adelaide and Darwin.

Worley said that this distance learning program was enormously successful in a number of ways. They found that clinicians in the rural communities where students were learning were using the equipment and information for their own education and clinical purposes, thus multiplying the effect of the program. Students "had profound academic outcomes as a result of learning in context" of these rural communities. Students were enabled to live in rural communities while studying, and often chose to remain in these communities as primary care rural practitioners after graduation. While some students chose other specialties, the rural and remote learning students were 17 times more likely to choose rural practice compared to students who learned in cities. Using technology to connect these students to the resources of the university allowed students to stay in the communities long enough to understand the issues and believe they can make a difference. Finally, the students studying in these rural communities are valuable to patients as part of the health care team. Worley emphasized that this model is not "medical tourism" but is "actual, real work" that benefits the community and patients while also delivering education in rural and remote areas.

One of the benefits of distance learning, said Worley, is the ability to scale up clinical education by enabling clinical venues to become educational venues. It has also opened up a career pathway for rural clinicians by allowing

them to be part of the academic team. For example, the director of their medical program works 3,000 kilometers from the main campus. The program is somewhat of a reinvention of an apprenticeship program, said Worley, allowing rural practitioners to become teachers, and allowing students to learn in the context of day-to-day practice. Using technology as an adjunct to the apprenticeship model, said Worley, ensures that students are able to access accurate information and can be evaluated on their knowledge and skills.

This distance learning approach will become increasingly necessary as the global requirement for health workers increases, said Worley. Some estimate that the world will need 18 million more health workers by 2030 (*BMJ*, 2016). "We can't train all of those people in the large quaternary hospitals in our major cities," he said. Students will have to be trained in rural and underserved areas because those are the areas that lack health professionals, and we need technology-enabled education in order to link these students to resources and information. Worley told participants about a book called *Longitudinal Integrated Clerkships: Principles, Outcomes, Practical Tools, and Future Directions* (Poncelet and Hirsh, 2016). The final chapter envisions a future system in which communities and health services are the drivers behind health professions education. Universities are seen as a partner and an adjunct, but they are partnered with local health organizations to build a grassroots, community-based approach to education.

DISCUSSION

Cox asked Worley for his perspective on how to spread this type of educational model throughout an entire country, noting the establishment of several similar regional programs in the United States. Worley responded that in his view, this model has to be driven by communities. He said that in 1997, he was a rural doctor living in a rural community and saw the need for a new model of medical education. He worked within his community to lobby for the money and resources to start the program, and it has now expanded across Australia. Twenty-five percent of medical students in Australia now undertake at least 1 year in a rural, regional, or remote community using technology to facilitate this experience, said Worley.

Julianne Sebastian asked Worley to comment on the state of today's technology, and whether it is adequate to meet the needs of these types of programs. "I don't believe that technology is limiting us right now," said Worley. "I think we have the technology. We don't have the will." Worley explained that there are structural forces and institutional inertia that are maintaining the status quo in education and health service delivery. There are, of course, issues with bandwidth or access to technology; people in rural areas may not have the bandwidth to support high data synchronous communication. However, Worley said, these issues do not necessarily

present a barrier. The Flinders distance learning program began with low-tech asynchronous communication, he said, and texting—a low-bandwidth asynchronous form of communication—is far more popular than FaceTime. Worley noted that while students in rural areas with low bandwidth may not be able to interact in real time with experts at the university, they have found that there is a great deal of expertise outside the university that students can take advantage of.

Laura Magaña Valladares, a forum member from the Association of Schools and Programs of Public Health, asked if this model could be expanded to include other health professions and to educate people as part of an interprofessional team. Worley said that a major barrier to this is that most health professions students have to be supervised by a member of the same profession (e.g., a speech therapy student has to be supervised by a speech therapist). In most of these rural areas, there are few if any specialists to serve as supervisors. This is an example of the institutional inertia that has to be overcome in order to expand this model further, said Worley. Worley did note that despite these barriers, students studying in rural areas are finding ways to get together with students of other disciplines and to solve problems together. "Rural and remote practice is a team sport," said Worley, and students are empowered to make these connections and build the interprofessional education they need.

Following up on this discussion about a lack of specialists in rural areas, Thibault asked Worley how the medical college works to produce and support medical specialists to serve in rural areas. Worley said that while 60 to 70 percent of medical students in the program go into primary care, the remaining 30 percent go into specialties such as surgery, obstetrics, and psychiatry. Working through the colleges and their accreditation systems, these students are encouraged to be "generalists" within specialties, said Worley, meaning that while they specialize in one area, they have broad knowledge about a range of issues within their specialty and can meet the needs of many different types of patients. For example, a surgeon working in a rural area will not specialize in one type of surgery, but will be a general surgeon able to perform many types of surgery. These specialists will spend some of their time training in the large urban hospitals, but like their primary care colleagues, will spend the majority of their time training in the rural and remote areas, enabled by technology.

BRIDGING THE GAP THROUGH SOCIAL MEDIA

Pimmer told workshop participants about efforts to use mobile social media to support new health care workers in parts of the world that are underserved by traditional professional networks. Pimmer said that two of the educational key challenges in these regions are that health care work-

ers have little access to up-to-date information, and they often work in professional isolation. For example, community health workers frequently work alone in their communities and have limited connections with other health workers or their supervisors, even in the first few months after training, which are a "particularly critical phase" (see Figure 3-2). This situation restricts the workers' opportunities for professional development and professional satisfaction, and it can result in attrition if workers are not supported. Because social media is already in the hands of many of these workers, it can be used for educating, training, connecting, managing, and supervising health workers and professionals, Pimmer said.

The research that Pimmer described analyzed the use of WhatsApp (a popular messaging app) to improve knowledge and skills and professional connectedness of nurses in rural communities in Nigeria, South Africa, and Zambia. The findings suggest that the informal use of this instant messaging platform alone was associated with higher levels of professional social capital, the development of a professional identity, and with reduced feelings of isolation from professional communities (Pimmer et al., 2018).

Specifically, the intervention sought to give nurses access to knowledge resources and to create and strengthen professional networks. To do so, WhatsApp groups were created with newly trained nurses; the group held moderated peer-to-peer discussions, including the circulation and discussion

FIGURE 3-2 Professional isolation of health care providers.
SOURCE: Presented by Pimmer, November 16, 2017.

of relevant clinical knowledge. In addition, the intervention sought to spark discussions and reflections among the nurses about their professional journeys, including successful moments as well as hardships. The interventions were maintained for 6 months. Pimmer said that preliminary findings show use of the WhatsApp interventions resulted in higher levels of knowledge and fewer feelings of professional isolation compared with the control group. One interesting finding, said Pimmer, was that participants who were active contributors to the group (versus passive "readers") were more strongly and positively affected by the intervention. This has significant implications regarding the moderation of the group, which needs to be activating and make participants share their own experience. Pimmer noted the major advantage to this type of intervention is most health care workers, particularly nurses, already have smartphones or advanced phone features and are comfortable with these types of apps. While social media apps may not be the gold standard for education, the fact that many health workers already have access makes the intervention scalable and sustainable.

In addition to small and bounded groups, Pimmer also gave an example of the use of a massive social media environment, which served as a rich reservoir for learning and professional development: a Facebook site for medical students and professionals that has more than 90,000 followers from across different Asian countries including India and Nepal (Medical Profession, 2018). The members of this Facebook group share learning resources and information, such as quiz questions and minicases, and hold discussions about professional roles, norms, and values. Interestingly the group is not tied to any institution, but is a bottom-up effort that is maintained by a local doctor (Pimmer et al., 2012).

One downside to social media, said Pimmer, is that it can be a vehicle for spreading disinformation and rumors. Pimmer said that fostering a sense of "digital professionalism" among health professionals would help mitigate this problem (Pimmer and Tulenko, 2016). He noted that his organization is working on developing resources for digital professionalism, but he is not aware of any existing framework in the domain of health professional education for this purpose. Based on his experience and research, Pimmer concluded social media interventions for health care professionals should use peer moderators who are close to the participants; should encourage active participation through games, contests, or quizzes; and should personalize the intervention by facilitating personal reflection and learning.

BRIDGING THE GAP THROUGH PROVIDER TRAINING

Walker presented to workshop participants about using technology to teach health professionals how to implant and program devices that Medtronic manufactures, such as implantable pacemakers. This type of

training is an adjunct to the training that providers receive in education and their fellowships. As the devices evolve over time, the providers have the opportunity to receive further training.

The motivation for developing this training, said Walker, came from several challenges that were identified. First, said Walker, moving into emerging global markets requires a different training model than what is used in the United States. Walker said that in the United States, there are around 1,600 technically trained Medtronic employees to support and educate providers. In countries like China and India, they have only a handful of people to support a large number of providers. Technology is the "only answer" to providing globally consistent quality training and support in these countries, she said. Another challenge, said Walker, is that professional education is largely voluntary, and professionals are incredibly busy. Finally, modern learners are visual, impatient, and social, said Walker. They want training opportunities that are fun, fast, and that can be accessed anytime and anywhere. With these challenges in mind, Medtronic sought to create training programs that were so engaging and fun that the program would grow by word of mouth.

Walker discussed two types of technology that Medtronic employs: augmented reality and interactive video. Virtual reality, said Walker, is an entirely digital representation of an object, the environment, or the world. Augmented reality, in comparison, adds a digital layer to the existing, real world. Medtronic worked with CAE Healthcare to come up with a training solution to offer simultaneous training to numerous learners using their Microsoft Hololens platform (CAE Healthcare, 2018). This augmented reality headset program offers a 3-D image so learners can see how and where to implant a small leadless pacemaker device through the groin. Surgical implanters in training use online modules to learn about the procedure, then can use the augmented reality simulator to "practice" implanting the pacemaker (see Figure 3-3). The simulator allows the provider to actually feel the heartbeat and feel the "tug" of the implanted device, said Walker. Cox asked Walker to explain how Medtronic assesses the competency of the providers that have been trained. Walker responded that Medtronic requires providers to have certain basic skills before being trained. She noted that because the industry is not responsible for credentialing, it is "up to the hospitals" to decide how and whether to allow the provider to perform the procedure. In response to a question from the audience, Walker noted that many procedures require a team approach, and that Medtronic seeks to train the entire team together.

The other technology that Medtronic uses, said Walker, is interactive video. She noted that people watch a lot of video—more than 1 billion users watch 1 billion hours of YouTube videos every day (YouTube, 2018).

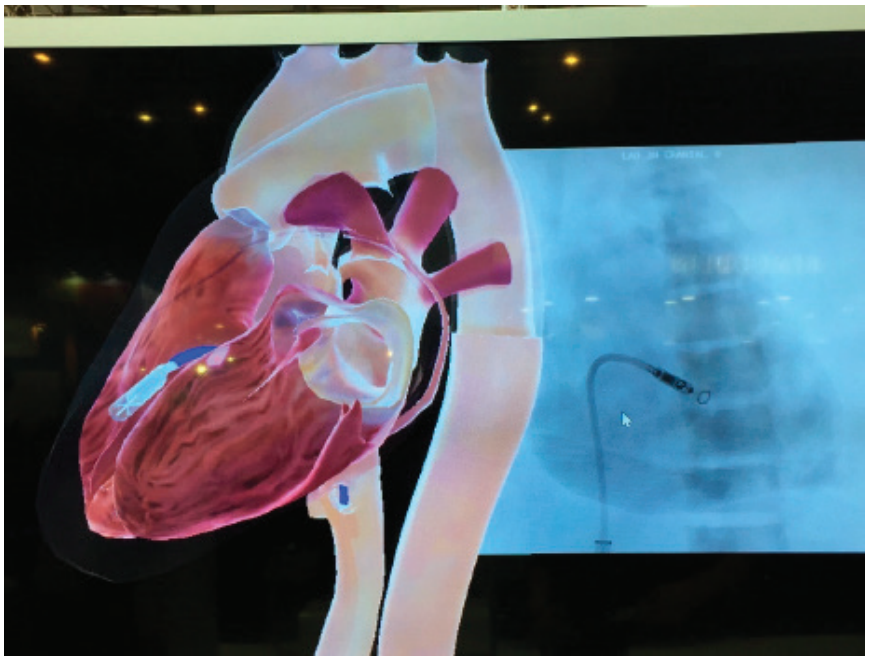

FIGURE 3-3 Augmented reality pacemaker training.
SOURCE: Presented by Walker, November 16, 2017. With permission from Jay Reid.

However, video is usually a passive experience and not an ideal way to engage and teach learners. Interactive video engages viewers in the content by allowing them to choose the topics, drive the storyline, and decide how they want to learn. Walker pointed out that many Medtronic videos are interactive and require the viewer to be involved by making decisions, taking quizzes, and providing feedback. This type of active learning engages the learner in the educational process and improves retention.

Walker acknowledged that integrating high-tech tools into training is expensive; however, for Medtronic, it would be cost prohibitive to *not* use technology when doing trainings in both developed and emerging markets. Not only does the use of technology in training allow Medtronic to reach more people, but standardizing the curriculum on a global scale reduces inefficiencies and saves money in the long term, said Walker.

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4

Technology in Research

Highlights

- Virtual reality reduces the traditional trade-off between conducting research in a realistic environment and having control over the variables in research. (Persky)
- Virtual reality games are engaging for participants and allow researchers to collect detailed information that would not be possible with traditional tools. (Song)
- Using simulations to train health professionals can save money and time, allowing trainings to be held more often. (Cid)

Another area that technology has the capacity to dramatically improve the status quo is in research. Researchers are using technologies such as virtual reality to study and explore areas as diverse as childhood obesity, motor skill training, and disaster response. Some of the tools developed for research may be suited for translation into health care practice; these technologies can help bridge the research-to-practice divide. In this session, three researchers—Susan Persky, Sunbin Song, and Victor Cid—spoke about their efforts to use technology in research and how these projects may translate into practice.

THE IMMERSIVE VIRTUAL ENVIRONMENT TESTING AREA

The Immersive Virtual Environment Testing Area at the National Institutes of Health (NIH), directed by Susan Persky, is a research facility with the primary goal of helping researchers integrate technology into their research programs. Persky said the program has existed for over a decade, and there is an emphasis on using technology to further research aims, not merely for the sake of technology itself. Persky told workshop participants about several advantages to using virtual reality in research.

First, virtual reality "reduces the trade-off between control and realism," said Persky. For example, in a research study that involves a participant interacting with a provider, a virtual provider can be programmed to say exactly the same things to every patient, resulting in high internal validity. At the same time, the research can take place in a realistic clinical environment. The second benefit to virtual reality is that it allows the researcher to simulate complex or impossible scenarios; for example, a virtual provider or patient can have any characteristic—a specific race, gender, weight—that is of interest to the researcher. Persky noted that a traditional way to study these characteristics is through patient vignettes that give information about the patient's race or gender. The virtual reality environment, where the characteristic is not called out explicitly, allows researchers to better study implicit biases. Third, virtual reality research provides an opportunity to collect specific behavioral measurements. Researchers can collect very granular data about what participants do and when they do it, which is difficult to collect in real-world environments, said Persky. Fourth, a virtual clinic experience is portable and distributable. Participants and researchers do not need to come to a specific place to conduct research; it can be done anytime and anywhere.

Persky gave several examples of how virtual reality can be used in research. One study sought to look at the relationship between a patient's weight and how a provider treats the patient and makes decisions for her care. Researchers used two different virtual versions of "Jennifer Taylor," who were identical in every way—including their nonverbal behavior and what they said—except for their weight (see Figure 4-1). Medical school students interacted with the patient in a controlled and realistic virtual environment, and researchers measured various parameters of interest. They found that the students made less visual contact with the obese version of the patient, and that the students believed that the obese patient was less likely to adhere to their medical advice. This suggests that "patient weight status, isolated from absolutely every other possible confound, elicits biased behavior and attitudes from physician trainees." Persky said this "is not something that you can look at in a real-world clinical environment" (Persky and Eccleston, 2011).

FIGURE 4-1 Two versions of the virtual patient "Jennifer Taylor."
SOURCE: Presented by Persky, November 17, 2017.

Another research project that used virtual reality, said Persky, looked at how obesity risk information could influence how parents feed their children. Researchers told parents about their child's risk for obesity, based on family history, and then asked parents to choose food for their children from a virtual buffet (see Figure 4-2). The buffet was a controlled and consistent environment—research participants always saw the same food every time, with no social pressures from other customers or differences in how fresh the food was. The virtual reality technology allowed researchers to measure which foods the parents selected, in what order they selected them, and the time delay in between their choices. Researchers validated the virtual buffet by comparing parents' choices in the virtual world and the real world. The study found that parents who received information about their child's specific risk of obesity put fewer calories on their food tray than the control group. In addition, parents who felt guilty about passing down a genetic risk for obesity to their child were able to reduce their guilt by choosing a healthier meal in the buffet.

Persky said that these types of research projects are being expanded to explore how manipulating the built environment (e.g., the buffet), can influence choices that people make, and to consider how other interventions or education can affect people's actions in the virtual environment. Persky told workshop participants that one of the goals of virtual reality

FIGURE 4-2 The virtual buffet.
SOURCE: Presented by Persky, November 17, 2017.

research is to generate communication strategies and approaches that can be brought into practice to help benefit patients. In addition, some of these virtual reality tools may be beneficial in educational, training, or practice settings. She noted specifically that using virtual reality to detect provider biases, such as the study with the lean and obese patient, could be a good first step to a training program that would make providers aware of their bias, educate them, and then offer tools to minimize the bias.

MOTOR SKILL TRAINING USING VIRTUAL REALITY

Sunbin Song, senior researcher with the National Institute of Neurological Disorders and Stroke, told workshop participants about using interactive and immersive virtual reality for motor skill training. Song said that motor skill training is used for rehabilitation after brain injury, such as stroke or traumatic brain injury, as well as for sports training. Song noted that there has been a lot of work done with therapies that use semivirtual reality technologies, such as Nintendo Wii. However, she said that these have generally not been shown to improve patient outcomes in multicenter clinical trials because the game learning does not generalize to real-life activities (Saposnik et al., 2016). Immersive virtual reality, on the other hand, can mimic real-life tasks of daily living. Some older immersive virtual reality systems, such as CAVE (cave automatic virtual environment), are quite expensive and not easily home based; however, immersive virtual reality is quickly becoming cheaper and easier to transport.

The traditional way of studying motor learning, said Song, is through serial response time tasks (SRTTs), in which a participant clicks buttons in response to a stimulus on a computer screen. This approach has been used for more than 40 years, and has allowed researchers to characterize many aspects of motor learning, including practice-dependent and sleep-consolidation stages, sequential learning, and visual motor binding (Song and Cohen, 2014). Researchers have been able to determine neural correlates between motor learning and structural features in the brain (Song et al., 2012, 2015). Virtual reality motor skill training is based upon these findings and years of experience, said Song.

The Virtual Reality SRTT (vrSRTT), said Song, is a mixed reality experience, in which participants use a VR headset to see a virtual ball appear in front of them. The balls are differently colored, and there is a corresponding colored hole to drop the ball into (see Figure 4-3). Using vrSRTT, researchers can collect detailed data on head movement, the trajectory that the ball travels, and speed of sorting. The program can be tailored for different needs, for example, color blind-proof colors can be used for the balls. Song said that vrSRTT has been judged by participants as much more engaging than the traditional button-pressing version of SRTT. Compared to the "gold standard" of an immersive "whack a mole" game, the ball sorting program was equally natural and immersive, though less engaging. Song said that future versions of vrSRTT will be more like a game and more engaging; engagement is essential for rehabilitation because "you

FIGURE 4-3 vrSRTT Ball Sorter v.1.0.5 demo.
SOURCE: Presented by Song, November 17, 2017.

want subjects to use" the game. Tests that compare vrSRTT with traditional SRTT have shown similar results in terms of participant learning.

Song reported a few preliminary conclusions that can be made about vrSRTT. First, subjects who are learning a task involving virtual objects show evidence of learning in the same way as they would with real-life objects. Second, virtual reality allows researchers to embed complex regularities into the ordering of the virtual objects and show learning in a way that would not be possible with a real-life environment. Third, the 3-D trajectory information that can be gleaned from vrSRTT is valuable for gaining insight into subtle aspects of sequential learning. The future of this technology, said Song, will involve integrating more detailed tracking of hand, head, and eye motion, developing a tennis version of the game, and creating a magnetic resonance imaging (MRI)-compatible version in order to study neural correlates. Song noted that creating an MRI-compatible virtual reality platform could be useful for diagnosing brain conditions such as traumatic brain injury, stroke, or Alzheimer's, which currently can be difficult to diagnose through imaging. These diagnostic tools, said Song, might be developed through using algorithms or artificial intelligence to analyze big, open datasets in order to find patterns.

VIRTUAL REALITY DISASTER TRAINING

The Disaster Information Management Research Center (DIMRC) at NIH's National Library of Medicine develops resources for disaster health preparedness, response, and recovery, said Victor Cid, senior computer scientist. One type of resource that is in development, said Cid, are simulations for training professionals in public health and disaster management. Along with collaborators, DIMRC is developing two specific projects.

The first is called Virtual Incident Command System Exercises (VIX), and it is designed to train professional staff that play roles in emergency operation centers at hospitals and other facilities. There is already an existing and widely used approach for this type of training in which participants typically gather around a table, pretend to be in a specific scenario, and role-play the various positions in the Incident Command System (ICS). However, this approach is not very engaging, said Cid, so DIMRC is leveraging technology to develop a more productive type of training. The VIX program is designed to be more engaging, realistically simulate the disaster scenario, and help participants access and use real information and communication tools as they practice their ICS roles. The use of technology will help organizations train more frequently by reducing cost and increasing the ability to have remote trainings. The VIX training simulator is like a multiplayer videogame, in which trainees gather in the simulated environment and interact with each other and the environment through

their avatars. Cid noted that DIMRC does not create and design the disaster exercise scenarios used in the simulations; rather, it collaborates with people who have already been trained to do so. VIX includes a tool to create such scenarios.

The second program in development is the Highly Infectious Disease Emergency Management (HIDEM) system. This program is designed to prepare caregivers at hospitals for an infectious disease event, and was inspired by the 2014 Ebola outbreak that resulted in several U.S. hospitals receiving patients suspected of being infected with Ebola. This program consists of a series of modules that allows caregivers to practice the main skills they will need. Modules are being developed to cover skills in donning and doffing personal protective equipment, managing waste, conducting x-ray procedures, doing lab work, and admitting procedures. The modules will allow participants to play different roles, and generally follow Centers for Disease Control and Prevention (CDC) guidelines, said Cid. For example, the doffing personal protective equipment module, which is already available, has two players, a caregiver and an observer, and the observer reads the checklist with the steps for doffing to the caregiver, who completes them with tools in the simulation. Following each step of the simulation, the participants watch a video of doffing steps and identify whether or not the step was done correctly. Afterward, the participants review any mistakes they made and receive a score.

Although these programs are still new, the preliminary results are promising. Overall, said Cid, these training programs have been well received by participants, but emergency managers tend to be "very practical" and somewhat suspicious of using computer games for training. Testing of these programs has shown higher engagement than with traditional training. Nearly 100 percent of participants would recommend adopting virtual training, and 79 percent of participants reported improvements in their preparedness attributable to the virtual training. Cid noted that using immersive virtual reality for these simulations would likely have positive benefits, but he said that barriers such as cost and user comfort need to be overcome.

DISCUSSION

While these presentations demonstrate that virtual reality is being integrated into research, Song admitted that there are several hurdles yet to be overcome to fully leverage the power of virtual reality. First, virtual reality is not being adopted quickly, owing in part to the cost as well as eye strain and simulation sickness. Second, there is a gap in knowledge; however, since virtual reality platforms can collect an enormous amount of data, knowledge about virtual reality and its application is growing rapidly.

A workshop participant asked the session speakers to comment about the research-to-practice divide, and how their work might help to bridge this divide. Persky said that some of her research projects that focus on clinical practice—such as the clinical simulator for studying weight bias—are already beginning to bridge the research-to-practice divide. In addition, she told participants about another clinical simulation that is being used to assess the efficacy of a pharmacogenetics training module. The simulation puts nurse practitioner students in a clinical situation with a patient, and examines how the student applies their classroom knowledge to patient care. Persky said these types of research will help inform education and practice, with the benefit that a virtual reality training environment allows for mistakes and learning with no harm to patients.

Song said that in her experience, technologies tend to be developed in research settings, and then are picked up by a business that develops the technology into a commercial product that can be implemented in hospitals or training centers. Song noted that researchers are not incentivized to think about the commercial or clinical application of a new technology; in fact, they are "kind of penalized." To get grant money, researchers must focus on developing new concepts, rather than practical application of technologies. Changing this incentive structure, she said, would likely require policy change. Persky agreed that most researchers are not incentivized to think about practical application, but said that she is lucky to work in a program—the Genome Institute at NIH—where thinking about translation is a top priority. This focus allows Persky to do research that can directly translate to the clinic.

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5

Applying Technology to Real-Life Problems

In this session of the workshop, there were seven quick presentations about innovative technologies and systems that are being used to train and educate health professionals and students. Each innovator gave basic information about the technology and how it worked, and then workshop participants were invited to walk around the room to ask the presenters questions and try out the technologies that they brought. Afterward, participants and presenters engaged in an open-ended discussion about issues that arose.

RAPID FIRE POSTER SESSION

Digital Clinical Experiences

Rob Kade and Benjamin Lok of Shadow Health Inc., talked about their program that simulates a clinical experience in order to allow students to learn communication skills and clinical reasoning. Lok said that health professions students are leaving school without the skills they need to communicate with patients and to think through complex patient situations. This lack of skills results in negative patient outcomes and poor communication with patients as well as other team members, he said. To remedy this situation, Shadow Health built a curriculum of virtual simulation experiences using virtual patients that are "realistic people and have a story behind them" (Shadow Health Inc., 2018). These patients have belief systems and personalities, and "challenge students to get the whole story." For example, "Rachel" is a teenager who wrecked her parents' car, and "Eric" is an adult who thinks he may be hav-

ing a heart attack. Using the technology, students act as health providers and interact with these patients; they can ask questions, do physical exams, and observe the patient. The system documents each action the student takes, and provides feedback. One patient the workshop participants interacted with was "Tina," who was having difficulty breathing (see Figure 5-1). Lok explained that as students interact with Tina, the program records everything that is said and flags places where the provider could have done something differently. The program also scores the student on both process (the questions that were asked) and outcome (whether the conclusion was correct). During the course of the interaction, Tina told the provider that her father recently died. The program flags this as a potential time for connection and empathy. Lok said he believed this program would help tackle issues such as cultural competency and patient-centered care in a safe and accessible digital world.

vSim for Nursing

vSim for Nursing is a computer simulation that focuses on clinical reasoning, critical thinking, competence, and building the confidence of nurses in training, said Jeanie Staton and Robin McCune. vSim allows students to interact with patients in a safe, realistic environment through various online nursing scenarios, and it allows learners to "make mistakes here in

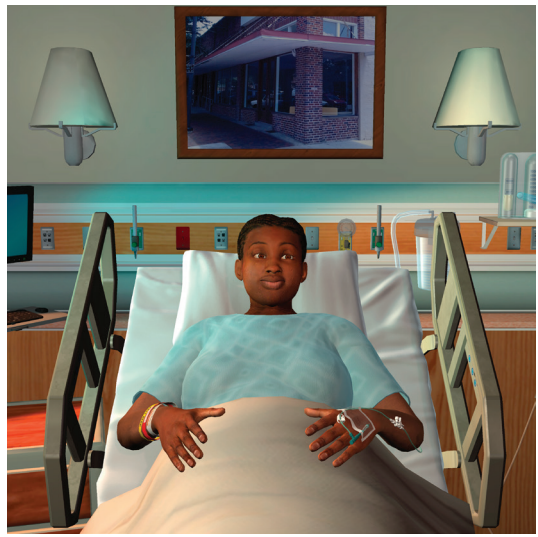

FIGURE 5-1 Clinical experience simulation patient "Tina."
SOURCE: Presented by Lok, November 16, 2017. Used with permission from Shadow Health Inc.

the virtual world instead of the real world." The simulation requires the user to click through the correct path of treatment, and each decision is recorded and measured against a validated algorithm that generates a user proficiency score. The user may go through one scenario multiple times, either to increase their proficiency score or to maintain competency in a skill set. There are currently 72 virtual nursing scenarios, said McCune, ranging from mental health to maternity. The program also includes instructor tools to assist with monitoring progress and assessing comprehension.

vSim can be used by nursing schools as well as in health care practice settings and has helped address some of the challenges in nursing education and training (Laerdal, 2018). For example, Midlands Tech in South Carolina has 400 nursing students per year, and was struggling to find clinical placements for all of their students, with some students traveling long distances to reach their designated locations. The college replaced a portion of their clinical experience with the vSim program, saving time and money while still allowing students to learn in a realistic clinical setting. Another user of the program, University of North Carolina Women's Hospital, was looking for a way that nurses could maintain their competency in high-risk, low-frequency obstetrics events. The hospital did conduct regular team training using traditional patient simulation, but these trainings were spaced out; using vSim in between these sessions allowed nurses to maintain their competency in a cost-effective and efficient way. McCune said they have seen high levels of engagement and enthusiasm from users of the technology. Students are motivated by the scoring system that demonstrates proficiency and creates a friendly competition among fellow students that drives them to continue using the program.

ReelDx

ReelDx is "focused on bringing the real patient experience to learners in their classrooms or online," said Bill Kelly. Rather than using virtual patients, ReelDx uses videos of real patient experiences in clinical and preclinical settings, primary and acute care (e.g., paramedic interactions, emergency rooms, or physician practice). There are more than 700 video cases of patients, all of which are made with strict conformance to the Health Insurance Portability and Accountability Act (HIPAA) and with fully informed patient consent (ReelDx, 2018). Kelly said that these patient cases are designed to "plug into any curriculum as case study material or to anchor problem-based learning." Professors can select cases and assign them to students in conjunction with classroom teaching. Each video comes with patient vitals and demographics, differential diagnosis, actual outcomes, and peer-reviewed standards of care. Many cases also include diagnostic elements such as ultrasound clips, X-rays, EKG, or lab results. Educators can not only choose what cases but what case details to reveal to students,

providing an opportunity for both synchronous and asynchronous learning activities. These video-based real patient cases can be used for a wide variety of purposes, said Kelly, from elucidating classroom discussion to full integration in simulation labs. The videos are "learning objects that can be leveraged in the course of whatever instructional model you are using," he added.

Filament Games

Filament Games is a design and development studio that "focuses exclusively on learning games and games for positive impact," said Dan Norton. The studio has developed more than 100 game-based training projects over the past 11 years, but the move into health training is fairly new (Filament Games, 2018). One recently designed health project is a game called Saving Lives that trains users to do cardiopulmonary resuscitation (CPR). Norton said that in the course of developing Saving Lives, they grappled with several challenges that affect many game-based health trainings. One specific challenge was ensuring the right balance between simulation fidelity and an effective learning experience. Norton said that in order for a game to simulate the reality of CPR, some patients should die in the simulation no matter how well the user performs the intervention. However, from a games perspective, the game should have feedback that rewards performance metrics—that is, if a user does everything right, he or she should be rewarded with the patient not dying. Getting the balance right is essential to making a game that is useful for participants but also keeps them engaged, Norton concluded.

Knowledge Acquisition and Testing System

Andrea Parodi said the Knowledge Acquisition and Testing System (KATS) was requested by the U.S. Department of Defense (DoD) and stemmed from a concern about how DoD could assess whether health professionals were ready for deployment. This included understanding trauma care while demonstrating an ability to perform adeptly during emergency situations. To accomplish this, Parodi described developing an educational, game-based program that would not be an administrative burden to the trainer who is frequently faced with inadequate staffing. The process uses computer automation and begins with a stand-alone module for learners to gain knowledge and speed for mastering a skill. As soon as the learner demonstrates competency, his or her results are automatically transferred to a storage cloud for future reference. With automation, instructors are not burdened with large amounts of time-consuming administrative duties.

The next stage of training requires the learner to become the teacher in what Parodi termed a *skill rodeo*. He or she must be able to teach the instructor before moving into the next phase of the instruction where the

individual learner becomes part of a team. This is a critical phase of the training where learners are graded on their ability to incorporate components of teamwork and safety into their skill sets.

PeriopSim

Angela Robert told workshop participants about her application that trains operating room nurses in hospitals. Today, said Robert, operating room nurses are trained on the job; this application allows them to train and practice in a virtual world before getting "scrubbed in" to surgery. The training program includes an iPad app as well as a virtual reality application that has many game-like attributes (PeriopSim, 2018). This program stemmed from discussions with surgeons who said that the best operating room nurses are the ones that "hand us something before we ask for it." When a nurse is tuned into what is happening in the surgery and anticipates the surgeon's needs, it allows the surgeon to focus on the patient and enables a shorter procedure, said Robert. PeriopSim was developed by talking to more than 1,000 nurses, identifying the problems that needed to be solved, and then building the app around these needs. Users of PeriopSim don a virtual reality headset that shows an operating room (see Figure 5-2); users can train on the app to learn about various instruments and to practice procedures step by step. Robert said that nurses learning with PeriopSim show the same outcomes as nurses learning in real life, but PeriopSim is more time efficient and uses fewer resources.

FIGURE 5-2 Forum member, Frank Ascione, testing the virtual reality application.
SOURCE: Photo by Ambar Saeed.

Simulation-Based Education

Geoff Miller told workshop participants about his experience with incorporating expertise into the simulation lab at Eastern Virginia Medical School (EVMS). Miller said that several years ago, they identified a problem at the simulation lab at the medical school: students had unequal access to expertise owing to the availability of clinical faculty. Miller and his colleagues decided to try to leverage technology to improve access to expertise. They worked with engineers and other industry partners to develop a way to capture the performance of experts in 3-D time-space models. For the first iteration of the project, they chose to focus on endotracheal intubation via direct laryngoscopy because it has a highly refined, very concrete procedure. Hundreds of different experts were captured intubating, and all of the data were combined to create an expert model. Students could play against this model expert using a game-based platform, and they could receive immediate synchronous feedback about their performance. Students could play this game "any time they want—3 in the morning or 3 in the afternoon," said Miller. The simulation lab at EVMS continues to refine and advance this type of application, and it is exploring the potential of augmented reality.

DISCUSSION

Referencing Jeffries's opening talk at the workshop, Mary Beth Mancini, a forum member with the Society for Simulation in Healthcare, brought up several big challenges in health professions education, and asked the innovators if and how their technologies might help address these problems.

Faculty Shortage

Kade said that one of the main drivers behind the Shadow Health digital clinical experiences is to reduce the burden on faculty. Shadow Health provides users with a transcript of the entire interaction, and they can compare their performance with that of an expert practitioner. This immediate access to feedback and expertise is one way to address the faculty shortage, he said.

Individualized Learning

Technology is a great enabler of individualized learning, said Miller. It can facilitate assessment of a student's knowledge, attitudes, behaviors, and skills in order to develop a "portfolio of performance." Using technol-

ogy to identify the needs of the students will better prepare each student for work in the clinical setting. McCune gave an example of this with the vSim for Nursing tool. vSim allows instructors to monitor student progress and focus attention on the critical skills and steps that the student is not performing well, she said.

Mastery

Miller stated that health professions education needs to "promote and push this concept of mastery learning as the model." In the early stages of learning, mastery may not be an appropriate model, but by the time a student is set to enter clinical practice, he or she needs to have mastered the needed skills. To make his point, Miller said, "Eighty percent proficiency on a skill like endotracheal intubation is great if killing 2 out of 10 is okay." To adopt a mastery model, health professions need to understand what expertise looks like, and how to measure it on a granular level. Assessment needs to be done rigorously and methodologically, he said, and technologies may provide a way to achieve this. Mastery requires a set of specific knowledge, the ability to do specific tasks, and self-identification as a master, said Norton. While some trainings are focused only on knowledge or tasks, Norton said that a robust game-based simulation could develop mastery "at a bunch of different angles." Kelly added that mastery requires repetition—ReelDx allows students to view and engage with a diverse set of patient scenarios "as many times as they want." Robert agreed that repetition is an essential part of mastery, and told a story about a nurse who was struggling with performance in the operating room. She was given an iPad with the simulation and told to practice over the weekend. When she returned for surgery the next week, she showed remarkable improvement. Their research, said Robert, shows that it "takes seven iterations on a procedure" to achieve a level of mastery, so the simulation is designed to help nurses practice over and over.

Cost

Miller said that while the cost of implementing technology can be high, the cost drops significantly as the technology becomes more widespread. For example, providing technology for the first student costs a lot, but adding the same technology for the second and third student adds little to the price. Kelly said they worked with early customers to find price points and structures that made sense. The current pricing for ReelDx is about $200 per faculty member, with discounts for volume. For students, it is approximately the price of a textbook, he said.

Other Factors to Consider

Cox said that empathy and trust are two key elements of the provider–patient relationship. While skills- and knowledge-based trainings are obviously essential, he implored innovators to consider how they could incorporate assessing and teaching empathy and trust into the technologies. In addition, Cox said that a key part of clinical education is learning how to manage uncertainty. "Decisions are often not binary: there is not a right answer or a yes/no answer," he said. These technological innovations would have even more value if they could explore and model ways to manage uncertainty, he said.

LEVERAGING TECHNOLOGY FOR SOLVING PROBLEMS

With the innovators' work in mind, workshop participants were asked to talk with others at their tables to identify a problem or challenge in health professional education, and to think of a way that technology could help overcome the problem or challenge. Below are the main areas of discussion as raised by individual participants.

Patient Education

Norton said that his table spent much of their time identifying the problem because "if you do not have a well-identified problem, your solution is worthless." The problem Norton said they settled on was that patients often do not have the skills necessary to be an active partner in their own care. The table discussed creating a free mobile game in which there would be multiple scenarios with different types of health care providers. While they did not have time to hammer out the details, said Norton, they agreed the game should focus in part on developing the patient's identity as a partner in care. Eric Bauman added that patient education is extremely important to the success of health care, but that current methods (e.g., pamphlets) are inadequate and do not focus on the needs of the patient. Compared to the number of health providers, there are a huge number of patients or potential patients, said Bauman. Well-designed technology that meets the needs of patients could make an enormous difference in health care.

Data

The next focus was on the challenge of managing and using the large amounts of data produced by new technologies such as digital health tools and wearables, said Hinton Walker. Hector Garcia from the Virginia Modeling, Analysis & Simulation Center at Old Dominion University followed by

saying that while these data convey important information, they must be connected and analyzed in order to be useful. Big data analytics can help "paint a picture of each individual over time" by using the data to create a model. This model, which includes the uncertainties inherent in medical practice, can be used to help students learn. Cox interjected that Garcia was really talking about probabilistic algorithms. Garcia agreed, adding that probabilistic models evolve over time as more data are added into the system. It allows the developer to fine-tune the model making it increasingly relevant to the user.

Another of the table conversations also focused on the issue of data. Miller framed his discussion by saying there are so many sources of data about individual health, but "there is no curation process for those data." He added, "I don't want big data, I want big, good data." He further stated that in order to develop a tool or a technology to deal with these data, we must first find out what the public wants to do with these data. When the public entrusts us with their health care data, he said, we, as developers, have a responsibility to consider the users' needs and wants, and to apply the data in ways that incentivize the public to want to share their data with no fears of it being mishandled.

Provider Role Change

As technology improves and resources such as clinical decision support tools become more widespread, providers may resist incorporating these technologies into practice, said Hinton Walker. How will health professionals use their knowledge differently when, for example, a machine determines the diagnosis or the treatment? How must health professions education change in order to prepare providers for this world?

Soft Skills

Kelly's table discussed how to use technology to teach softer skills such as empathy, listening, and teamwork. The table suggested using technology to capture patient interactions (e.g., video-recording clinical rounds), and then having students evaluate and discuss the opportunities that arose for empathy or connection, and how they are progressing on these skills. Kelly noted, however, that it can be challenging to assess these types of skills, and that an "automated empathy assessment" game may be difficult to build.

Suicide Prevention

Wendi Schweiger, representing the National Board for Certified Counselors International, talked about using technology to make suicide assessment and prevention more accessible to the general population. She

suggested that lay people in the community could be trained as first-level assessors who could then help get people to professionals when needed. Miller pointed to some interesting evidence coming out of the military about using technology for suicide prevention—specifically, using automated processes to monitor speech and physical behavior to detect a soldier's risk of suicide. Robert followed Miller's comment with information about emerging tools to track a person's online behavior or text messages to detect patterns that suggest a risk of suicide. Miller responded that there is another effort under way to use virtual providers for counseling. Evidence suggests, he said, that people are willing to talk to virtual providers over face-to-face encounters. Evans added that a game-based application might be quite useful for suicide prevention, especially among boys, who may be unable or unwilling to talk to their parents or other authority figures about their problems.

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6

Making Connections Through Technology

Highlights

- The future health care system will require health professionals to have new skills and be comfortable with new roles. (Skiba)
- Technology has the potential to solve global challenges, but it is a two-sided coin that can have unintended consequences. (Shah)
- Technology has to be married with good pedagogy to be a truly learner-centered approach, and technology is not the end, it is the instrument. (Jeffries)

EXPLORING THE PROMISES AND PITFALLS OF TECHNOLOGY

Technology has great promise to transform health professions education, health care, and health itself. Current, emerging, and future technologies will change the structure of the health care system and have the potential to address broad societal challenges such as poverty and inequality. However, leveraging the potential of technology will require overcoming challenges—such as institutional inertia—and grappling with the ethical issues surrounding the use of technology. Diane J. Skiba, professor and director of Health Care Informatics at the University of Colorado Denver, spoke to workshop participants about what the future of health care will look like: what types of technologies will be used by patients and provid-

ers; how will people and devices be increasingly interconnected; and how will health care professionals be prepared for this future? Radhika Shah, co-president at Stanford Angels and Entrepreneurs, shared her perspective on harnessing the power of technology to bring positive social change to the world while addressing the potential downsides of these tools.

Examining the Future of Connected Health Care

Skiba started by defining the "Internet of Things" and the "Connected Age." Both of these concepts describe a world that is made up of connections between everything and everyone, said Skiba. The Internet of Things focuses on connections between physical objects (e.g., smartphones linked to home systems), whereas the Connected Age refers to virtual connections, such as those between people, resources, and ideas. Several groups have attempted to estimate the scope of the Internet of Things: IHS Markit estimates that there are 17.6 billion things that are interconnected. Future projections are that by 2020, the number of Internet-connected things could reach as high as 50 billion with more conservative estimates at 20–30 billion (IEEE Spectrum, 2016).

These types of interconnectivity between people and things are related to the concept of "Connected Health." This model of health has the patient at the center and the goal of achieving proactive and efficient health care with the help of interconnection. Caulfield and Donnelly (2013) define Connected Health as:

> a conceptual model for health management where devices, services, or interventions are designed around the patient's needs, and health-related data is shared in such a way that the patient can receive care in the most proactive and efficient manner possible. All stakeholders in the process are "connected" by means of timely sharing and presentation of accurate and pertinent information regarding patient status through smarter use of data, devices, communication platforms, and people.

Connected Health, said Skiba, blends high-tech devices with high-touch connections between people. Skiba gave some examples of how the ecosystem of Connected Health works. A provider may connect with another provider to discuss an experience with a patient and seek advice. Patients may reach out to a patient community to get information about a diagnosis and to get peer support. Families, patients, providers, and caregivers are involved and engaged as part of a collaborative care team that shares information and resources. This health care system may largely take place outside the walls of traditional health care, said Skiba.

Skiba introduced workshop participants to a vision of a future patient who lives in a Connected Health world: "Josephine," an 86-year-old who

is recovering from a hip fracture. While in the hospital, Josephine is given a tablet with a Web-based patient toolkit. This program helps her learn and keep track of who her health care providers are and their roles on her team. Josephine would be responsible for setting her own goals. She would learn what will happen when she goes home, and how her health care team would continue to help with her recovery. The Web-based toolkit would allow Josephine's family members to access information to stay current on how Josephine is doing with her care. It would also allow multiple providers—primary care provider, surgeon, and physical therapists—to share information and manage handoffs between providers. When discharged from the hospital, Josephine would be sent home with various digital tools to continue to manage her care: for example, a blood pressure monitor, a scale, and a digital stethoscope. She would wear an Internet-enabled necklace to allow her to order prescription refills, call for emergency services, or connect with her providers. She would have virtual visits with providers via her computer. She would wear smart socks and use a smart cane that could help keep track of her progress by monitoring her gait. Sensors in these items would collect information and alert someone when there is a problem. A smart watch would remind her when it is time to take her medicine. She would have a smart refrigerator that could order groceries, act as a virtual assistant, show her educational videos, and give her recipes that are appropriate for her health conditions. These tools are all interconnected, and the data are available to her providers and caregivers. She may be assisted by robots like Zora, Pepper, or RoBear, which interact with patients and help them navigate their care.

This future of connected health care, said Skiba, will require overcoming several challenges. First, it will require new skills and knowledge for health care providers. Health professionals will not only need to know how to use these various technologies, but they will need to know how to incorporate them as part of a health care team. There will be a "data deluge" from wearables and other in-home technologies, said Skiba, and providers will need a way to manage these data and use them to improve their services. Health care is undergoing a transformation, and health professions education needs to prepare students for the future rather than for the present; professionals need to be agile and able to respond to and incorporate new technologies into care. In addition to the issues with preparing the workforce, said Skiba, there is a need to address the digital divide. Some patients—particularly those in low-income brackets and rural communities—lack broadband or smartphones that are needed to become part of the connected world. Payment may also be a barrier; health insurance companies have begun paying for virtual visits, but the reimbursement for technologies may lag behind the innovation. Ethics and the issue of patient choice must also be dealt with; some people may not want sensors

and robots in their home while others welcome these technologies. Finally, said Skiba, patients differ in terms of their comfort with and aptitude for technologies. The challenge will be to ensure that all patients are able to access their personal data and information and know how to use these tools in ways that has the greatest benefit for each person.

Leveraging Technology to Solve Global Challenges

Technology offers solutions to some of the biggest challenges of our times, said Radhika Shah, including poverty, inequality, public health, and gender equity. The world is at an inflection point right now in two ways, she added. First, the United Nations developed a set of 17 ambitious global goals known as the Sustainable Development Goals (SDGs) that weave together social, economic, and environmental challenges (see Figure 6-1). The 191 World Health Organization member states are working on these intertwined goals and it will take a collaborative effort from the global community to solve the challenges. Second, technology is rapidly developing and spreading across the globe, making it possible to integrate and leverage technology to address global issues. Investors have recognized this potential and are funding technological innovations to achieve social change.

Shah gave a few examples of how technological innovations have already begun to advance the SDGs. Technology has the capacity to solve existing problems, for example, new artificial intelligence tools are outperforming humans in medical diagnosis. Technology can give people all across the globe access to information through free courses and resources

FIGURE 6-1 Sustainable Development Goals.
SOURCES: Presented by Shah, November 16, 2017; UN, 2015.

available online. Technology can disrupt markets and transform the workplace through innovations such as Samasource digital microwork, which allows marginalized women and youth to perform work from home via the Internet and receive a sustainable wage. Technology can use the power of data to solve problems; for example, in a natural disaster, credit card usage data can provide information about which stores and services are still operational. Above all, said Shah, technology enables knowledge sharing, transparency, and anticipating and locating major trends.

However, despite this remarkable potential, technology is a two-sided coin. There are potentially harmful side effects of technology, and technology can be leveraged to do harm as well as good. For example, Shah said, animal poaching has increased in recent years because of the ability of poachers and buyers to transact anonymously on the Internet. Disinformation that is spread on social media can lead to xenophobia, distrust of the media, and negative treatment of others. Technological innovations can bring the risk of identity theft and invasion of privacy. There is the potential for technology to bridge the inequality divide, but technology may also increase this divide if people have unequal access.

As technology continues to advance and spread, it is essential that the world think about these potential downsides, and take action to mitigate the consequences, said Shah. There is a need for leadership on this front, and a number of questions need to be answered. Should government, technology creators, academia, or consumers be responsible for controlling or anticipating the downsides to technology? Should policy be made on the national or global level? What other stakeholders should be involved? How do we solve the tension between freedom of expression and manipulation of social media and information? Should technological innovation be seen as a tool to achieve social goals, or as an end unto itself? Should educational institutions be teaching technology ethics? How do we make decisions about controversial technologies such as genetic engineering?

Shah concluded with a quote from the Copenhagen letter, which was a letter signed by more than 100 participants at the Techfestival in 2017: "Let us move from human-centered design to humanity-centered design" (Copenhagen, 2017). Shah said that technology should be seen as a tool for global good, not just as an individual benefit, and that humans are the custodians of technology and must make informed decisions about its proper usage. She called for the global community to come together to collaborate, innovate, and leverage technology, while being careful and accountable about the negative externalities.

In the next part of her presentation, Shah shared numerous examples of innovators who have leveraged technology for addressing certain SDGs. The first example seen in Box 6-1 intertwines education and health care within the technology field.

BOX 6-1
Technological Innovations Advancing Social Change

ZMQ—Phone app offers health/social knowledge (SDGs 3, 4, 5)

- Health/social issues—icons so girls who cannot read can also learn
- Powerful stories around social issues/role models lead to social change
- Gamify health info for girls; participative, girls engage

YourDost—Mental health online service (SDG 3)

- Tech anonymity helps solve social taboo around seeking help

Akshaya Patra Foundation—Serves more than 1.6 million mid-day meals for school children in 12 states (SGDs 2, 3, 4)

- Tech innovation using an automated kitchen and a public–private partnership allows the delivery of low-cost, nutritious meals in schools ($15/year/child)

Healing Fields—women in rural India provide (SDGs 3, 4, 5, 8)

- Local community health information, health education, basic health services
- Financing via local community resource pooling
- Employment for local women—community health provider

SOURCE: Presented by Shah, November 16, 2017.

Coordinated out of Stanford University, the initiative brings best practices from Stanford's emergency room to places like Inner Mongolia and now rural India by engaging with organizations such as the Healing Fields Foundation. They use a train-the-trainer model to build the skills of doctors and other local providers in underserved regions using in-person and virtual connections.

After citing many more examples of technology-enabled learning in line with local customs, Shah expressed her sincere appreciation for what she referred to as "deep collaborations among people from across the globe." This is only possible because online technology can be used to train and connect people, she added. With that, Shah made a final call to action for all people to come together as a global community to collaborate, innovate, and leverage technology while remaining ever vigilant to avoid the potential negative externalities of technology.

DISCUSSION

With these potentials and pitfalls in mind, workshop participants held table discussions about the ethics and unintended consequences of technology. Individuals at each table reported to the group about the issues that arose during their conversation. Issues included

- Guiding health professions students in the proper use of social media through establishment of boundaries between personal and professional selves
- Teaching digital professionalism and digital ethics at educational institutions
- Leveraging digital immigrants (those who grew up without today's technology) for teaching digital natives about the social mores and professional roles that existed prior to the digital revolution
- Getting health professions organizations to restate their professional mandate in the age of technology, and express how the values undergirding the profession have not changed despite changes in the tools
- Calling on health professionals to help consumers filter through the enormous amount of health information that is available and determine which sources provide quality information
- Engaging technology developers with communities to identify and define real problems that need technological solutions (i.e., using technology to enable collaborative problem solving)
- Using technology to challenge and upend deep-seated cultural beliefs and structures

LESSONS LEARNED

At the closing of the workshop, Jeffries asked participants to identify notable messages or "aha moments" and share them with the group. Responses included

- To be effective, technological innovations need to be scalable and sustainable. (Scrimshaw)
- Research incentives need to be changed so research and practice are not siloed but instead work hand in hand and inform each other. (Scrimshaw)
- A major challenge to leveraging the potential of technology is overcoming institutional and professional inertia, getting leadership on board, and preparing faculty for the changes ahead. (Cahill)

- Innovations need to start with the user and a well-identified problem and be built from there. (Ascione)
- We should focus efforts on using technology in order to do things we cannot do otherwise, or improve the things we are already doing. While high-tech tools are exciting, sometimes the most impact can be made with low-tech, low-bandwidth solutions that are reliably and widely implemented. (Merrick)
- As technology advances, it will be essential to teach responsible and ethical use of technology. (Cain)

After listening to the forum members and other workshop participants, Jeffries shared her memorable points from the meeting that included a Wordle (see Figure 6-2). Technology has to be married with good pedagogy to be a truly learner-centered approach, she said, and technology is not the end, it is the instrument. This new learner-centered approach will enable and empower students to take responsibility for their learning, but it will also require faculty to shift from being a transmitter of knowledge to a facilitator of learning. The learning of the future will focus less on gaining knowledge of facts, and more about building relationships and seeing ways to connect people, information, and ideas.

Open access to information resources is a dramatic shift from the traditional model of education but one that will open doors and broaden the

FIGURE 6-2 Jeffries's Wordle from her workshop notes.
SOURCE: Presented by Jeffries, November 17, 2017.

impact of education. The promise of technology must be tempered with the pitfalls; people must be cognizant of the downsides, take action to mitigate them, and teach "digital wisdom" as part of health professions education. With that, Jeffries closed the workshop.

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Appendix A

Workshop Statement of Task

An ad hoc committee will plan and conduct a 1.5-day public workshop to explore gaps—within and across the continuum of health professional education—that impede progress toward the Institute for Healthcare Improvement's (IHI's) expanded Triple Aim[1] that includes better care for the caretakers themselves. The discussions will then look at current and future technologies that could bridge the identified gaps in order to optimize health and education system performance and access in high-, middle-, and low-income regions.

The workshop will encourage open sharing of ideas across professions, countries, and sectors within areas such as:

Knowledge, Skills, Attitude, and Competencies

- Using technology to support health professional learning (especially with rural and underserved populations), to encourage interprofessional education and collaboration, and to address the social determinants of health
- Transforming health care delivery environments to enable interprofessional, team-based care, and to maximize providers' education and training for achieving the Triple Aim
- Teaching trust and humanism from a distance

[1] The Institute for Healthcare Improvement (IHI) Triple Aim is a framework for health system performance involving (1) better patient care (including quality and satisfaction), (2) improved population health, and (3) reduced health care costs (IHI, 2018).

- Using technology with health professions, patients, and populations to address "health in all policies" and the Sustainable Development Goals (SDGs)
- Using technology as the interface between education, practice, patients, and populations
- Preparing the current and future health workforce for understanding and appropriately using personalized genomic data for interacting with patients and health consumers
- Learning from digital native millennial health profession students and faculty to manage knowledge obsolescence (staying organized and current)

Technology Platforms

- Learning from social media platforms and applying lessons to education and credentialing
- Employing artificial intelligence in decision support
- Creating new ways of employing and using simulation, wearables, and other technological innovations for educational purposes
- Leveraging technology to expand access to health professions education (expanding capacity)
- Addressing a lack of preceptor training sites and virtual supervision for trainees from all the health professions
- Optimizing teaching and learning for health professional education through technology (including faculty development and recognizing errors introduced through technology)
- Exploring challenges of access to and unfamiliarity of technology in select populations

Assessment, Evaluation, and Regulation

- Using big data and crowd sourcing for structuring more individualized online education
- Understanding the role of technology in real-time and automated assessment and evaluation, accreditation, and curriculum design
- Exploring regulation and accountability in the use of technology and software applications, including building the evidence for updating regulatory processes and requirements

The committee will develop a workshop agenda, select and invite speakers and discussants, and moderate the discussions. Following the workshop, a

proceedings of the presentations and discussions at the workshop will be prepared by a designated rapporteur in accordance with institutional guidelines.

REFERENCE

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Appendix B

Workshop Agenda

Improving Health Professional Education (HPE) and Practice Through Technology: A Workshop

November 16–17, 2017

Keck Center of the National Academies, Room 100
500 Fifth Street, NW, Washington, DC 20001

DAY 1: November 16, 2017

WORKSHOP OBJECTIVE: To explore the effective use of technologies as tools for bridging identified gaps within and between health professions education and practice in order to optimize learning, performance and access in high-, middle-, and low-income areas while ensuring the well-being of the formal and informal health workforce.

9:00 am **Welcome**
Malcolm Cox, Global Forum on Innovation in Health Professional Education (IHPE) Co-Chair

SESSION I: Setting the Stage

Objective: To encourage open sharing of ideas across professions, countries, and sectors within three broad categories designed to provide the appropriate tools for training and sustaining a competent health workforce.

9:15 am **Orientation to the Workshop**
Pamela Jeffries, Workshop Chair

9:30 am **Opening Addresses**
Moderator: Ruth Nemire, American Association of Colleges of Pharmacy

Using Social Media to Support Health Professional Learning and Collaboration in Rural and Underserved Environments
Christoph Pimmer, University of Applied Sciences and Arts, Northwestern Switzerland

Technology Platforms: Questioning Outdated Models
Catherine M. Casserly, Fellow with the Aspen Institute (via video connection)

Current State of Research and Practice in Digital Learning
George Siemens, Technology Enhanced Knowledge Research Institute, Athabasca University, Canada

SESSION II: Technology for Customer-Driven Workforce Development

Objective: To explore the use of technology for enabling an improved customer experience—for the learner, consumer, patient, provider, educator, etc.—while considering potential risks that could widen disparities between populations.

11:15 am **Technology-Driven Education and Care**
Moderator: Javaid Sheikh, Weill Cornell Medicine–Qatar

How Technology Enables Teaching and Learning
Katherine McKnight, Center for Evaluation and Study of Educational Equity, RTI International

Customer-Driven Health Workforce Development Using Technology
Cynthia Walker, Global Medical Education, Field Training & Customer Insight, Cardiac Rhythm and Heart Failure, Medtronic

Discussion/Q&A: Participants at each table talk among themselves and come up with a group question for each of the speakers.

12:15 pm **Lunch**

1:15 pm **Innovators: Rapid Fire Poster Session**
Moderator: Eric B. Bauman, Clinical Playground, LLC

Example 1: Digital Clinical Experiences, Shadow Health Inc.—Benjamin Lok and Rob Kade
Example 2: vSim for Nursing, Laerdal Medical Corporation—Jeanie Staton and Robin McCune
Example 3: ReelDx, Transforming Healthcare Education with Real Patient Video—Bill Kelly
Example 4: Filament Games—Dan Norton
Example 5: KATS, a Knowledge Acquisition & Testing System—Andrea Parodi
Example 6: Eastern Virginia Medical School, a pioneer in simulation-based education—Geoff Miller
Example 7: PeriopSim: Simulation Training for Operating Room Nurses—Angela Robert

Participants are free to wander around the room to ask individual presenters questions.

2:45 pm **Break**

3:15 pm **Leveraging Technology for Solving Problems**
Speaker/facilitator: Eric B. Bauman, Clinical Playground, LLC

Participants at each table will talk with each other and an innovator to come up with one problem and how technology could aid the solution.

4:00 pm **Two Sides to Technology: Stories from Around the Globe**
Moderator: Emilia Iwu, Rutgers University and Jonas Nurse Scholar

- Radhika Shah, Stanford Angels and Entrepreneurs (via video connection)
- 5-minute table discussion for a group question or comment
- Radhika Shah's closing remarks

4:45/5 pm **Adjourn**

DAY 2: November 17, 2017

A continental breakfast will be available starting at 7:30 am

7:30 am **Breakfast**

SESSION III: Technology Innovation from Education to Practice

Welcome
Susan Scrimshaw, IHPE Global Forum Co-Chair

8:00 am **Innovation in e-Care Delivery**
Moderator: Pamela Jeffries, Workshop Chair
- Diane Skiba, University of Colorado Denver

Q&A

8:30 am **Bridging the Education-to-Practice Divide with Technology**
Moderator: Christoph Pimmer, Workshop Vice-Chair
- Paul Worley, Flinders University, South Australia (via video connection)

Interactive Discussion

9:15 am **Break**

9:45 am **Applying National Institutes of Health Research in the Virtual Space to a Practice Environment**
Moderator: Micki Cuppett, Athletic Training Strategic Alliance

Panelists:
The Immersive Virtual Environment Testing Area
Susan Persky, National Human Genome Research Institute

Virtual Reality to Study Motor Learning
Sunbin Song, National Institute of Neurological Disorders and Stroke

Virtual Preparedness Training
Victor Cid, National Library of Medicine

Panel Discussion

SESSION IV: The Way Forward

10:45 am **Take-Home Messages**
Facilitator: Pamela Jeffries, Workshop Chair

Each table comes up with one take-home message to share.

11:00 am **Adjourn**

Appendix C

Speaker Biographical Sketches

Eric B. Bauman, Ph.D., received his Ph.D. in 2007 from the University of Wisconsin–Madison School of Education, Department of Curriculum and Instruction. He was one of the early Games+Learning+Society (GLS) students and was advised by Professors Betty Hayes and Kurt Squire, both renowned scholars in the game-based learning movement. Dr. Bauman is also a registered nurse, firefighter, and paramedic with more than 20 years of clinical, research, teaching, and command experience.

After receiving his Ph.D., Dr. Bauman held the position of Faculty Associate in the Department of Anesthesiology at the University of Wisconsin School of Medicine and Public Health. He subsequently founded Clinical Playground, LLC, a consulting service focusing on game and simulation-based learning. Dr. Bauman is Assistant Dean for the Institute for Research and Clinical Strategy and was recently named Fellow and Visiting Scholar at the University of Wisconsin–Madison School of Education, Department of Curriculum and Instruction, with GLS. Dr. Bauman also currently holds the rank of Division Chief of Emergency Medical Services for the Blooming Grove Fire Department.

David Benton, R.G.N., Ph.D., FFNF, FRCN, FAAN, took up post as Chief Executive Officer (CEO) of the National Council of State Boards of Nursing (NCSBN) on October 2, 2015. Immediately prior to this he worked at the International Council of Nurses in Geneva, Switzerland, for the previous 10 years, firstly as their consultant on nursing and health policy specializing in regulation, licensing, and education, and then as CEO. He qualified as a general and mental health nurse at the then Highland College of

Nursing and Midwifery in Inverness, Scotland. His M.Phil. research degree focused on the application of computer-assisted learning to post-basic nurse education. Over the past 30 years he has had articles published in relation to research, practice, education, leadership, regulation, and policy topics. He has a Ph.D. summa cum laude from the Complutense University of Madrid for his work on researching an international comparative analysis of the regulation of nursing practice. Dr. Benton has held senior roles for 25 years across a range of organizations. These roles included working as Executive Director of Nursing at a health authority in London, as a senior civil servant in the Northern and Yorkshire regions, as Chief Executive of a nurse regulatory body in Scotland, and as Nurse Director of a University Trust Health System.

Dr. Benton is the recipient of several awards and honors. He is particularly proud of being awarded the inaugural Nursing Standard Leadership award in 1993. He was presented with Fellowship of the Florence Nightingale Foundation in 2001, Fellowship of the Royal College of Nursing in 2003 for his contribution to health and nursing policy, and most recently became a Fellow of the American Academy of Nursing in 2015. Dr. Benton has held several visiting appointments and is currently a visiting professor of nursing policy at the University of Dundee in Scotland.

Catherine M. Casserly, Ph.D., works at the nexus of research and practice as a catalyst for openness, innovation, and leadership with a passion for learning ecosystems that support high-quality education experiences for all. Dr. Casserly works on a number of high-impact projects and is engaged by a portfolio of organizations. She is currently Interim Open Educational Resources (OER) Lead at the Hewlett Foundation and Senior Advisor for the Carnegie and Lumina Foundations. She is a member of the Advisory Council for the National Science Foundation, chairing its subcommittee on open licensing, and a Research Affiliate with Institute for the Future. Previously, Dr. Casserly was Chief Executive Officer and President of Creative Commons, Vice President at EdCast, Fellow with the Aspen Institute, and Vice President at the Carnegie Foundation for the Advancement of Teaching. She was founding architect of the OER field, developing, managing and launching the 100M inaugural portfolio for the Hewlett Foundation.

Early in her career, she taught mathematics in Kingston, Jamaica. Dr. Casserly earned her Ph.D. in the economics of education from Stanford University, B.A. in mathematics from Boston College, and holds an honorary doctorate from Open University, United Kingdom.

Victor Cid is a Senior Computer Scientist with the Disaster Information Management Research Center (DIMRC), a branch of the Specialized Information Services Division of the National Library of Medicine (NLM) at the

National Institutes of Health (NIH). Mr. Cid has been conducting research and development activities for NLM for more than 20 years in a variety of computer science and engineering topics that include virtual reality and serious gaming applications for training and education. Mr. Cid is a frequent presenter at the Uniformed Services University of the Health Sciences and a member of several cross-institutional groups and committees, including the Subcommittee on Disaster Reduction of the U.S. National Science and Technology Council, the Coordinating Board of the NLM-sponsored Latin American Network of Disaster and Health Information, and General Services Adminitration and NIH Virtual Reality and Artificial Intelligence Special Interest Groups.

Malcolm Cox, M.D., is an Adjunct Professor of Medicine at the University of Pennsylvania. He most recently served for 8 years as the Chief Academic Affiliations Officer for the U.S. Department of Veterans Affairs (VA) in Washington, DC, where he oversaw the largest health professions training program in the country and repositioned the VA as a major voice in clinical workforce reform, educational innovation, and organizational transformation. Dr. Cox received his undergraduate education at the University of the Witwatersrand and his M.D. from Harvard Medical School. After completing postgraduate training in internal medicine and nephrology at the Hospital of the University of Pennsylvania, he rose through the ranks to become Professor of Medicine and Associate Dean for Clinical Education. He has also served as Dean for Medical Education at Harvard Medical School; upon leaving the Dean's Office, he was appointed the Carl W. Walter Distinguished Professor of Medicine at Harvard Medical School. Dr. Cox has served on the National Leadership Board of the Veterans Health Administration, the VA National Academic Affiliations Advisory Council (which he currently chairs), the National Board of Medical Examiners, the National Advisory Committee of the Robert Wood Johnson Foundation Clinical Scholars Program, the Board of Directors of the Accreditation Council for Graduate Medical Education, and the Global Forum on Innovation in Health Professional Education of the National Academies of Sciences, Engineering, and Medicine (which he currently co-chairs). Dr. Cox is the recipient of the University of Pennsylvania's Christian R. and Mary F. Lindback Award for Distinguished Teaching and in 2014 was recognized by the Association of American Medical Colleges as a nationally and internationally renowned expert in health professions education.

Micki Cuppett, Ed.D., ATC, has served as the Executive Director of the Commission on Accreditation of Athletic Training Education (CAATE) for the past 3 years. Prior to taking the position of Executive Director, she served as President of the CAATE and has a long history of involvement

with accreditation including time as a site visitor and CAATE Commissioner. Dr. Cuppett previously served as Professor and Vice Chair of the Department of Orthopedics and Sports Medicine and the Director of Athletic Training at the University of South Florida. Her area of research interest and expertise includes the use of simulation, educational technology, and interprofessional education. She earned her Ed.D. in curriculum and instruction from the University of Northern Iowa, while her undergraduate degree is from the University of North Dakota. Prior to entering academe, she worked as an athletic trainer in various settings, including high schools, colleges, hospitals, and the military.

Hector M. Garcia, M.A., is a Senior Project Scientist at Old Dominion University's (ODU's) Virginia Modeling, Analysis & Simulation Center in the areas of visualization, virtual environments, and virtual reality; integrating state of the art visualization systems with modeling and simulation applications; and the scientist most closely involved with the CAVE (cave automatic virtual environment) on ODU's Norfolk campus. Mr. Garcia received his master's degree in architecture from the University of Houston in 1997. Mr. Garcia's expertise include the use of large-scale visual simulation display systems, the use of tracking devices and robotics, and haptic devices used in training and education.

Mr. Garcia has more than 20 years of experience developing highly interactive virtual environments for training. He has been involved in a variety of research projects funded by the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the Office of Naval Research, the Agency for Healthcare Research and Quality, and private industry. Before joining ODU, Mr. Garcia spent 5 years as a researcher at the University of Houston affiliated with the Virtual Environments Technology Laboratory working on several NASA projects for astronaut training as well as NSF-funded research for using virtual reality as a teaching tool. While working on these past research projects, Mr. Garcia developed the virtual environments, as well as managed teams of developers to design the game play of all of these simulations, to achieve the proposed training goals. He has also successfully managed projects, collaborated with other researchers, and helped produce several peer-reviewed publications on each of the projects in which he was involved.

Emilia Iwu, M.S.N., R.N., APNC, FWACN, is a Nurse Practitioner, Robert Wood Johnson and Jonas Foundations Fellow, and faculty at the Rutgers School of Nursing in New Jersey. Since 2006, Dr. Iwu has worked as a Technical Advisor with the Institute of Human Virology Nigeria supporting their U.S. President's Emergency Plan for Aids Relief–funded Nursing and Community Health programs. During this period, she served on policy,

technical, and guideline committees and trained and mentored nurses and community health workers to provide HIV services at health facilities and communities in Nigeria. She led the development and implementation of a Nigerian National HIV & AIDS curriculum currently in use at pre-licensure nursing, midwifery, and community health schools in Nigeria. She implemented nurse-managed antiretroviroal therapy in Nigeria and instituted regional trainings to enhance the knowledge and skills of nurses and community health workers. Dr. Iwu is a co-chair of the Global HIV Nursing committee, Association of Nurses in AIDS Care, and a recipient of the Sigma Theta Tau International Global Nursing Research Grant in 2014 for her Ph.D. dissertation research "Shifting HIV Treatment from Doctors to Nurses in Africa: Correlations among Nurse and Setting Characteristics, Self-Efficacy and Job Satisfaction among Nurses Performing Task Sharing Roles." Her research interests are health professional education, workforce, HIV clinical and community outcomes, emerging models of care to improve patient access and outcomes, and the reduction of health disparities for vulnerable populations. She plays active leadership roles in several professional organizations, including the National Association of Nigerian Nurses in North America, where she applies her global experience to build collaborations with nurse leaders in Nigeria for practice and education.

Pamela Jeffries, Ph.D., R.N., FAAN, ANEF (*Workshop Co-Chair*), Dean and Professor at The George Washington University (GW) School of Nursing, is nationally known for her research and work in developing simulations and online teaching and learning. Throughout the academic community, she is well regarded for her expertise in experiential learning, innovative teaching strategies, new pedagogies, and the delivery of content using technology in nursing education. Dr. Jeffries has served as the principal investigator on grants with national organizations such as the National League for Nursing, has provided research leadership and mentorship on national projects with the National Council State Board of Nursing, and has served as a consultant for health care organizations, corporations, large health care organizations, and publishers providing expertise in clinical education, simulations, and other emerging technologies.

Prior to joining GW, Dr. Jeffries was Vice Provost for Digital Initiatives and professor at the School of Nursing at Johns Hopkins University, where she was previously the Associate Dean for Academic Affairs. Dr. Jeffries is a Fellow of the American Academy of Nursing, an American Nurse Educator Fellow, and most recently, a Robert Wood Johnson Foundation Executive Nurse Fellow. She also serves as a member of the National Academies of Sciences, Engineering, and Medicine's Global Forum on Innovation in Health Professional Education and is now serving as past President of the interprofessional, international Society for Simulation in Healthcare. She

has numerous publications, is sought to deliver presentations nationally and internationally, and has edited three books: *Simulations in Nursing Education: From Conceptualization to Evaluation* (2nd edition), *Developing Simulation Centers Using the Consortium Model*, and her newest book published by Lippincott and being launched at the International Meeting on Simulation in Healthcare called *Clinical Simulations in Nursing Education: Advanced Concepts, Trends, and Opportunities*.

She has received federal and state grant funding to support her research focus in nursing education and the science of innovation and learning. Dr. Jeffries was inducted in the prestigious Sigma Theta Tau Research Hall of Fame and is the recipient of several teaching and research awards from the Midwest Nursing Research Society, the International Nursing Association of Clinical Simulations and Learning, and teaching awards from the National League for Nursing, Sigma Theta Tau, International, and most recently, the American Association of Colleges of Nursing Scholarship of Teaching and Learning Excellence award.

Rob Kade started his career back in the 1990s with Abbott Labs within its sales and marketing division. Prior to joining Shadow Health Inc. as Chief Marketing Officer, Mr. Kade headed up Intuitive Surgical's Southeast robotic sales team.

Bill Kelly is co-founder and board member at ReelDx. His company focuses on capturing real patient experience in medical settings, and making these cases available for true case studies in a variety of educational settings. Mr. Kelly is an expert in both online health information and online education, having built award-winning products at Sapient Health Network (WebMD) and Learning.com. In addition to ReelDx, Mr. Kelly is on the board of directors for Leavitt Risk Management and Great Minds, and is a partner at the private equity firm AgriCascadia.

Ben Lok, Ph.D., M.S., is a Professor in the Computer and Information Sciences and Engineering Department at the University of Florida (UF) and co-founder of Shadow Health Inc., an educational software company. His research focuses on virtual humans and mixed reality in the areas of computer graphics, virtual environments, and human–computer interaction. Dr. Lok received a Ph.D. (2002, advisor: Dr. Frederick P. Brooks, Jr.) and an M.S. (1999) from the University of North Carolina at Chapel Hill and a B.S. in computer science (1997) from the University of Tulsa. He did a postdoctoral fellowship (2003) under Dr. Larry F. Hodges.

Dr. Lok received a UF Term Professorship (2017–2020), the Herbert Wertheim College of Engineering Faculty Mentoring Award (2016), National Science Foundation Career Award (2007–2012), and the UF

Association for Computing Machinery (ACM) Computer & Information Science & Engineering Teacher of the Year Award in 2005–2006. He and his students in the Virtual Experiences Research Group have received Best Paper Awards at Association for Computer Machinery I3D (Top 3, 2003) and Institute of Electrical and Electronics Engineers (IEEE) Virtual Reality (VR) (2008). He currently serves on the Steering Committee of the IEEE VR conference, was general chair of IEEE VR 2014 and IEEE VR 2013, and was program co-chair of the ACM VR Software and Technology 2009, IEEE VR 2010, and IEEE VR 2011. Dr. Lok is on the editorial board of the *International Journal of Human-Computer Studies*, *Computer and Graphics*, and *ACM Computing Surveys*.

Elliot Maxwell, J.D., advises public- and private-sector clients on strategic issues involving the intersection of business, technology, and public policy in the Internet, e-commerce, health care, and higher education domains. He is a member of the Board on Research Data and Information of the National Academies of Sciences, Engineering, and Medicine; a member of the Advisory Board of the Center for Democracy and Technology; a Fellow of the International University of Japan; a Trustee Emeritus of Brown University; and a member of the Board of Trustees of Salve Regina University. He has served as a Fellow of the Communications Program at Johns Hopkins University and as a Distinguished Research Fellow at the eBusiness Research Center of The Pennsylvania State University. He worked closely with the Committee for Economic Development on a series of reports on the digital economy, and with the Massachusetts Institute of Technology and Electronic Product Code global/GS1 on policy issues surrounding the implementation of the Electronic Product Code version of radio-frequency identification (RFID). He serves as an expert advisor to the Organisation for Economic Co-operation and Development and has consulted with—among others—the Office of the National Coordinator for Health Information Technology in the U.S. Department of Health and Human Services and the William and Flora Hewlett and Ewing Marion Kauffman Foundations.

From 1998 until 2001, Mr. Maxwell served as Special Advisor for the Digital Economy to U.S. Secretary of Commerce William Daley and U.S. Secretary of Commerce Norm Mineta. In this position he was the principal advisor to the Secretary on the Internet and e-commerce. He coordinated the U.S. Department of Commerce's efforts to establish a legal framework for electronic commerce, ensure privacy, protect intellectual property, increase Internet security, encourage broadband deployment, expand Internet participation, and analyze the impact of electronic commerce on all aspects of the economy. He was deeply involved in the development of federal e-government activities and was a founding member of the Federal Interagency Working Group on Electronic Commerce.

Robin McCune is the Director of Corporate Accounts for Laerdal Medical. She is responsible for a team of Strategic Account Managers focused on training initiatives in the U.S. Department of Defense, Defense Health Agency, and federal health care agencies. She also leads a team of program consultants focused on leveraging simulation industry standards, guidelines, and best practices in hospitals and schools of nursing. Prior to joining Laerdal, Ms. McCune was the National Sales Director for Commercial and Healthcare Markets for the American Heart Association.

Katherine McKnight, Ph.D., M.A., is a member of RTI International's Center for Evaluation and Study of Educational Equity whose work emphasizes teaching and learning, school improvement, and educator effectiveness. Using the latest quantitative social science methods, Dr. McKnight develops studies for mission-driven organizations and collaborates with policy makers to turn research findings into practice.

Currently, Dr. McKnight is involved with a study of parent–teacher home visits in four districts across the United States. She is reviewing research on implicit biases related to race and culture that may affect the visits, and conducting focus groups of the educators and families involved. The study is funded by the Flamboyan Foundation. She is also leading a study funded by the Kellogg Foundation, investigating what expert teachers do to reduce or eliminate opportunity gaps for their students in underresourced schools and communities.

Geoffrey T. Miller, M.S., EMT-P, joined Eastern Virginia Medical School in January 2011 and oversees the expansion of simulation-based educational activities, curriculum development, educational outcomes, and translational research. Previously, he was the Associate Director and Curriculum Development for the Division of Prehospital and Emergency Healthcare at the Micahel S. Gordon Center for Research in Medical Education at the University of Miami Miller School of Medicine.

Joel Nelson, M.S.W., M.P.H., is the Acting Director of the Division of Nursing and Public Health at the Health Resources and Services Administration's (HRSA's) Bureau of Health Workforce, where he provides strategic guidance for a $200 million portfolio of programs spanning more than 800 federal awards (FY16) in nursing, public health, and behavioral health and two national coordinating centers. Mr. Nelson has a Master's in Public Health and a Master's in Social Work, and his work experience prior to HRSA includes psychological health and traumatic brain injury research, prevention, and care; case management in rural primary health care; public health advocacy; environmental health and justice initiatives; and emergency preparedness and response.

Ruth E. Nemire, Pharm.D., Ed.D., joined the American Association of Colleges of Pharmacy as the associate executive vice president in January 2013. Dr. Nemire's responsibilities include strategic planning, developing and assessing programs, design of products and services to assist members in leadership and curriculum development, educational research and scholarly teaching including interprofessional education, and global partnerships and development. She is responsible for scanning and interpretation of the higher education, health professions education, and health care environments for trends, information, and resources of potential interest and benefit for members. She works with leadership groups to facilitate their work in service to American Association of Colleges of Pharmacy members and builds relationships with external organizations that complement and support programs of the association.

Dr. Nemire is a graduate of Ohio Northern University and the University of Toledo Colleges of Pharmacy. She completed formal fellowship training in neurology with an emphasis in epilepsy at the University of Miami College of Medicine in Miami, Florida. Dr. Nemire completed a Doctorate in Education with a major in higher education leadership at the Nova Southeastern University Fischer School of Education in December 2009.

Dan Norton is the Chief Creative Officer and a Founding Partner of Filament Games. He has been a designer, creative director, and advocate for games and game-based learning (GBL) for more than a decade, working on playful experiences that explore topics as diverse as plant anatomy to empathy. Mr. Worton specializes in both GBL design practices and processes for fostering creative teams.

Andrea Parodi, Ph.D., R.N., is a Research Associate Professor and Lead for Medical/Healthcare focus areas at the Virginia Modeling, Analysis & Simulation Center, a dedicated research center within Old Dominion University (ODU). Prior to working at ODU, she completed 26 years in the U.S. Navy Nurse Corps. During this time she had various assignments such as Head of Nursing Research and the Lead for the Navy's Team Resource Center for Team Strategies and Tools to Enhance Performance and Patient Safety, a patient safety and research activity dedicated to supporting patient safety and communication that enables the development of high-performance clinical teams in the Navy/Marine Corps and the U.S. Department of Defense. This Center was located at Naval Medical Center Portsmouth, Virginia. Prior to this assignment Dr. Parodi was the Program Manager for Field Medical Technologies for the Navy and Marine Corps while based at Naval Health Research Center in San Diego, California.

Dr. Parodi completed a Ph.D. in Nursing at The University of Alabama at Birmingham, with dual specializations in Health Policy Analysis and

Higher Education Leadership. The education foci incorporated course work completion at Peabody, the School of Education at Vanderbilt University, and the remaining degree requirements were completed concomitantly with the Health Policy Analysis work while at The University of Alabama at Birmingham. During her course of study in health policy, Dr. Parodi completed a doctoral residency in Health Policy Analysis in the Washington, DC, office of U.S. Senator Daniel Inouye of Hawaii. Prior to her doctoral degree, she earned a Master of Science degree in Nursing as a clinical nurse specialist in critical care nursing and burns at Vanderbilt University, Nashville, Tennessee, and also served as the Clinical Coordinator of the Surgical Intensive Care Unit and Open Heart Recovery Room at the Vanderbilt University Medical Center, After leaving Vanderbilt, she was the Program Lead for Critical Care Nursing in the B.S.N. Nursing Program, Austin Peay State University, Clarksville, Tennessee. Dr. Parodi also holds a Bachelor of Arts degree in Psychology from College of Mount St. Vincent on-the-Hudson and a B.S.N. degree in Nursing was pursued at Pace University in Westchester, New York, and 1 year of course work and practicum was completed in Special Education at The University of Texas at El Paso.

Susan Persky, Ph.D., is an associate investigator and head of the Immersive Virtual Environment Testing Unit in the Social and Behavioral Research Branch (SBRB), National Human Genome Research Institute (NHGRI), National Institutes of Health. She earned a B.A. in psychology from Northwestern University. She earned an M.A. and a Ph.D. in social psychology from the University of California, Santa Barbara, where she studied at the Research Centers for Virtual Environments and Behavior. After conducting postdoctoral research at Columbia University, she came to the SBRB in 2005. Here, she built and led the Immersive Virtual Environment Testing Area, an immersive virtual reality technology-based experimental research lab within the SBRB. She became an associate investigator at NHGRI in 2009 and the head of the Immersive Virtual Environment Test Unit in 2011.

Dr. Persky splits her effort between providing leadership for the Immersive Virtual Environment Testing Area and conducting her programmatic research. Her work investigates the function of new genomic knowledge about common conditions like obesity in interactions between health care providers and patients and in public and online discourse. She has authored several publications and given a number of invited lectures related to this research program. She has also published both peer-reviewed and invited pieces on immersive virtual reality research methodology.

Christoph Pimmer, Ph.D. (*Workshop Co-Chair*), is senior researcher and lecturer at the University of Applied Sciences and Arts Northwestern Switzerland Fachhochschule Nordwestschweiz. He completed his Ph.D.

(Dr. oec.) at the University of Zürich, Faculty of Economics, Business Administration and Information Technology with distinction/summa cum laude. Dr. Pimmer acted as visiting research associate at the University College London and at Columbia University in New York City.

Dr. Pimmer has been working in the fields of digital global learning and knowledge management for more than 15 years and he has developed a particular interest in global and public health. In these areas, Dr. Pimmer has published extensively and his work has been accepted in leading journals in the fields of health care sciences and services, medical informatics, and education.

Angela Robert co-founded Conquer Mobile with a vision to transform the way people work by effortlessly embracing mobile technology. She leads with effervescent passion and inimitable style—driving an unusual combination of innovation and process efficiency.

Ms. Robert established her credentials as a software engineer at Scotiabank, IBM, and Electronic Arts (EA). At EA she worked on more than 20 games in 5 years and as Development Director for Skate and Skate 2.

Susan C. Scrimshaw, Ph.D., is President of The Sage Colleges, Troy, New York. Previous positions include President of Simmons College, Boston, Massachusetts; Dean of the School of Public Health at the University of Illinois at Chicago; and Associate Dean of public health and professor of public health and anthropology at the University of California, Los Angeles. She is a graduate of Barnard College, with a Ph.D. in anthropology from Columbia University. Her research includes community participatory research methods, health disparities, pregnancy outcomes, violence prevention, and culturally appropriate delivery of health care. She is a member of the National Academy of Sciences and a fellow of the American Association for the Advancement of Science and the American Anthropological Association. She served on the Chicago and Illinois State Boards of Health. She is past President of the board of the U.S.-Mexico Foundation for Science and of the Society for Medical Anthropology, and former Chair of the Association of Schools of Public Health. Her honors include the prestigious Yarmolinsky Medal, given by the National Academy of Medicine for distinguished service; the Margaret Mead Award; and a Hero of Public Health gold medal awarded by President Vicente Fox of Mexico. Dr. Scrimshaw lived in Guatemala until age 16. She speaks Spanish, French, and Portuguese.

Radhika Shah is an Angel & Impact investor, tech industry veteran, and Co-President of Stanford Angels & Entrepreneurs, a more than 1,000-member Stanford club of entrepreneurial Stanford students, faculty, and alumni. She

has been an an advisor, mentor, and judge at Innovation Accelerators Startx & Skydeck Labs. She is a co-founder of the mentoring group RajeevCircle.org. She has been a speaker/panelist at Stanford classes, seminars, and at events such as the 2016 Global Entrepreneurship Summit at Stanford.

She is an advisor to the Sustainable Development Goals Philanthropy Platform, and she co-founded the former Ashoka SV chapter, on the SV-Leadership Council for Action for India. She is also on the International Advisory board of the Business and Human Rights Resource Center and an advisor to Impact Experiences and Illumen Capital, a fund of impact funds.

She has been a judge at the United States Small Business Association and is deeply engaged with the United Nations. She is passionate about leveraging technology for social good and active in civic engagement and social causes since her early childhood, having grown up under the influence of Gandhi Ashram in India. She holds an M.S. in Computer Science from Stanford University and an M.B.A. from the University of California, Berkeley.

George Siemens is an educator and researcher on learning, technology, networks, analytics, and openness in education. He is the author of *Knowing Knowledge*, an exploration of how the context and characteristics of knowledge have changed and what it means to organizations today, and the *Handbook of Emerging Technologies for Learning*. *Knowing Knowledge* has been translated into Hungarian, Italian, Mandarin, Persian, and Spanish. Dr. Siemens is the Associate Director of the Technology Enhanced Knowledge Research Institute at Athabasca University, leading the learning analytics research team.

He has delivered keynote addresses in more than 30 countries on the influence of technology and media on education, organizations, and society. His work has been profiled in provincial, national, and international newspapers (including *The New York Times*), radio, and television. His research has received numerous national and international awards, including an honorary doctorate from Universidad de San Martin de Porres for his pioneering work in learning, technology, and networks.

Dr. Siemens is a founding member of the Society for Learning Analytics Research (http://www.solaresearch.org). He has served as a member of the Steering Committee for Association for the Advancement of Computing in Education's ED-MEDIA conference since 2008. He is on the editorial board of numerous journals, including Multimedia Educational Resource for Learning and Online Teaching's *Journal of Online Learning and Teaching* and *Journal of Interactive Media in Education*. He pioneered massive open online courses that have included almost 20,000 participants.

Diane J. Skiba, Ph.D., M.Ed., is a Professor and the Director for Healthcare Informatics Specialty at the University of Colorado College of Nursing. She has taught course for nurses about technology since 1982. She is the editor of the Emerging Technologies Column for the journal *Nursing Education Perspectives*. She is a Fellow in the American College of Medical Informatics and an honorary Fellow in the American Academy of Nursing and the Academy of Nursing Education. She is the Chair of the International Medical Informatics Association Nursing Informatics Special Interest Group.

Sunbin Song is a Senior Research Fellow at the National Institutes of Health's National Institute of Neurological Disorders and Stroke. Dr. Song received a Bachelor of Science in Biology from the Massachusetts Institute of Technology and a Ph.D. in Neuroscience from Georgetown University.

Jeanie Staton is a Strategic Accounts and Implementation Specialist for Laerdal Medical. She is a former educator with more than 10 years in health science publishing. She currently works with hospitals and nursing schools to implement digital resources into their programs and departments. Understanding the transformation taking place in health education, Ms. Staton seeks to continue the shift from traditional modes of learning into innovative technology and practice.

Cynthia A. Walker, M.B.A., joined Medtronic in 1997 and brings a wide range of experience in effective leadership. Her current responsibilities include Global Medical Education, Fellows Programs, Procedure Training, Sales Force Technical Education, the Grants and Donations function, Customer Insight, and Professional Relations. She leads a team of individuals who develop educational curricula and provide an in-depth overview of cardiac rhythm heart failure products and therapies, including history, terminology, products, and cardiac therapies in easy-to-understand language. Global curriculum is delivered using multiple modalities including in vivo, didactic, blended, peer-to-peer symposium, and via an extensive Learning Content Management System. The Customer Insight Group is responsible for gathering both qualitative and quantitative blinded and unblinded data to help the business incorporate the voice of the customer in all cardiac rhythm disease management products, processes, and programs. This group manages advisory boards, focus groups, and market research studies for the organization with the vision to bring the voice of the customer into all that they do.

She has held various roles in field sales, field management, and market development. In 2004, she assumed the role of a Director, Training and

Education, and is responsible for technical field education and customer training. As a Senior Director, she has held leadership positions of increasing responsibility in medical education and diagnostic sales. Prior to Medtronic, she held roles in sales and account management with Kimberly-Clark Professional Healthcare and AT&T.

Ms. Walker holds Bachelor of Science degrees in Business and Psychology from the University of Pittsburgh and an M.B.A. from the University of Pittsburgh.

Paul Worley, Ph.D., M.M.B.S., is an academic rural doctor and was appointed as Australia's first National Rural Health Commissioner. Previously, Dr. Worley served as the Dean of Medicine at Flinders University. His work in the science of rural, community-based, medical education, and its impact on addressing the maldistribution of doctors for rural and underserved areas, has changed the face of medical education and rural medical workforce policy nationally and internationally. Dr. Worley's leadership of junior doctor training in general practice has transformed the transition from medical school to postgraduate training for general practice. He is a past President of the Rural Doctors Association of South Australia (SA), a previous national Vice President of Australian College of Rural and Remote Medicine, and a current Council Member of the Australian Medical Association (SA).

Appendix D

Forum-Sponsored Products

Convening Activity Publication: ***Interprofessional Education for Collaboration: Learning How to Improve Health from Interprofessional Models Across the Continuum of Education to Practice: Workshop Summary*** **(2013)**
In 2012, the Global Forum on Innovation in Health Professional Education held its first two workshops, focusing on linkages between interprofessional education (IPE) and collaborative practice. The workshops set the stage for defining and understanding IPE and provided living histories of speakers from around the world who shared experiences working in and between IPE and interprofessional or collaborative practice. This publication summarizes the workshops.

Convening Activity Publication: ***Establishing Transdisciplinary Professionalism for Improving Health Outcomes: Workshop Summary*** **(2013)**
This publication looks at professionalism among the different health professions and considers whether it might be possible for all the health professions to share a common understanding of professionalism with each other (in a transdisciplinary fashion) and with society (through a social contract), and have that understanding be practiced and promoted in the education of all health professionals.

Convening Activity Publication: ***Assessing Health Professional Education: Workshop Summary*** **(2013)**
The content covered at the workshop and captured in this publication involves assessing core competencies particularly within interprofessional ed-

ucation and health professional collaborations that include patient-centered health care teams. Discussions at the workshop helped describe these competencies and explored the challenges, opportunities, and innovations in assessment across the education-to-practice continuum.

Convening Activity Publication: ***Building Health Workforce Capacity Through Community-Based Health Professional Education: Workshop Summary*** **(2014)**

In setting the stage for the workshop that is summarized in this publication, the first speaker reminded participants of the importance of learning from and with communities for understanding the values and challenges faced by the community they serve. It was later remarked that health systems are *of* the community thus reinforcing the importance of bi-directional learning. Innovative examples of community-based learning that followed this idea were presented and discussed.

Convening Activity Publication: ***Empowering Women and Strengthening Health Systems and Services Through Investing in Nursing and Midwifery Enterprise: Lessons from Lower-Income Countries: Workshop Summary*** **(2015)**

Experts in women's empowerment, development, health systems' capacity building, social enterprise and finance, and nursing and midwifery explored the intersections between and among these domains. Innovative and promising models for more sustainable health care delivery that embed women's empowerment in their missions were examined. This publication highlights examples and explores broad frameworks for existing and potential intersections of different sectors that could lead to better health and well-being of women around the world, and how lessons learned from these examples might be applied in the United States.

Consensus Study Report: ***Measuring the Impact of Interprofessional Education on Collaborative Practice and Patient Outcomes*** **(2015)**

Whereas considerable research has focused on student learning in interprofessional education (IPE), only recently have researchers begun to look beyond the classroom and beyond learning outcomes for the effect of IPE on such issues as patient safety, patient and provider satisfaction, quality of care, health promotion, population health, and the cost of care. The forum members wanted to know what data and metrics are needed to evaluate the effect of IPE on individual, population, and system outcomes. To answer this question, the individual sponsors of the forum sponsored an Institute of Medicine study to examine the existing evidence on this complex issue and consider the potential design of future studies that could expand this evidence base.

Convening Activity Publication: *Envisioning the Future of Health Professional Education: Workshop Summary* (2015)
This publication summarizes a workshop where forum members focused on envisioning the future of health professional education in light of the *Lancet Commission Report*. The workshop aimed to explore the implications that shifts in health, policy, and the health care industry could have on health professional education and workforce learning; identify learning platforms that could facilitate effective knowledge transfer with improved quality and efficiency; and discuss opportunities for building a global health workforce that understands the role of culture and health literacy in perceptions and approaches to health and disease.

Consensus Study Report: *A Framework for Educating Health Professionals to Address the Social Determinants of Health* (2016)
The World Health Organization defines the social determinants of health as "the conditions in which people are born, grow, work, live, and age, and the wider set of forces and systems shaping the conditions of daily life." These forces and systems include economic policies, development agendas, cultural and social norms, social policies, and political systems. Educating health professionals in and with communities negatively affected by the social determinants of health can generate awareness among those professionals about the potential root causes of ill health, contributing to more effective strategies for improving health and health care for underserved individuals, communities, and populations. This is the context in which the expert committee of the National Academies of Sciences, Engineering, and Medicine developed a high-level framework for educating health professionals to address social determinants of health. The committee's framework aligns education, health, and other sectors to better meet local needs in partnership with communities. The individual sponsors of the forum sponsored this study.

National Academy of Medicine (NAM) Perspective Paper: *Breaking the Culture of Silence on Physician Suicide* (2016)
Every year an estimated 400 U.S. physicians take their lives. Numerous global studies involving every medical and surgical specialty indicate that approximately one in three physicians is experiencing burnout at any given time. Medical students appear to be at an equal or higher risk of burnout, depression, substance abuse, and suicide. Because of the perceived and real risks associated with seeking help for such problems, many students, trainees, and doctors, and health care organizations fail to recognize, report, discuss, or pursue treatment for these conditions. The purpose of this paper is to shine a spotlight on this culture of silence, to understand the scope and complexity of the underlying issues, and to drive changes to deliver indi-

vidual, organizational, and societal interventions that preserve and promote the physical and emotional health of caregivers.

Convening Activity Publication: *Exploring the Role of Accreditation in Enhancing Quality and Innovation in Health Professions Education* (2016)
The purpose of accreditation is to build a competent health workforce by ensuring the quality of training taking place within those institutions that have met certain criteria. It is the combination of institution or program accreditation with individual licensure—for confirming practitioner competence—that governments and professions use to reassure the public of the capability of its health workforce. This workshop explored global shifts in society, health, health care, and education, and their potential effects on general principles of program accreditation across the continuum of health professional education. This publication summarizes the workshop.

NAM Perspective Paper: *I Felt Alone But I Wasn't: Depression Is Rampant Among Doctors in Training* (2016)
Dr. Elisabeth Poorman, a primary care doctor and a former resident at Cambridge Health Alliance, answered the call and agreed to reprint her entry in WBUR's CommonHealth blog, published in August 2016. This piece is Dr. Poorman's personal reflection on the rampant depression experienced by doctors and doctors in training. As with any challenge, the first step is to identify the problem so solutions can be formed jointly by those most affected.

NAM Perspective Paper: *Defining Community-Engaged Health Professional Education: A Step Toward Building the Evidence* (2017)
The Global Strategy for Health Workforce 2030 outlines a set of milestones and strategies to expand and strengthen the health workforce that could better position countries to achieve universal health coverage and relevant Sustainable Development Goals (SDGs). The strategy underscores a need to counter the global shortage of health workers (expected to be 17 million by 2030) and ensure the workforce is appropriately trained to address the evolving health needs of the population. This training would ideally produce health professionals who are responsive to the population, socially accountable, both person- and population-centered, and supportive of empowered and engaged communities. Community-engaged health professional education is a mechanism for learning how to work in and with communities while obtaining the attributes just listed. Developing socially accountable individuals and institutions within a health system is key to improving the health and well-being of present and future societies.

NAM Perspective Paper: *100 Days of Rain: A Reflection on the Limits of Physician Resilience* (2017)

By January 1999, it rained, they say, for more than 100 days in a row. Seattle has a reputation for precipitation, which I have to believe could lead to higher rates of seasonal affective disorder and the need for strong coffee. It was during this month that I can say I may have reached my low point. I was a young, insecure, and nervous intern in the Harborview Medical Center intensive care unit that month—one in which our attending physician later admitted was the busiest of his long career. Myself and my senior resident, Phil, came to expect the admission of more than 10 critically ill patients every fourth night.

The idea of caps on resident duty hours has been studied and discussed since the early 1970s, and even in 1999 the 80-hour workweek was implemented, if not necessarily followed. But caps were not a term we used on-call—they were what our surgical colleagues wore in the operating room, and what I wore on the rare off day I could attend a Mariners game. Despite a deep-seated feeling that I was an imposter in such a well-regarded training program, I was always a relatively happy-go-lucky guy, who tended to be a shoulder to cry on rather than the one who might suffer from burnout.

NAM Perspective Paper: *A Multifaceted Systems Approach to Addressing Stress in Health Professions Education and Beyond* (2017)

There are unique stressors faced by health professionals that begin during the educational process and continue throughout training and into practice. While stress is expected owing to the intense nature of the work in health care, the systems in which faculty and health professionals work often intensifies this already stressful environment and can lead to negative mental and physical effects. Stress takes a major toll on individuals and has been reported to increase absenteeism, errors, burnout, and substance use, and it can even lead to individuals quitting the health professions altogether. While it is indisputable that the nature of the work in health care causes stress, organizations also bear responsibility for accepting and even creating an institutional culture where stress can be worsened by outdated or negative policies and behavioral patterns. Moral distress can be experienced when there is difficulty obtaining appropriate interventions or care to support patients and families.

Convening Activity Publication: *Future Financial Economics of Health Professional Education: Proceedings of a Workshop* (2017)

Health workforce shortages affect people's access to quality health care around the globe, and can result in untreated sickness, disability, and adverse economic consequences. Chronic underinvestment in health workforce education and training creates a mismatch between strategies to educate

the right number and mix of health professionals and meeting the needs of the population particularly within remote and underserved communities. Addressing this mismatch while considering how supply and demand drive decisions within education and health was the topic of the workshop summarized in this document. The workshop sought to explore resources for financing health professional education in high-, middle-, and low-income countries, and to examine innovative methods for financially supporting investments in health professional education within and across professions.

NAM Perspective Paper: *Addressing Burnout, Depression, and Suicidal Ideation in the Osteopathic Profession: An Approach That Spans the Physician Life Cycle* (2017)

Burnout, depression, and suicidal ideation are key areas of concern because of the consequences they can have on physicians as well as the patients for whom they care. The level of burnout in the medical profession has increased at an alarming rate in the past decade. Statistics reveal that about 54 percent of all physicians are burnt out (30–40 percent of employed physicians and 55–60 percent of self-employed physicians). Students, interns, and residents also factor into the equation as reports indicate they experience burnout at a rate of 20–40 percent. According to the *International Classification of Diseases*, Tenth Edition (ICD-10), burnout is defined as "a state of vital exhaustion." It manifests as emotional exhaustion that affects a person's passion for work; ability to relate to others; sense of accomplishment or purpose; judgment; productivity; emotions; and overall health.

NAM Perspective Paper: *Burnout, Stress, and Compassion Fatigue in Occupational Therapy Practice and Education: A Call for Mindful, Self-Care Protocols* (2017)

Now more than ever is the time for occupational therapy educators, students, and practitioners to invest in strategies to combat burnout and stress. Current health care practice requires occupational therapy practitioners to manage many dimensions of patient care. Combining professional and educational duties with the emotional energy required for patient encounters and managing one's personal life can create the potential for burnout and compassion fatigue and an imbalanced professional quality of life. Yuen (1990) called on occupational therapy fieldwork educators to put more time in their formal training toward teaching experiences with their students, and to recognize potential for burnout by increasing self-awareness.

NAM Perspective Paper: *Promoting Well-Being in Psychology Graduate Students at the Individual and Systems Level* (2017)

More than 70 percent of psychology doctoral students report experiencing stressors that can affect their ability to fully function. Common stressors

include academic responsibilities, debt, anxiety, and poor work–life balance. Lack of support from faculty, poor relationships with faculty, and cohort tension are sources of stress and negatively affect both personal and professional functioning while serving as barriers to effective coping. This can result in trainees who have difficulty developing and exhibiting the proper degree of professional competence (termed as problems with professional competence). These problems with professional competence can be manifested in difficulties attaining identity as a psychologist, self-awareness, and reliable clinical judgment and reflection skills, as well as developing the ability to have effective interpersonal interactions. Once competency problems emerge, they demand immediate attention in order to ensure patient safety and effective care. A proactive and preventive strategy involves implementing both individual- and systems-level approaches designed to increase self-care.

NAM Perspective Paper: ***Stress-Induced Eating Behaviors of Health Professionals: A Registered Dietitian Nutritionist Perspective*** **(2017)**
For health professionals, stress and eating often combine in unhealthy ways. The stress comes early in their training and lingers throughout their careers. Anyone who has worked or trained in a hospital knows all too well the cycle of workplace stress leading some individuals to overeat and gain excess weight, which in turn leads to physical and mental stress owing to the weight gain itself. Others react to stress by eating less and losing weight, which can similarly have negative consequences. Often stress comes with unhealthy food choices such as skipping meals, reliance on fast food, restricting fluid intake, or choosing foods high in sugars and fats and low in nutrients. Skipping meals and drinking too little fluid have not been shown to increase medical errors, but they do contribute to burnout and jeopardize weight and nutritional status.

NAM Perspective Paper: ***Breaking Silence, Breaking Stigma*** **(2017)**
In a late March issue of the *New England Journal of Medicine*, the dean of my medical school published a beautiful essay on the tragic death of one of my classmates. Kathryn had committed suicide last August. Earnest and humble, Dr. Muller's piece demonstrates his ongoing commitment to promoting wellness among medical trainees in a way that is not reactionary but rather proactive and sustained. With student input, he and his colleagues are studying ways to enhance work–life balance, relieving the pressure to perform according to unforgiving metrics, and expanding access to mental health resources. As I read his thoughtful words, a gnawing question formed in my mind: Why has a medical school community with deeply compassionate leadership seen two trainee suicides in 1 year? More broadly, if Hippocrates's words are true that those who love medicine also love

humanity, how does profound suffering pass unnoticed among our own? Perhaps we residents can play a role in bringing that suffering out into the open. While continuing to expect confidential mental health services, we should at the same time foster a culture that embraces open conversation about experiences with depression and other mental illnesses.

NAM Perspective Paper: *Breaking the Culture of Silence: The Role of State Medical Boards* (2017)

The NAM Perspectives paper *Breaking the Culture of Silence on Physician Suicide* brought together four unique voices from surgery, nursing, medical training, and the clergy to consider what led Kaitlyn, a young medical student, to take her own life on April 11, 2013. Drawing from personal experiences, the authors exposed what they thought was a culture of silence under intense pressure that pushes physicians, health professionals, and trainees to experience depression and in some cases to tragically end their lives. But these are just four opinions based on four experiences. The authors hope to bring more voices into the conversation by asking others who are comfortable doing so to share their own reactions to situations they have been forced to navigate throughout their education and careers as health care providers.

NAM Perspective Paper: *The Role of Accreditation in Achieving the Quadruple Aim* (2017)

Interprofessional education (IPE) and collaborative practice continue to gain momentum within the health sector. Recently, accreditors from multiple health professions have joined together to discuss their role and to set continuing education standards for IPE and guidance for interprofessional foundational education. And although models for IPE exist to guide the learning process from education to practice, there are few guides for the historic work of accreditors to promote interprofessional collaboration across education and practice.

Convening Activity Publication: *Exploring a Business Case for High-Value Continuing Professional Development: Proceedings of a Workshop* (2018)

Continuing education, continuing professional development, and high-value continuing professional development (CPD) exist along a continuum. The Global Forum on Innovation in Health Professional Education hosted a workshop on April 6–7, 2017, to explore the value proposition for CPD. Forum members and workshop participants gathered in Washington, DC, to learn about innovative CPD programs around the world, to consider the perspectives of those who invest in CPD, and to discuss the businesses case for CPD. The workshop rapporteurs prepared this proceedings as a factual summation of the session discussions.