Effective Use of Educational Technology in Medical Education

Colloquium on Educational Technology: Recommendations and Guidelines for Medical Educators

AAMC Institute for Improving Medical Education

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Case Study 1

A biochemistry course director receives a grant to develop a Web site for teaching first-year medical students in metabolic pathways. To better understand typical student perception and performance, he holds a student feedback session and analyzes pre-test scores. Before selecting a technical approach, he consults other basic scientists and clinicians to ensure that the educational objectives are relevant, well-organized, and integral to other elements of the curriculum. A professional educator with technology expertise is consulted to carefully analyze the objectives and suggest an appropriate instructional strategy. The decision is made that use of the Web site will be mandatory for all students enrolled in the course.

The instructor apportions content into topic-based chapters organized around patient cases, which are designed to focus learner attention and integrate various concepts. Each chapter begins with a description of the learning objectives and a brief tutorial to stimulate recall of relevant prerequisite information. The material is presented through interactive animation using Mayer's ten principles of effective multimedia. Learners are occasionally given advice and tips for learning particularly difficult concepts. Each chapter ends with a succinct summary and practice problems. The last section of the Web site offers a sample exam with multiple-choice questions derived from each of the learning objectives. Learners are provided individualized feedback based on their performance.

The instructor provides appropriate basic science and clinical faculty with links to the Web site and helps them understand how they can use relevant content. The instructor uses student feedback to further refine the site.

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Executive Summary

Medical educators increasingly use technology to supplement the delivery of learning resources. The advent of multimedia technology, the World Wide Web and the ubiquitous nature of networked computers, have transformed educational technologies from esoteric legacy applications used by a few pioneering faculty to mainstream applications integral to the medical school educational enterprise. This increased use is reflected in the growing number of publications and conference presentations related to educational technology.

There is no doubt that educational technologies have enhanced teaching and learning in medical education. There is also no doubt that technologies will continue to evolve and become further integrated into all facets of our professional and personal settings. The medical education community must be able to assure itself that the information presented to medical students and the venues through which it is presented are compatible and optimize learning and justify the substantial investment of resources (people, facilities, money) that these resources require. For medical schools to "make the case" for such investments it is imperative that use of technology be linked to what we know about learning. Often there is a "cultural lag" in appropriately pairing novel technology with effective use, making it essential that medical educators be confident that educational theory guides and supports their use of technology.

AAMC's Institute for Improving Medical Education convened an invited colloquium of national experts to consider the state of research and documented efficacy of educational technologies in the medical school curriculum. Indeed these participants confirmed that more evidence is needed to determine precisely ***when*** to employ technology during the medical education process and ***how*** best to use it when it is employed. This summary report offers the consensus of the IIME expert panel around these issues, suggests recommendations on how best to utilize available technologies in the medical education setting, and proposes research questions to further guide our understanding and advance the established literature.

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Background

Educational technology tools offer compelling instructional capabilities and provide faculty and students with new educational possibilities. These resources can portray anatomical and physiological processes with remarkable clarity, tailor instruction to learner needs, allow learners to practice skills in a safe environment, standardize instruction and assessment activities, and be offered anywhere and anytime. Furthermore, today's learners are accustomed to technology-enhanced learning environments.

Educational technologies are used extensively at all points on the medical education continuum and vary widely in complexity, degree of realism, and cost. Such resources include relatively straightforward online multimedia tutorials; high-fidelity virtual patient applications that ask learners to diagnose and manage simulated patients; and immersive, team-based simulations designed around lifelike mannequins. Many institutions have purchased commercial products developed for the medical education market, while others have created in-house development teams of educators, illustrators, Web designers, programmers, and other multimedia specialists, who create excellent products for their own use.

The widespread adoption of information technologies has led to a corresponding growth in the development of sophisticated, realistic teaching resources. However, our understanding of how these resources might best be incorporated into the curriculum is inadequate, as advances in *what* could be created often outpace our ability to understand *how* they should be developed or used. While a variety of compelling studies in the medical education literature have described new applications and occasionally compared their effectiveness with traditional instructional approaches such as lectures, they generally do not examine which technology approaches are best suited for a given educational goal. Fortunately, several studies in the educational and cognitive sciences offer evidence-based principles that might be used to guide the effective use of technology in medical education.

The AAMC Educational Technology Colloquium

The Association of American Medical Colleges (AAMC) has a longstanding interest in the use of educational technology by its institutional members. To facilitate the use of effective educational technologies in medical education, the AAMC's Institute for Improving Medical Education charged a panel of experts to consider the current use of certain educational applications at medical schools, and to examine the relevant literature in order to develop recommendations that could be used to help medical schools select, develop, and use appropriate technologies.

In April 2006, the institute convened recognized experts in educational technology to participate in a one-day colloquium, charged with three specific goal;

1. Identify the advantages that educational technologies provide over traditional approaches

2. Recommend the educational theories, principles, and features that should be considered when developing or purchasing educational technologies

3. Suggest directions for future research

Because the overall technology topic is so broad, colloquium participants were charged to focus consideration on interactive instructional and assessment applications: namely, those that teach or assess understanding of biomedical concepts, patient diagnosis and management, and procedural skill training. Resources with little interactivity—such as those that only enable basic learner navigation of text and images—were considered less relevant to the colloquium's scope. Likewise, the group did not discuss delivery systems such as teaching management systems (e.g., BlackBoard), pod-casting, computer-based testing, digitized lecture dissemination, and distance learning.

With a few notable exceptions, the bulk of educational technology research in the medical education literature has been criticized as deficient in either methodological approach, conceptual framework, or both. However, scores of rigorous studies have been published in the fields of educational psychology, cognitive science, information science, military and aviation training, and educational technology. The colloquium participants agreed to consider the seminal literature from each of these fields and suggest principles that may be reasonably inferred from them.

This report summarizes the findings of the April 2006 Colloquium on Educational Technology held in Washington, D.C. The report does not prescribe a single educational technology approach that can be adopted in all learning environments, nor is it a formal analysis of the literature. Instead, it offers principles and recommendations derived from multiple disciplines and perspectives. Notably, this report highlights the essential role of instructional design principles to promote the effective use of educational technology.

The primary audience for this report is medical school teaching faculty members who develop, purchase, or use educational technology to enhance learning. A secondary audience is staff members who support the development, procurement, and implementation of these applications.

Advantages of Educational Technologies

Educational technologies provide instructors with numerous advantages in the areas of contextual learning, active and individualized learning, and automation.

Technology can reproduce an object or concept in a form that may be manipulated by the designer and, ideally, the user for educational purposes. These advantages are particularly clear in simulation technologies and can also exist with computer-based models of real-life processes. Exploration in a realistic environment provides multiple benefits to learners: opportunities to practice rare and critical events, safe and controlled environments that eliminate risk to patients, enhanced visualization, and authentic contexts for both learning and assessment. In these environments, assessment of learner behavior and outcomes can be documented.

Modern educational technologies can process learner decisions and present realistic responses to provide an individualized learning experience. Educational technologies attuned to the characteristics of adult learners promote active, student-centered learning. Instruction can also be tailored to individual needs by empowering learners to control their educational experience, including opportunities for repetition and deliberate practice with structured guidance. These principles apply to both group and individual instructional settings.

Because of their automated nature, educational technologies provide perpetual resources that uncouple instruction from physical space constraints or instructor availability. These tools can facilitate standardized instruction and assessment and offer new economies of scale, despite the higher initial investment likely to be required.

Educational technologies are advantageous in providing:

- safe, controlled environments that eliminate risk to patients
- enhanced, realistic visualization
- authentic contexts for learning and assessment
- documentation of learner behavior and outcomes
- instruction tailored to individual or group needs
- learner control of the educational experience
- repetition and deliberate practice
- uncoupling of instruction from place and time
- standardization of instruction and assessment
- perpetual resources and new economies of scale

Common Technologies in Medical Education

There are numerous frameworks that may be used to characterize and classify educational technology applications. Colloquium participants considered three broad categories based on the predominant usage in medical education. While these applications overlap in terms of technology components and instructional possibilities, they are sufficiently distinctive to consider independently:

1. **Computer-aided Instruction (CAI)**—Instruction in which computers play a central role as the means of information delivery and direct interaction with learners (in contrast to applications such as PowerPoint); to some extent human instructors are replaced. These programs may make use of Internet technologies (Web-based learning), and include a wide variety of standalone applications or online materials.

2. **Virtual Patients (VP)**—A specific type of computer-based program that simulates real-life clinical scenarios; learners emulate the roles of health care providers to obtain a history, conduct a physical exam, and make diagnostic and therapeutic decisions.

3. **Human Patient Simulation (HPS)**—The use of mannequins or models to simulate patient care environments for instructional or assessment purposes. Tools in this category include task-based trainers that simulate specific procedural tasks (e.g., virtual reality colonoscopy trainers).

Each of these approaches has advantages and disadvantages (see Table 1) based on its inherent technical capabilities.

Table 1. Advantages and disadvantages of various educational technologies.

Type of Instruction	Advantages	Disadvantages
Computer-aided Instruction	• Useful for visualizing complex processes • Independent exploration of complex phenomena • Easy access • Relatively low-cost of production	• Limited physical interactivity • Limited fidelity
Virtual Patients	• Encompasses multiple aspects of clinical encounter • Longitudinal and multidisciplinary care lessons • Easy access • Readily customized	• Limited physical interactivity • Limited fidelity • High production costs
Human Patient Simulation	• Immersive, active experience • Engages emotional and sensory learning • Fosters critical thought and communication • Animates basic science in clinical context	• Cost and space requirements • Limited to simulator and staff availability • Engineering limitations

Effective programs match instructional approaches with educational goals. The medical education environment may include any combination of cognitive, perceptual, and psychomotor educational goals. Each type of goal may be achieved through the use of at least one educational technology. Table 2 suggests how the various technologies might be used, based on a combination of available research, perceived benefits, and technical capabilities:

The Role of Fidelity

When designing an application that simulates a biomedical or patient care phenomenon, instructors should consider the appropriate level of fidelity and the degree to which the technology accurately simulates the intended task, resource, or environment. Many computer-aided instruction applications are considered low-to-medium fidelity as the display is limited to a computer monitor and learner interaction consists of standard keyboard and mouse inputs. In contrast, human patient simulation (HPS) applications are often high-fidelity because they require learners to assume the behaviors of a healthcare providers in realistic healthcare environments centered on models and mannequins. However, even with human patient simulation scenarios and full-scale simulations, there are limitations to the fidelity that can be achieved. Moreover, perceived fidelity has a strong subjective component and participants may have different experiences. Fidelity should be conceived more as a negotiable currency than an absolute concept.

How fidelity affects learning is not clearly understood; certain high-fidelity features can be costly and haven't yet proved to improve learning. Furthermore, some low-fidelity models have been shown to improve surgical skill acquisition. Appropriately matching the level of fidelity with the learner's expertise and the corresponding educational goal is, however, generally accepted. This being the case, since the optimal level of fidelity (realism) required ***likely*** varies depending upon the learner's degree of prior practical experience and exposure, a novice can engage in a meaningful learning experience with less sophisticated fidelity than might be needed for an expert learner who has already acquired substantial expertise and

Table 2. Educational technologies best suited to accomplishing particular educational goals.

Educational Goal	Suggested Educational Technology
Facilitate basic knowledge acquisition	Computer-aided Instruction Virtual Patients
Improve decision making	Computer-aided Instruction Virtual Patients Human Patient Simulation
Enhance perceptual variation	Computer-aided Instruction Virtual Patients
Improve skill coordination	Human Patient Simulation Task Trainers
Practice rare/critical events	Virtual Patients Human Patient Simulation
Conduct team training	Human Patient Simulation
Improve psychomotor skills	Task Trainers

experience. While not definitively substantiated, Figure 1 illustrates the conventionally posited relationship of optimal level of fidelity along the novice, experienced, and expert learner continuum.

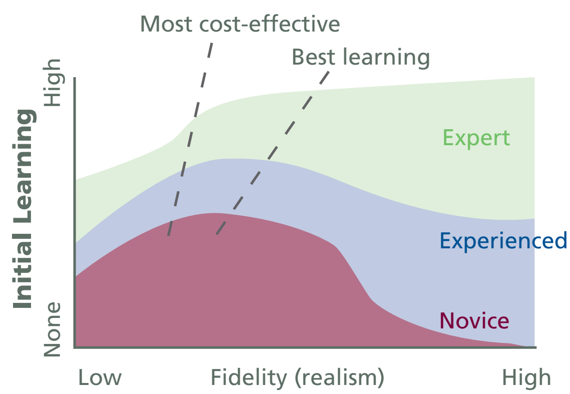

Figure 1. The hypothesized relationship between level of learner and degree of fidelity. This diagram suggests that the optimal level of fidelity may change with the learner's level of experience. Diagram adapted from Alessi S. Fidelity in the Design of Instructional Simulations. *Journal of Computer-Based Instruction*. 1988; 15: 40-47.

Evidence-Based Features and Practices that Promote Effective Learning

Multimedia
(computer-aided instruction, virtual patients)

When designing or purchasing an educational technology resource that contains multimedia components, particular attention should be paid to the selection, sequencing, and presentation of information. Certain elements can induce cognitive overload and detract from learning, such as the presentation style of information and the appropriateness of the learning material. Thus, one challenge of effective instructional design is creating applications that include only those features that promote learning while avoiding gratuitous elements that may distract. Richard Mayer's widely accepted ten instructional multimedia principles can offer medical educators guidance on the application of multimedia components in educational interventions in order to maximize the positive effects for optimum student learning. With these principles in mind, instructional multimedia should conform to the following:

1. **Coherence Principle**—Exclude extraneous words, pictures and sounds.
2. **Pre-Training Principle**—Ensure students possess prior knowledge about names and characteristics of the main concepts.
3. **Spatial Contiguity Principle**—Present corresponding words and pictures in close proximity to one another.
4. **Temporal Contiguity Principle**—Present corresponding words and pictures simultaneously rather than successively.
5. **Signaling Principle**—Highlight important words.
6. **Redundancy Principle**—Pair animation and narration together ***without*** on-screen text.
7. **Voice Principle**—Use non-accented human spoken voice for narration over a machine simulated or foreign-accented human voice.
8. **Personalization Principle**—Employ conversational style, instead of formal, to present words.
9. **Segmenting Principle**—Offer narrated animation in learner-paced segments rather than a continuous unit.
10. **Modality Principle**—Pair animation and narration together ***instead*** of pairing animation and on-screen text.

Simulation
(virtual patients, human patient simulation)

An increasing number of specialized programs in medical education employ high-fidelity simulations. They vary in how technology is utilized, how instructors are engaged, and the extent to which the simulation activity is incorporated into the curriculum. Because they can be costly, investments in high-fidelity simulations usually demand evidence of positive results. A recently published qualitative, systematic review—spanning 34 years and 670 peer-reviewed journal articles—identified 10 characteristics of effective high-fidelity medical simulations in a range of specialties, including anesthesiology, cardiology, and surgery. Many characteristics are consonant with Ericsson's model of deliberate practice for mastering professional performance. Although this list was derived from research on high-fidelity simulation, many principles may well apply to virtual patients.

1. **Feedback**—Formative and constructive feedback of performance is the single most important feature of simulation-based medical education. It is the most important factor in ensuring skills transfer to patient settings and helps slow the deterioration of skill over time.

2. **Repetitive practice**—Opportunities for learners to engage in focused, repetitive practice with the intent of skill improvement, not idle play, is an essential learning feature. This factor is also essential to ensuring skills transfer to actual patients; the practice "dose" should be determined by learners' needs, not instructors' demands.

3. **Curriculum integration**—Simulation-based education should not be an extraordinary activity, but built into learners' routines and required training schedules, and grounded in the ways learner performance is evaluated. Simulation should also be fully adopted within the broader medical school educational program and not dependent on a single "champion," who often has competing research or patient care responsibilities.

4. **Range of difficulty level**—Learning is enhanced when learners have opportunities to engage in medical skills practice across a wide range of difficulty levels. Helping learners master skills at increasingly difficult levels slows their deterioration of skills over time.

5. **Multiple learning strategies**—Ideally, simulations should offer a variety of educational strategies including large groups (e.g., lectures), facilitated small groups (e.g., tutorials), and both individual and small-group learning without an instructor. The strategies adopted should be determined by the desired outcomes, the available resources, and the institution's educational culture.

6. **Capture clinical variation**—High-fidelity medical simulations that capture or represent a wide variety of patient problems or conditions are more effective than simulations having a narrow patient range. This provides more "contextual experiences" that are critical for obtaining problem-solving skills.

7. **Controlled environment**—In a controlled clinical environment, learners can detect and correct patient care errors without adverse consequences, while instructors can focus on learners rather than patients.

8. **Individualized learning**—Learners' opportunities for reproducible, standardized educational experiences in which they are active participants, not passive bystanders, is an important feature.

9. **Defined outcomes or benchmarks**—Learners are more likely to master key skills if outcomes are defined and appropriate for their training level prior to the simulator exercise.

10. **Simulator validity**—A high degree of realism or fidelity provides an approximation of complex clinical situations, principles, and tasks and is essential to help learners increase their perceptual skills and to sharpen their responses to critical incidents. Although it is important to note that the desired outcome should be matched with the appropriate degree of fidelity. Many competencies can be learned and mastered with relatively low-fidelity simulators.

Faculty Development and Training

The effective use of technology in medical education is in large part dependent on faculty readiness. This is especially true for sophisticated mannequin-based devices and virtual reality environments that may involve physiological responses to drug administration and drug interaction, interpretation of three-dimensional visual displays, and interpersonal conflict within medical teams. Medical faculty should be prepared in at least two ways to insure optimal use of these educational technologies: they must be skilled in the technical operation of simulators and other devices, and know how to employ the technologies to facilitate learning and assessment.

Expertise in clinical teaching is necessary within a simulated clinical environment but is not sufficient, as there are important differences in the two settings. Faculty training in the specific demands of simulation-based teaching is key, especially with high-fidelity settings utilizing human patient simulation technology.

These demands go beyond an understanding of simulator technology. In clinical teaching, patients' needs always take priority. In simulation-based teaching, learners' needs become central, dramatically altering the emphasis of the encounter. This shift may have a significant impact on teaching style and should be explicitly addressed.

Moreover, approaches to debriefings, feedback, and learner support within a simulation may differ from those employed by teachers in clinical practice. Considerable support may be needed to help clinicians function effectively in simulated settings.

Faculty use of educational technology to maximum advantage will not occur by chance or seniority. The academic medical community should develop competency-based faculty training and certification programs in the use of advanced educational technologies. The programs should teach the theoretical underpinnings of educational technology, coupled with practical expertise in specific approaches. Just as the weight of evidence shows that clinical experience alone does not determine the quality of an individual's delivery of health care, medical faculty competence in educational technologies should be assured, not assumed. In many cases, specialists with formal training in instructional design can serve as useful advisors to faculty content experts.

In addition, certified training expertise should be available to various health professionals, as physicians are not the sole source of medical education. Clinicians in physical therapy, respiratory therapy, specialized nursing, and surgical support, among others, should be eligible for training and certification, especially for simulator operation.

Putting it All Together

There is clearly no single theory or set of principles to guide the practical use of technology in medical education. Researchers have proposed dozens of frameworks and models. Ideally, the effective use of educational technology should begin with the classic instructional design approach, a systematic method of analyzing learner needs and developing appropriate instructional activities. The 'ADDIE' framework is commonly used to help organize an educational technology project. The acronym represents the following steps:

Analyze	Analyze relevant learner characteristics and tasks to be learned
Design	Define objectives and outcomes; select an instructional approach
Develop	Create the instructional materials
Implement	Deliver the instructional materials
Evaluate	Ensure that the instruction achieved the desired goals

The design, development, and implementation phases of this process have been further extended by educational psychology researchers. Robert Gagné's *Nine Events of Instruction* constitutes one instructional design framework:

1. **Gain attention**—Capture learners' attention by presenting a problem, a case, a compelling question, or an interesting statistic. Focus learners' attention so they will be engaged by the material.

2. **Inform learners of educational objectives**—Convey expectations to learners by introducing the educational objectives. Consider describing them in terms of specific knowledge, skills, or behaviors that learners are expected to acquire.

3. **Stimulate recall of prior knowledge**—Help learners build on what they already know by reminding them of prior knowledge (previous material, personal experience, etc.) that is relevant to the current material.

4. **Present the material**—Present logically organized information (or practice) to avoid cognitive overload. Consider incorporating Mayer's principles for the effective use of multimedia. Organize material in order of increasing difficulty. Periodically revisit concepts to facilitate recall.

5. **Provide guidance for learning**—Offer learners specific guidance on how to best understand concepts or acquire skills. Use a different media or format to avoid confusion with the instructional material.

6. **Elicit performance**—Present learners with numerous opportunities to use newly acquired knowledge, skills, or behavior. Repeated practice allows learners to confirm their understanding.

7. **Provide feedback**—Provide learners with specific, constructive, and immediate feedback regarding their performance.

8. **Assess performance**—Assess learners against the aforementioned learning objectives to determine if the knowledge, skills, or behavior have been appropriately acquired.

9. **Enhance retention and transfer**—Review the material. Inform learners of opportunities to apply the new knowledge, skills, or behavior. Offer opportunities for additional practice.

Gagné's method is intuitive to many instructors and can readily be used within educational technology environments. While the relative merit has not been proven for each recommendation, they continue to serve as 'good practices' employed by researchers. Table 3 suggests how the principles might be effectively used with the three common educational technologies. While, medical educators may not be accustomed to such a formal approach in developing an educational activity, instructional design may be even more important when using educational technologies than in face-to-face teaching, because the learning activities must be explicitly planned in advance. A systematic approach to instructional design is essential to the effective use of educational technology, and indeed, educators unfamiliar with such approaches may benefit from engaging experts in instructional design when newly developing learning materials.

Table 3. Technical approaches to help realize each phase of instructional design.

	Computer-aided Instruction	Virtual Patients	Human Patient Simulation
Gain attention	Present a short patient scenario, an interactive model, or a compelling video clip.	Display an opening video (e.g., a dramatic patient presentation).	Put learners in urgent patient scenarios (e.g., cardiac arrest) with worsening condition until appropriate action taken.
Inform learners of educational objectives	Clearly state desired learning objectives/outcomes.	Clearly state desired learning objectives/ outcomes.	Clearly state desired learning objectives/ outcomes.
Stimulate recall of prior knowledge	Analyze material presented in "gain attention" phase or offer an advance organizer to help bridge prior and new knowledge.	Present a series of multiple choice questions related to the "gain attention" phase and consider offering succinct feedback.	In "gain attention" phase, elicit proper actions to manage cardiac arrest—e.g., implement proper protocol for pulseless ventricular tachycardia.
Present the material	Use text or multimedia to present basic concepts (see Mayer's principles) through combinations of lecture, narratives, cases, interactive multimedia, and drill and practice problems.	At the end of a single virtual encounter, direct learners to a Web-based, menu-driven tutorial that addresses core topics of the case.	Provide clinical experiences in controlled settings applicable to real clinical situations. Learner experiences should evoke feelings associated with similar clinical situations.
Provide guidance for learning	Guide understanding by analyzing problems, summarizing, or alternate explanation of concepts.	Use a virtual preceptor to provide decision guidance when too much time has elapsed.	With clear goals allow learners to make mistakes while guiding them on technique or course of action.
Elicit performance	Assign practice problems or cases.	After they view a tutorial on diagnostic imaging, ask learners to interpret a series of radiographs.	Offer opportunities for all learners to be actively engaged and evaluated in simulation experience regardless of role.
Provide feedback	Deliver specific feedback regarding practice problem performance.	When learners ask virtual patients interview questions, the virtual preceptor comments on their relevance to the chief complaint.	Focused formative feedback during simulation or teachable moment. Review video recordings during formal debriefing with faculty and peers.
Assess performance	Deliver a post-exercise exam aligned with the learning objectives.	At program's end, learners receive scores summarizing their performance on multiple-choice questions.	Align objectives and learning opportunities with performance evaluations. Use checklists and rating scales to evaluate processes or outcomes.
Enhance retention and transfer	Consider revisiting material through periodic email updates, reminders, or practice cases.	After using the virtual patient, learners write a narrative reflection on how it reminded them of a real-life patient experience.	Integrate learning strategies and evaluation tools from simulation into clinical practice. Implement mandatory remediation training for skills most prone to deterioration.

A Research Agenda

Colloquium participants agreed that the current evidence base for educational technology in medicine is anemic. Although numerous publications have documented the feasibility of technology to enhance learning in various settings, ***little is established about precisely when to employ technology during medical education*** (versus the many other methods and media available), and ***how best to use it when it is employed.*** Although much can be learned from research in non-medical education fields, future research on educational technology in medical training will require a significant change in focus. Simple answers are unlikely. Rather, solutions will be contingent upon multiple factors including learner attributes, desired learning outcomes, institutional characteristics, and other factors in the learning environment. Future research will have to accommodate these complexities as well.

Colloquium participants called for fewer studies that simply compare instructional approaches (e.g., computer-aided instruction versus lectures) and instead set out the challenge that subsequent research should clarify the uses of technology to facilitate learning—for example, the effectiveness of specific technological features or instructional methods—and when and how to integrate educational technology into the medical training continuum.

Proposed Research Questions

Addressing the following research questions will serve to clarify the appropriate use of education technologies in medical education:

HOW

- How can instructional methods and designs be tailored to individual learner's needs?
- How does the use of educational technology differ for groups compared with individuals?
- How does fidelity impact learning outcomes, educational contexts, and learner characteristics?
- Which technology approaches are appropriate for particular learning outcomes?
- How can we best integrate educational technology into existing curricula?
- What is the most appropriate use of specific simulation technologies?
- What infrastructure (human and technical) is needed to effectively support educational technology in the curriculum?

WHEN

- What are the barriers to successful integration of educational technology into the curriculum?
- What are the characteristics of individuals and institutions that have successfully integrated educational technology into the curriculum?
- How can educational technology be integrated in existing educational settings?
- What is the cost-benefit ratio of various technologies?
- What outcome measures are reliable, valid, and feasible?
- What training opportunities will help ensure that educators possess the necessary competencies listed above?

Case Study 2

A surgery residency program director would like to improve her junior residents' ability to work as a cooperative team during patient crises in the Surgical Intensive Care Unit (SICU). She asks a professional educator to help plan and design the instructional activity. The educator suggests conducting the communication training with a new human patient simulator capable of portraying crisis scenarios. Before designing a simulation scenario, they agree to conduct a literature search and consult other faculty to develop the relevant knowledge, skills, and behaviors; they then develop specific learning objectives and desired outcomes.

They choose a high level of fidelity, designing an environment that includes the human patient simulation device, a nurse, and recognizable features of the SICU. They will videotape group performance to facilitate feedback sessions; some scenarios vary in level of difficulty. Each scenario requires active participation from all residents.

The session is offered at the start of the PGY-1 year and again at the end of PGY-2. The instructor begins the session by sharing an incident from her own experience and asks participants to articulate what they know about teamwork. Educational goals are shared with the team before the scenario begins. After each scenario the instructor plays the video and offers specific feedback. Participants are encouraged to exchange roles during subsequent practice scenarios. The instructor revisits key concepts through an existing weekly seminar series.

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