# Bronchoscopy Education: New Insights

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*"Tell me and I'll forget; show me and I may remember; involve me and I'll understand."*
Chinese proverb

## Background

I have always been amazed that medical education involved learning "on" patients as well as from them. Many years ago, surrounded by other medical students, I positioned myself so as to stand directly beside my senior resident as he prepared to perform a lumbar puncture. Erect in our long white coats, leaning inward with anticipatory curiosity and awe, we marveled at the way he told the patient what he was going to do before ordering her to turn onto her side. After prepping the skin, he inserted the spinal needle effortlessly. We cringed collectively, however, as it was repositioned, causing the patient to cry out in pain. We sighed with relief when a clear fluid suddenly appeared, and the procedure finished; we admired the authoritative tone with which our resident informed this small, frail, and frightened 18-year-old girl with sweat-drenched hair and a poorly fitting hospital gown that uncovered her bare buttocks and lower back that she must lay quietly for several hours and that everything was going to be fine. As we followed the resident out of the room (the ward had several patients, all of whom had been watching us), we felt important in our white coats. Like a swarm of flies around a picnic table covered with food, we excitedly spoke about how cool the resident had been and how easy the procedure seemed. Later that afternoon, I recalled that we had never been told the patient's name nor been introduced to her as she lay passively on her bed. We were not given much of an explanation about the procedure either, and I had not yet had the opportunity to watch others before I was told the very next morning to "go tap that patient in bed 3."

Until very recently, medical training has followed guidelines established by Flexner and Halsted in the early twentieth century [1]: A stepwise postgraduate training program is designed within a "see one, do one, teach one" paradigm, with patients serving as teaching material. Trainees gradually achieve independence from faculty supervision as they progress through their years of apprenticeship. Competency is often presumed based on numbers of procedures performed, and objective measures of knowledge (high-stakes tests) are used for licensure and certification purposes [2].

Today, "see one, do one, teach one" is no longer an acceptable paradigm of procedure-related medical instruction, so patients need no longer suffer the burden of procedure-related training. Furthermore, teachers need no longer devote hours to enumerating facts and figures related to medical illnesses because educational media are increasingly accessible, with information at the fingertips and on the computer screens of

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health-care providers and patients alike [3]. Using inanimate and computer-based platforms, technical skills can be practiced independently or under supervision; structured curricula help assure a foundation of knowledge regardless of the diversity and variability of the clinical setting, and new norms and expectations governing professionalism help guide physician behaviors that promote respect for patient autonomy and shared decision making.

These early twenty-first century learning environments empower both teacher and learner. Benefitting from a bidirectional learning process, they are able to explore together many new and exciting roles. Digital simulation allows students to practice procedures before ever going to the patient's bedside, and, as new delivery systems for instructional materials replace conventional textbooks, enhancing the portability, access, and design of information, both learners and teachers can devote more time to learning *how to think* or *how to teach*, rather than on rote memorization and content development [4]. The availability of web-based instruction, use of interactive case-based exercises, role-playing sessions, opportunities for individualized instruction, and an open forum where teachers serve more as coaches or wise elders free teachers from their podiums. Low-stakes assessment tools and self-assessments can be used to identify areas that warrant remedial training, as well as to document one's progress toward competency and proficiency because at the bedside and in the classroom, the implementation of new models of instruction allows educators more time to build personal relationships with learners. Learners benefit from this because face time with instructors can be used to encourage learning through positive reinforcement, provide key insights into a procedure or management decision, enhance intrinsic motivation, and discover fun in learning. Learning curves may thus be climbed with greater confidence and comfort in a truly caring education environment.

Taking the liberty to depart from a conventional chapter devoted to science and literature review, my objectives in the following paragraphs are instead to (1) address major elements of curricular structure and delivery, (2) provide an example of how a structured curricular approach using a combination of onsite and online materials such as those provided in the Bronchoscopy Education Project might facilitate learning, (3) describe how assessment tools might help guide the educational process and assure procedure-related competency, and (4) discuss how an ethics of teaching underlies and justifies the paradigm shift occurring in today's world of medical procedural education. While flexible bronchoscopy and airway procedures are used as models for discussion, much of what I write is applicable to other areas of procedure-related medicine.

## Curricular Structure and Delivery

Bronchoscopy is performed by a variety of medical and surgical specialists including pulmonologists; thoracic surgeons; ear, nose, and throat specialists; anesthesiologists; and intensivists. Indications vary from simple inspection to diagnosis of lung and airway disorders, assistance with intubation, and therapeutic procedures to remove foreign bodies, restore airway patency, and treat emphysema, asthma, or cancer, to name but a few. There does not appear to be a universally accepted convention by which to teach the technical skills required to perform this procedure, nor to introduce learners to the complexities of a bronchoscopy-related consultation.

In many institutions, the bronchoscopy learning experience is variable, in part because of diverse practice patterns and patient referrals but also because of different teaching interests, methodologies, and time committed to the educational process [5]. In fact, despite its existence since the late 1960s, many questions remain regarding the clinical practice of flexible bronchoscopy. The variability of equipment used and resources available for teaching further complicates matters when contemplating a global approach to the educational process. Videobronchoscopes, for example, are used in most prosperous areas of North America, Europe, and the Middle East, whereas flexible fiberoptic bronchoscopes are still the workhorses of South Americans and many developing

countries in Asia. Techniques are also controversial: Should the scope be held in the left of the right hand? Where should assistants stand? Should the procedure be performed from the head or from in front of the patient? Should the patient be supine or semi-erect? What kind of sedation, if any, should be used? Are universal precautions, including gown, gloves, and protective eyewear, always necessary, and how should equipment be cleaned? Finally, who should be considered able and competent to perform the procedure? Could it be performed by nonphysician providers in specific settings such as an intensive care unit or as part of a lung donor eligibility assessment, or should bronchoscopy remain a physician-only performed procedure? Should training and certification processes be different depending on medical specialty? Should bronchoscopy privileges extend to all types of procedures, or should only certain specialists perform certain types of procedures? How many procedures should one perform to be deemed competent, and if numbers are used as a metric, how many must be performed each year to maintain competency? If they are not used as a metric, what assessment and testing tools might be employed to assure that procedures are performed safely and competently?

**Table 7.1** What we know about bronchoscopy education today

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| • Various learning and teaching modalities are and can be complementary |
| • Didactic lectures can be conveniently accessed off-site though the use of the Internet |
| • Well-edited videos can replace watching cases performed in real time, without jeopardizing patient care or programmatic structure |
| • A learner's active engagement time is maximized if less time is devoted to hands-off demonstrations, and more time is spent assisting learners with clearly identified hands-on skill sets and exercises |
| • Participation in problem-solving and critical thinking (practical approach, case-based) exercises helps assure procedural safety, effectiveness, efficiency, and systems-based practice and tells instructors "how" learners think and process information |
| • The sacrifice of live animals for practice purposes has been rendered unnecessary because cadavers, inanimate models, and computer-based simulation are excellent, proven, and cost-efficient alternatives |
| • Assessments and outcome metrics help identify a learner's position along the experience curve, ascertain knowledge, and measure technical skill acquisition. Insights are provided regarding a program overall effectiveness, and assessments identify weaknesses that can be corrected through remedial, individualized training |
| • A "Bronchoscopy university at your fingertips" is possible using portable tablets and mobile devices. This increases access to learning materials and helps achieve a democratization of knowledge, whereby bronchoscopy training is more uniformly achievable regardless of one's place of work or practice |

## What Is a Bronchoscopy Curriculum?

In most countries, there is no fixed curriculum pertaining to bronchoscopy education (Table 7.1). It is assumed that physicians in various specialties become competent in the procedure as a result of their subspecialty training. In the United States, where more than 500,000 bronchoscopies are performed each year, there is no uniform structure for bronchoscopy training other than learning during residency or fellowship [6]. Nor is there a standardized method by which technical skills and procedure-related knowledge are assessed. In fact, very few questions (usually less than five) are devoted to bronchoscopy on subspecialty board examinations, even though it is the major minimally invasive procedure performed by chest physicians.

Surveys pertaining to flexible bronchoscopy in countries as diverse as Singapore, Great Britain, India, Poland, Egypt, and the United States consistently identify variations in practice and training [7–9]. This diversity derives from a lack of uniform requirements, paucity of structured curricula, absence of validated measures of competency and proficiency, unequal access to learning materials, variability of patient-based learning experiences, and differences in skill, interest, and teaching abilities of medical practitioners designated as bronchoscopy instructors. Furthermore, the lack of a uniform competency-based framework for bronchoscopy education makes it difficult for physicians already in practice to acquire new skills.

A curriculum (noun, plural of which is cur-ric-u-la or cur-ric-u-lums) can be defined as a group of related courses, often in a special field of study [10]. As such, it pertains to the purpose, content, activities, and organization inherent to an educational program [11]. There are many challenges that must be overcome, however, as one contemplates curricular structure [12]. Some of these are related to conceptualizing the instructional process and defining meaningful learning experiences. Others relate to tradition, availability of resources, variability of deeply held beliefs and teaching styles, and the paucity of bronchoscopy education-related research.

## Instructional Process and Defining Meaningful Learning Experiences

John Dewey (born 1859–1952), probably one of America's most influential philosophers, wrote "the belief that all genuine education comes about through experience does not mean that all experiences are genuinely or equally educative" [13]. For health-care providers, being obliged to perform what might be for the first time, albeit with guidance, a procedure in a patient is both discomforting and anxiety-provoking. A social mandate for accountability and truly informed consent will make it increasingly difficult for practitioners to learn by doing. In addition, such a learning environment creates an ethical dilemma for the competent instructor being asked to advocate for efficient, evidence-based, cost-effective quality of care and who knows that he or she can perform the procedure more quickly and more efficiently and with greater patient comfort than the learner. These arguments justify, whenever possible, a more widespread use of simulation-based bronchoscopy training.

Changes in the perception of the educational process have resulted from modifications of medical education systems. In the United States, for example, the Accreditation Council of Graduate Medical Education currently advocates a competency-based training model that replaces one based on process and number of cases performed [14]. Great emphasis is placed on objective measurements of competency, including elements of professionalism, systems analysis, and health-care team development. In designing a bronchoscopy curriculum, therefore, one must consider how learning processes reach beyond technical skill development to involve the cognitive, affective, and experiential forms of knowledge, as well as how knowledge acquisition and retention might be assessed both during and after training [15]. In my opinion, these arguments, particularly in view of the expansion of bronchoscopic practice,[1] give good reason for a more structured approach to bronchoscopy training. One such approach might include a curriculum that includes recommended reading assignments, case-based and problem-based learning exercises [16], hands-on simulation and real patient-based procedure performance, low-stakes assessments to document progress along the learning curve [17], individual learner-centric training opportunities, and outcome metrics [18] to identify strengths and weaknesses of continued medical education programs as well as the effectiveness of courses and seminars on both individuals and groups.

From a learner-centric perspective, therefore, bronchoscopy education should entail elements of critical thinking, problem-solving, ethical values and behaviors, mastery of critical facts and figures, mastery of certain technical skills unique to each type of procedure being performed, self-realization, self-esteem and emotional stability, safety, and an ability to effectively and efficiently integrate procedural practice into one's institution-based medical practice. While much of this is presumed to be learned during traditional apprenticeship-style training, various components are often not documented, and in most

[1] Bronchoscopy is increasingly used to diagnose and treat patients with a variety of lung and airway disorders. Therapeutic procedures such as bronchial thermoplasty, endobronchial valve insertion, and airway stent placement have been added to the traditional interventional pulmonology armamentarium. Additionally, evolving acoustic and optical technologies augment diagnostic capabilities, and the need for greater amounts of tissue for tumor markers and other lung cancer-related analyses is expanding the role of bronchoscopists in the area of cancer management.

institutions, from what I have been told by many bronchoscopy experts, no precise written curricular structure is in place.

Despite increasing patient care responsibilities and the stress of providing cost and time-effective quality care, many bronchoscopists create time in their busy schedules in order to devote themselves to the educational process. From a teacher's perspective, such unselfish involvement might be enhanced if curricular elements were developed in a manner that is time and cost-efficient, nonalienating, and conducive to individualized and collective learning. Some educational methodologies and curricular content, for example, could be standardized to the extent that a generally accepted or more uniform foundation of facts and philosophies becomes available and can be integrated into various individual and group educational venues (i.e., clinical settings, online or computer-based programs, postgraduate seminars, online and onsite courses).

All of us, regardless of our experience and level of competence or expertise, can benefit from pedagogical technical assistance. As new concepts, learning materials, and techniques are introduced into practice, faculty development programs could be used to enhance teaching skills, assure continuity and growth, and develop educational resources. During these venues, experiences could be shared regarding the advantages and challenges of moderating small group interactive learning sessions, using presentations and audience participation software, and integrating video, other media, real-time decision trees, instant messaging, Twitter, tablet PCs, or writing boards into educational programs (Figs. 7.1 and 7.2).

While a mentor's behaviors might readily be emulated after observation, it is unrealistic to expect that the ability to teach effectively comes naturally to everyone. Of course, many physicians are excellent teachers, but the assumption that a medical doctor is a natural-born instructor represents, in my opinion, a significant shortcoming of our academic philosophy and runs contrary to assumptions in other professions such as public education and sports, where particular emphasis is placed on learning how to teach. The purpose of faculty development programs, often referred to as train-the-trainer seminars, therefore, is to help motivate, stimulate, inspire, and train professionals interested in serving as role models, mentors, and instructors in the use of diverse educational techniques and methodologies and to develop, provide, and study resources that are incorporated in whole or in part into various learning curricula.

**Fig. 7.1** Example of instructor-led small group discussion in Peru. Participants are debating the advantages of using bronchoscopy skills and task assessment tool (BSTAT) in background quiz to develop a common language for airway secretions and mucosal abnormalities

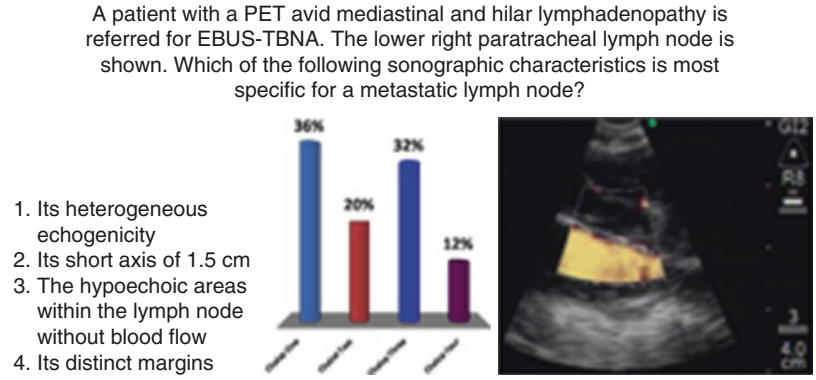



**Fig. 7.2** Example of using audience participation software during an interactive question/answer session. In view of the wide variety of responses shown on the graph, the instructor will provide insight regarding each of the possible answers

## Tradition, Teaching Styles, and Beliefs

There is a grand tradition in bronchoscopy education. This tradition is twofold. In the first instance, we assume that learners will learn bronchoscopy during the course of their specialty training [19] and that learning will be satisfactory because learners are exposed to different faculty members who might each perform bronchoscopy in a different way (setup, positioning, sedation and medication use, techniques, etc.). Accompanying this is the idea that the complexities of a bronchoscopy-related consultation are always learned while rotating on a specialty consultation service and that all of the items pertinent to such a consultation are satisfactorily addressed, even if they are not explicitly reviewed with the attending faculty (i.e., indications and informed consent, procedure-related strategy and planning, technique and expected results, response to complications, post-procedure management, and follow-up).

The second tradition pertains to the popularity of 1- and 2-day postgraduate courses, devoted until recently and for the most part to physicians already in practice. We have always trusted that these courses were effective and met particular training objectives. For bronchoscopists, the tradition comes from decades of hands-on learning that began with the admired and effective patient-based rigid bronchoscopy instruction programs conducted by Gustav Killian and Chevalier Jackson. In such a program, the expert speaker lectures on a topic, while the learner group listens dutifully. Often, individual experts prepare their lectures with little information or fixed-in-advance knowledge regarding common purpose that might integrate their lectures with content from other talks given during the course. Popular hands-on sessions are organized using animal models and equipment loaned from equipment manufacturers. More recently, computer-based simulation and inanimate models have been introduced. Learners rotate from station to station, listening to experts tell them about a procedure or technique, then watch as he (until recently, most bronchoscopy experts have been male) demonstrates the technique. Then one after another, learners take the scope in hand and do something, some less well than others. Sometimes, live transmissions of cases are included in the program, with either the operator or other faculty member interacting with the audience to discuss indications and procedural techniques.[2]

During these programs, we had always assumed learners would learn by simply being present: preliminary or postcourse assessments are rarely performed and little time is devoted to truly individualizing the learning process. An

[2]Live transmissions carry many challenges not the least of which are that cases may be selected based on the expectant participants, intraoperative decisions might be made solely on the basis of educational or theatrical need, and the operator may be distracted by questions or other interactions with the audience.

objective commentary about these programs, however, might include the following:

1. The complexities of bronchoscopy-related instruction and consultation are increasing in view of the rapid expansion of interventional pulmonology.
2. Time constraints, accountability, concerns for cost-effectiveness, and a mandate for enhanced patient safety and respect make patient-based instruction increasingly problematic, so complementary venues for learning are necessary.
3. Passive learning from listening to a speaker giving a lecture is not as effective as when learners are actively engaged.
4. Critical thinking and problem-solving are rarely addressed, yet these are major components of achieving procedure-related competency.
5. Educational content and the effectiveness of its delivery depend on who prepares the lecture and how it is delivered.
6. Active engagement time (the time the learner is actually devoting to learning by doing) is minimal, consisting of, for example, only 3–5 min per person for a group of five people during a 30-min station session.
7. Specific tasks and learning objectives are often not made explicit at each hands-on station, decreasing the likelihood that a specific skill will actually be enhanced or acquired at the skill station.
8. Substantial time is spent listening to lecturers during didactic as well as hands-on sessions.
9. Baseline knowledge and skill levels of course participants are rarely assessed, making targeted individualized or problem-focused instruction difficult.
10. After they return to their clinical practices, few resources are available to help participants apply and master what they have experienced.

A paucity of studies pertaining to the effectiveness, or lack thereof, of these traditional methods of bronchoscopy education makes it challenging to step out of the box in order to view the abovementioned traditional educational processes differently. It is equally challenging to introduce and potentially justify changing a well-entrenched educational system. The reality is, however, that an older paradigm frequently provides a dynamic vision for what is to come after it. Today, we know that:

1. Different learning and teaching modalities are and can be complementary.
2. Many lectures could be accessed off-site through the use of the Internet.
3. Well-edited videos could replace long periods of watching a transmitted “live” case, without jeopardizing patient care.
4. Not all bronchoscopists, especially myself, are as good at teaching as they could be.
5. Not all lectures provide a foundation of knowledge considered useful or required by learners.
6. Active engagement time can be maximized if less time is devoted to demonstrations. and more time is spent assisting learners as they perform specific skill sets or exercises.
7. Problem-solving and critical thinking needs to become a standard part of bronchoscopy courses because they are essential to the safety, effectiveness, and efficiency of bronchoscopic practice.
8. Animals, veterinary services, cadavers, and animal laboratories are costly and regulated, also prohibiting instructional programs in hotels or congress halls.
9. (9) The unnecessary sacrifice of live animals can almost always be avoided by using inanimate models and computer-based simulation.
10. (10) Metrics are needed to help ascertain knowledge and skill acquisition as well as program effectiveness as part of a competency-oriented program of procedure-related learning.

This list is obviously not exclusive, and many other elements are important in rethinking traditional methods of bronchoscopy

education. Agents of change are necessary to develop and implement different teaching strategies and methodologies across the globe. Industry support is essential to educational programs, and professional societies may need to work together, rather than compete, in order to foster a foundation of information and assure a greater democratization of knowledge. Finally, either/or debates and opposing points of view can be synthesized in a manner that promotes learning and choice, acknowledging both points of view in the context of a broadened educational perspective [20] (Fig. 7.3).

## Bronchoscopy Education-Related Research

The bronchoscopy-related literature is gradually supporting the paradigm shift, whereby patients will no longer bear the burden of procedure-related training. In a review pertaining to the use of simulation for bronchoscopy education [21], we noted that simulation helps learners improve procedural efficiency and economy of movement, thoroughness, and accuracy of airway examination and decreases airway wall trauma [22]. In addition to increasing learner satisfaction

| EITHER | OR | BOTH-AND SYNTHESIS |
|---|---|---|
| Scope handling with the left hand. | Scope handling with the right hand. | Both are correct and impact positioning of bronchoscopy assistants and handling of ancillary equipment. Operator comfort and theching traditions with influence choice. |
| Operator position from the head of the patient. | Operator position from in front of the patient. | Both are correct and should be learned because either may be necessary depending on procedural setting and indication. |
| Tests | Assessments | Both are important in improving learning. How should competency be ascertained? Is there a role for Mastery learning? What kind of remedial training may be warranted? How can both be used in the setting of physicians-in-training as well as for physicians already in practice? |
| Teacher-centered instruction | Learner-centered learning | Teacher-learner relationships are important and allow teachers to assume various roles. New technological platforms create greater opportunities for independent study, collaboration, and long distance learning. |
| Apprenticeship-style learning | Competency-oriented learning | Both are important as learners take on greater responsibilities. Using new technologies and educational methodologies are likely to help accelerate quality patient care and safety, and allow a more rapid introduction of new procedures and techniques into the patient care arena. |
| Face-to-face instruction | Online learning | Both are important. Face-to-face instruction and active engagement time, especially during hands on training, takes on even greater value when learners learn using online resources. Face-to-face time can occur though videoconferencing as well as during onsite seminars, and of course at the patient's bedside or in the simulation center. |
| Learning on patients | Learning using simulation | Both are important. All facets of bronchoscopic knowledge and skill, including elements of professionalism, physician behaviors, procedural techniques, response to complications, and management decision making can be improved upon using inanimate models, computer-based simulation, and by helping learners work through the decision-making process during individual or group learning sessions. These can occur prior to or concurrent with patient-based experiences. |
| Reading conventional textbooks and articles | Media and technology | Both are important. Reading conventional textbooks may still be helpful, but media and technology are changing the way learners can interact with reading, both online and in print. Videos and interac tive images and text (such as patient-centered exercises and clinical pathways) enliven the learning process and help learners analyze their performance. Articles are easily retrieved today using online informational databases and can be used to justify decision-making and enhance evidence-based quality care practice. |
| Competency determined based on single institution subspecialty training | Competency determined based on completing a core curriculum that maight be applicable in part or in whole in many | Both are necessary. For example, a curriculum similar to one proposed in the Bronchoscopy Education Project and modified based on institutional needs or medical practice setting (see Figure 4) assures objective monitoring of trainees who attend onsite learning programs, clinical pathways, experience the advantages of simulation, and demonstrate skills using checklists and assessment tools in both the simulation and patient-care environment. |

*Inspired from reference #20: Chen M, Education Nation pg 23-24.

**Fig. 7.3** Examples of turning either/or debates into both/and syntheses

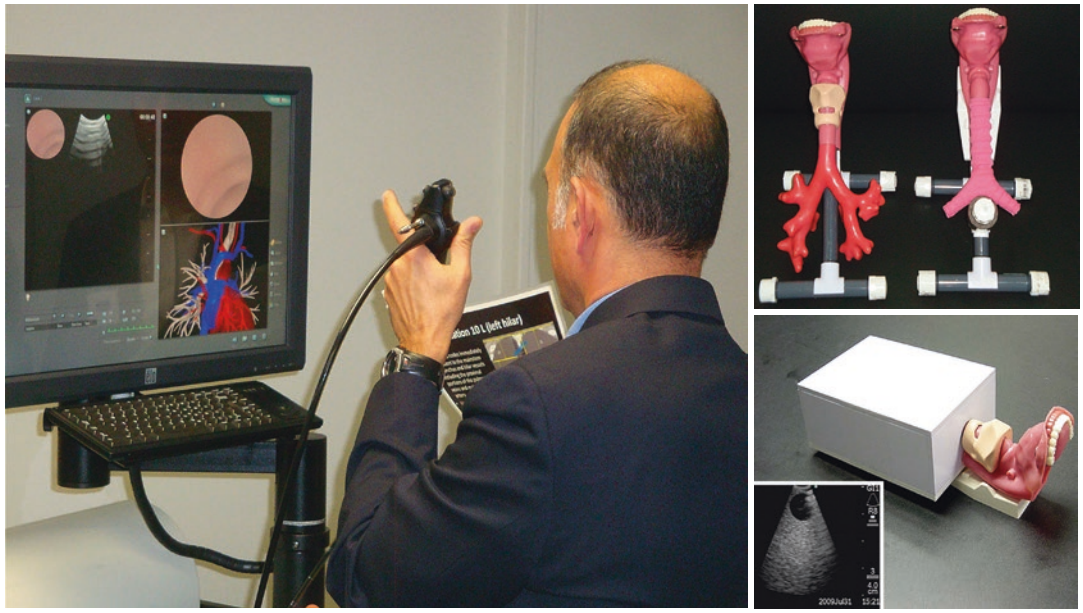


**Fig. 7.4** Examples of inanimate and computer-based simulation platforms for learning bronchoscopy. Shown are the Simbionix Bronch Mentor (EBUS module) and inanimate models assembled by Bronchoscopy International: bronchoscopy airway inspection model using bifurcated normal airway from CLA, Germany; transbronchial needle aspiration model using silicone airway from Sawbones Seattle, WA, USA; and inanimate EBUS model using Laerdal Laryngeal structure and ATS Laboratories ultrasound phantom with bifurcated airway and simulated lymph nodes at levels 2, 4, and 7 (ATS Laboratories, Bridgeport, CT)

and interest, simulation allows tasks to be practiced repeatedly without jeopardizing patient safety, and training scenarios can be individualized. Both low- and high-fidelity simulation have been shown to enhance competency in procedural skills while saving time and improving the learning curve [23, 24]. Furthermore, skills acquired through practice on simulators are transferable to the clinical setting [25]. Objective assessment identifies errors and provides opportunities for remedial training [26, 27].

High-fidelity simulation platforms using three-dimensional virtual anatomy and force feedback technology can be used to teach conventional and EBUS-guided transbronchial needle aspiration (TBNA) although less expensive, low-fidelity models comprised of molded silicone excised animal airways and ultrasound phantoms are also effective [28]. The efficacy of a low-fidelity hybrid airway model made of a porcine trachea and a plastic upper airway was demonstrated for learning transcarinal and transbronchial needle aspiration [29]. This model gave learners an opportunity to practice needle insertion, positioning, safety measures, and communication with ancillary personnel. It has since been modified so that a plastic airway is used, obviating the need for discarded animal parts and making the use of such training materials possible in hotel conference centers and nonhospital facilities. Models can also be used to teach scope manipulation and airway anatomy, foreign body removal, bronchoscopic intubation, EBUS-guided TBNA, and other interventional techniques, some of which can also be practiced using high-fidelity computer-based simulation[3] (Fig. 7.4). New, portable computer-based bronchoscopy simulation is becoming available using laptop computers and proxy bronchoscopes.[4]

Demonstrating improvements in technical skill complete only part of the picture [30]. The increasing emphasis on competency-oriented education

[3] See, for example, http://simbionix.com/.

[4] See, for example, http://www.orsim.co.nz/ and http://www.anesthesia.utoronto.ca/edu/cme/bronch.htm.

warrants that bronchoscopy courses also use competency-based measures to assess the efficacy of course curricula and training modalities [31]. Outcome measures might take the form of high- or low-stakes testing in the various cognitive, technical, affective, and experiential elements of procedure-related knowledge [32–34]. Using quasi-experimental study design and a series of pretest/posttest assessments with calculations of absolute, relative, and class-average normalized gain, we have demonstrated the efficacy of a 1-day structured curriculum including a uniform set of didactic lectures, interactive sessions, workshops, and hands-on simulation-based training in flexible bronchoscopy and thoracoscopy [35, 36].

Assessment tools that objectively measure skill and knowledge acquisition will also need to be designed and validated in various learning settings and medical environments [37]. Ideally, their design should be flexible so that instructors with different habits or biases can still incorporate them into their programs without feeling compelled to radically modify their own way of performing procedures. As faculty development programs are integrated into curricular structures, it may become helpful to study their value and contributions to enhanced teaching and learning. Finally, research targeting curricular platforms and the results of educational interventions will contribute to the elaboration of new bronchoscopy instruction-related theories and processes.

## The Bronchoscopy Education Project

Developed by Bronchoscopy International[5] in collaboration with many experts from all over the world, the Bronchoscopy Education Project (BEP)[6] has been officially endorsed by several international bronchology and interventional pulmonology societies. Its aim is to complement and hopefully enhance existing educational programs by providing bronchoscopy instructors and training program directors with competency-oriented tools and materials. These may be used to help train bronchoscopists and assess progress along the learning curve from novice to competent practitioner. The curriculum includes *The Essential Bronchoscopist*™ series of books and e-books [38, 39]; a series of training manuals [40]; an encyclopedia of *Practical Approach*© patient-centered exercises that integrate cognitive, affective, and experiential knowledge pertinent to bronchoscopy-related consultation; *Bronchoscopy Step-by-Step*© lessons; a problem-oriented BronchAtlas™ video series[7]; a compilation of PowerPoint-based lecture programs called Fundamentals of Bronchoscopy©; and a set of *Bronchoscopy Assessment Tools*© and Checklists. Material can be integrated in whole or in part, as needed by each program. Learning is based on individual and group study of training manuals, participating in didactic and interactive lecture programs delivered onsite and online, viewing instructional videos on social media sites such as YouTube and Facebook, and participating in deliberate hands-on practice sessions during postgraduate programs and in the course of subspecialty training. Officially supported by and in collaboration with professional medical societies, faculty development programs are being conducted across the globe to help an international group of bronchoscopists, early adopters, and agents of change use these learning materials, improve their presentation skills, create personalized curricula specific to the needs and medical culture of their region, and develop concepts that will strengthen future educational programs. Specific criteria exist by which instructors become certified. A brief description of some of the BEP resources built on the philosophy of using frequent, repeated group and individual exposures to multimedia

[5]Bronchoscopy International is a transnational group of educators and agents of change devoted to the development of educational resources and to the dissemination of bronchoscopy-related knowledge.

[6]The BEP is a work in progress with materials constantly being added. For more information, visit HONcode certified website at www.Bronchoscopy.org and the BronchOrg page on YouTube.

[7]For example, video found at http://www.youtube.com/watch?v=-MP-WdVcCxY

rather than single-medium instruction [41] is found below:

- As part of the *Essential Bronchoscopist*™ series of e-books, *The Essential Flexible Bronchoscopist*© and *The Essential EBUS Bronchoscopist*© are comprised of specific reading materials, learning objectives, and posttests. Each module contains thirty question/answer sets with information about major topics relating to bronchoscopic procedures. The aim of these modules is not to replace the apprenticeship model but to complement in-hospital subspecialty training and to encourage open dialogue between learners and faculty.
- A *Bronchoscopy Step-by-Step*© and *EBUS Step-by-Step*© series of graded exercises help learners acquire technical skills necessary to perform these procedures.[8] Instructional videos are readily viewable on desktop computers as well as handheld devices, IPADs, or cell phones. Specific training maneuvers help the learner practice incrementally difficult steps of bronchoscopy and EBUS-guided TBNA.[9] Steps are designed to enhance the development of "muscle memory" by breaking down complex moves into constituent elements and practicing the separate elements repeatedly before gradually combining them into more complex maneuvers.
- *The Fundamentals of Bronchoscopy*© lecture series includes a compilation of PowerPoint lectures and interactive slide presentations that can be delivered as part of online or onsite courses. Material has been developed with input from many generous experts worldwide and constitutes a uniform collection of learning resources that can be presented by speakers as part of local, regional, or international training programs.
- *The Introduction to Flexible Bronchoscopy* and *The Endobronchial Ultrasound and EBUS-Guided TBNA* are specific training manuals that are available in hard copy as well as in the form of e-books. Each contains program materials, model schedules of 1-day seminars, suggestions for elements of a program completion checklist, specific simulation scenarios, recommended reading assignments, patient-centered practical approach exercises, checklists, and procedure-specific assessment tools. Volumes pertaining to other aspects of bronchoscopic practice are being developed.
- An encyclopedia of *Practical Approach Patient-Centered Exercises* using a four-box approach to bronchoscopy-related consultation (includes elements from the initial evaluation, procedural strategies, techniques and results, and long-term management). Specific scenarios and case resolutions can be used for purposes of individual and group study, assessment, or as content for didactic or interactive lecture sessions.
- *BronchAtlas*™ includes a series of PowerPoint presentations and the BronchAtlas™ video series, a group of concise problem-oriented text files and short, hyperlinked videos designed to address specific issues encountered in daily bronchoscopic practice. Each text (PDF) file enunciates the problem (e.g., bronchoscopy in patients with obstructive sleep apnea) and uses bullet lists to describe the problem with greater detail before providing solutions, a video, and a handful of relevant references. Files can be downloaded onto IPADs and mobile devices for easy review.
- A series of *Bronchoscopy Assessment Tools*© designed as learning instruments provide objective measures of knowledge acquisition. Fixed numeric scores are attributed to learners based on performance of technical skills that include dexterity, accuracy, anatomic recognition, navigation, posture and position, economy of movement, atraumatic instrument manipulation, pattern recognition, and image analysis (Fig. 7.5).

[8] Colt HG. *Bronchoscopy Lessons.* Instructional video pertaining to various aspects of bronchoscopy You Tube (posted 2010): http://www.youtube.com/watch?v=phRv73Ik7fI&feature=related

[9] For example, video found at http://www.youtube.com/watch?v=Z9FdgVx_xrM

## EBUS-STAT 10 Point Assessment Tool

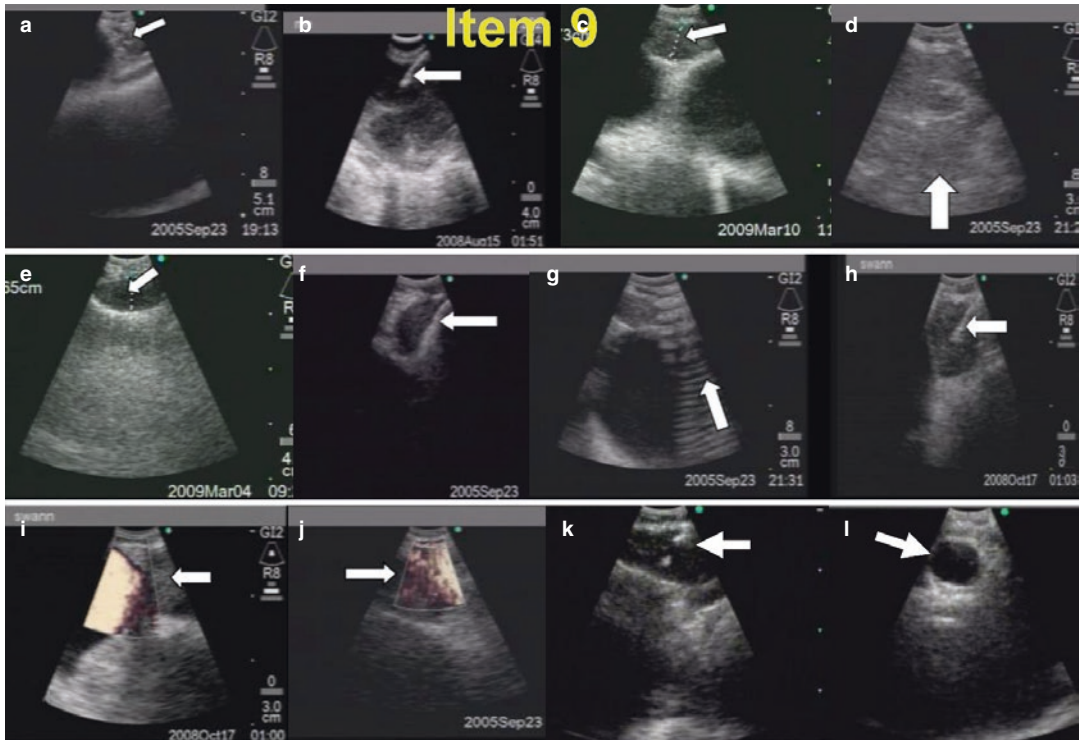
Learner: _____ Year of Training _____
Faculty _____ Date _____

| Educational Item*<br>Items 1-10 each scored separately | Satisfactory<br>Yes/No |
|---|---|
| **1. Able to maneuver the scope through upper airway into trachea, without trauma or difficulty (5 points for single item tested)**<br>☐ Mouth and Vocal cords ☐ ET Tube ☐ Laryngeal mask airway | Yes / No<br>Score ____/5 |
| **2. Able to maneuver scope using white light bronchoscopy within tracheobronchial tree without trauma (4 points, no partial points)**<br>☐ Scope centered in airway lumen avoiding airway wall trauma | Yes / No<br>Score ____/4 |
| **3. Ultrasound image obtained without artifacts (5 points, no partial points)**<br>☐ Absence of artifacts on image, any target | Yes / No<br>Score ____/5 |
| **4. Identify major mediastinal vascular structures (4 points per item)**<br>☐ Aorta ☐ Pulmonary artery ☐ Superior vena cava ☐ Azygos vein ☐ Left atrium | Yes / No<br>Score ____/20 |
| **5. Identify lymph node station (Select 3 targets, 5 points each)**<br>☐ 2R ☐ 2L ☐ 4R ☐ 10R ☐ 7 ☐ 4L ☐ 10L ☐ 11L ☐ 11Rs ☐ 11Ri | Yes / No<br>Score ____/15 |
| **6. Able to operate EBUS processor (2 points each item)**<br>☐ Gain ☐ Depth ☐ Doppler | Yes / No<br>Score ____/6 |
| **7. Performance of EBUS-TBNA (1 point each, target 15 points)**<br>☐ Advance needle through working channel (neutral position) ☐ Secure needle housing by sliding the flange ☐ Release sheath screw ☐ Advance and lock sheath when it touches wall ☐ Release needle screw ☐ Advance needle using jab technique ☐ Visualize needle entering target node ☐ Move stylet in and out a few times ☐ Remove stylet ☐ Attach syringe ☐ Apply suction ☐ Pass needle in and out of node 10-15 times ☐ Release suction ☐ Retract needle into sheath ☐ Unlock and remove needle and sheath | Yes / No<br>Score ____/15 |
| **8. Image analysis: CT scans (1 point each, target 10 points)**<br>☐ Image 1 ☐ Image 2 ☐ Image 3 ☐ Image 4 ☐ Image 5 ☐ Image 6 ☐ Image 7 ☐ Image 8 ☐ Image 9 ☐ Image 10 | Yes / No<br>Score ____/10 |
| **9. Image analysis: EBUS views (1 point each, target 10 points)**<br>☐ Image 1 ☐ Image 2 ☐ Image 3 ☐ Image 4 ☐ Image 5 ☐ Image 6 ☐ Image 7 ☐ Image 8 ☐ Image 9 ☐ Image 10 | Yes / No<br>Score ____/10 |
| **10. Decision-making tasks: (2 points each, target 10 points)**<br>☐ Image 1 ☐ Image 2 ☐ Image 3 ☐ Image 4 ☐ Image 5 | Yes / No<br>Score ____/10 |

* The combined use of the 10 items tests competencies needed to climb the learning curve from novice to advanced beginner to intermediate to competent bronchoscopist able to independently perform EBUS-TBNA.

**FINAL GRADE** PASS FAIL **SCORE** _____/100

**Fig. 7.5** Example of EBUS-STAT (checklist and one component of the EBUS-STAT image quiz), an assessment tool for endobronchial ultrasound, and EBUS-guided transbronchial needle aspiration (*STAT* Skills and Tasks Assessment Tool)




| ITEM 9: Match the photo (A-L) to the corresponding 10 EBUS views (Only one response per description) | | | |
|---|---|---|---|
| ____ Station 4R adjacent to pulmonary artery superior vena cava and ascending aorta | ____ Needle penetrating through and through | ____ Needle missing target node | ____ Station 4L adjacent to aorta and pulmonary artery |
| ____ Station 4L adjacent to pulmonary artery | ____ Needle within lymph node | ____ Normal lung | ____ Reverberation artifact |
| ____ Station 7 adjacent to left atrium | ____ Hilar node adjacent to normal lung | NO RESPONSE | |

**Fig. 7.5** (continued)

## Using Assessment Tools to Guide the Educational Process

Whether learning to play a musical instrument, participate in a sporting activity, or perform a medical procedure, learning requires acquisition of technical skill, facts (cognition), experience, and an understanding about how we relate emotionally to what we are doing (affect). The effectiveness of the learning process depends, in part, on the frequency, variety, quality, and intensity of the learning encounter, as well as on the presence, quality, interest, skill, and demeanor of the teacher. One's natural talents and predisposition, motivation, and

personality come into play, as do the various written, passive, visual, aural, interactive ways that are used to present learning materials.

Just as tasting is a prerequisite to good cooking, assessments are a fundamental part of learning. In health professions education, written tests, performance tests, clinical observation, and other methods of evaluation such as chart reviews and oral examinations are used as in high-stakes tests for certification[10] or licensure but are also valuable as low-stakes assessments[11] that are part of the learning process during a learner's quest for competency.[12] In this case, they help document progress along the learning curve,[13] identify gaps in knowledge warranting remedial or individualized training, uncover strengths and weaknesses of an educational program, may help identify different knowledge levels among a group of trainees or course participants in order to design a more individualized sequence of training, and help determine congruence with self-assessments performed by learners as part of a feedback or debriefing session [42].

When cognitive knowledge is assessed using standardized tests with written multiple-choice questions or oral interviews, questions should ideally be validated using specific criteria that include testing for difficulty and internal reliability. This may not be absolutely necessary when designing assessment tools where learning is the major objective. Assessments, contrary to tests, have the primary purpose of giving feedback to both teachers and learners about gaps in knowledge and how to improve learning. Technical skill assessments, however, to be of value across a broad range of learners, should probably use measures that are validated in various learning settings, be reliable,[14] and have a strong correlation to the procedure being taught. Checklists can be used to ascertain progress toward competency in various components of a procedure such as ability to obtain informed consent or safe use of fluoroscopy. Checklists also democratize knowledge and have the potential to improve safety and quality of care [43].

It is noteworthy that validity evidence refers to the data and information collected in order to assign meaningful interpretation to assessment scores or outcomes designed for a specific purpose and at one specific point in time [44]. Hence, validity refers to score interpretations and not to the assessment itself [45]. While validity has been traditionally divided into *construct*, *content*, *criterion*, and *face*

[10] *Certification* is defined as a process that provides assurance to the public that a medical specialist has successfully completed an educational program and undergone some type of evaluation, which almost always includes a high-stakes written examination that is designed to test the knowledge, experience, and skills requisite to the provision of high-quality care in that specialty (see ACGME—Accreditation Council for Graduate Medical Education).

[11] *Low-stakes* testing usually does not have pass/fail thresholds or carry significant consequences. Such assessment would be consistent with an educational process that emphasizes a quest toward professionalism and competency (progress along the learning curve) but does not measure skill or knowledge with significant consequences. A *high-stakes* assessment, on the other hand, usually carries significant consequences, such as licensure or pass/fail certification.

[12] *Competency* is the ability gained from knowledge and skills, which forms a basis for performance. To be competent means having the ability to activate and utilize specific knowledge when faced with a problem.

[13] In medicine, a learning curve, also called an *experience curve*, applies to a process where performance improves as a function of practice. This curve may be more or less steep depending on the learner's skill and knowledge, circumstances, and experience and on whether the procedure being learned is new or established. We increasingly tend to differentiate learners into novices, beginners, intermediate learners (also referred to by some as advanced beginners), experienced, and experts, but simpler delineations of beginner, intermediate, and competent practitioner might also be used. Progress along the learning curve usually occurs in steps, with learners remaining or choosing to remain on a particular plateau that itself may have its occasional dips and peaks.

[14] Reliability is defined as the proportion of reproducible data to random noise recorded by the assessment instrument. Using criterion-referenced testing, concrete criteria are established and the individual is challenged to meet them. This explores what proportion of specific content of knowledge and skills the learners know or are able to perform, as opposed to norm-referenced tests that compare an individual's performance to the performances of a group (see http://www.valparint.com/CRITERIO.HTMreference downloaded May 25, 2012).

**Introduction to Flexible Bronchoscopy Program**
**Program Completion Checklist**

| Educational Item* | Completed Yes/No | Assessment Item | Pass/Fail/Incomplete |
|---|---|---|---|
| 1. Participation in regional introductory course | Yes / No | Post-test scores Target 12/20 (60% correct) Score _____% | Pass / Fail / Incomplete |
| 2. Assigned reading: *The Essential Flexible Bronchoscopist* | Yes / No | Post-test scores Target 7/10 (70% correct) | Pass / Fail / Incomplete |
| Module 1 | Yes / No | Score _____ | Pass / Fail / Incomplete |
| Module 2 | Yes / No | Score _____ | Pass / Fail / Incomplete |
| Module 3 | Yes / No | Score _____ | Pass / Fail / Incomplete |
| Module 4 | Yes / No | Score _____ | Pass / Fail / Incomplete |
| Module 5 | Yes / No | Score _____ | Pass / Fail / Incomplete |
| Module 6 | Yes / No | Score _____ | Pass / Fail / Incomplete |
| 3.*Sedation module* | Yes/No | Score _____ | Pass / Fail / Incomplete |
| 4. *Fluoroscopy Module* | Yes/No | Score _____ | Pass / Fail / Incomplete |
| 5. Informed consent, patient safety, and procedural pause simulation workshops | Yes / No<br>Yes / No<br>Yes / No | IC 10-pt Checklist Target 100% Score _____% on each | Pass / Fail / Incomplete |
| 6. Informed consent, patient safety, and procedural pause patient-based scenarios | Yes / No<br>Yes / No<br>Yes / No | IC 10-pt Checklist Target 100% Score _____% on each | Pass / Fail / Incomplete |
| 7. Practical Approach interactive workshop | Yes / No | Subjective scores Target Pass | Pass / Fail / Incomplete |
| 8. Flexible bronchoscopy simulation workshop | Yes / No | Target scores 100% BSTAT _____% TBLB/TBNA ____% | Pass / Fail / Incomplete |
| 9. Flexible bronchoscopy patient-based scenario | Yes / No | Target scores 100% BSTAT _____% TBLB/TBNA ____% | Pass / Fail / Incomplete |
| 10. Proctored case bronchoscopy checklist | Yes / No | FB 10-pt Checklist Target 100% Score _____% | Pass / Fail / Incomplete |

*When completed, learners are assumed to be able to perform flexible bronchoscopy independently. Programs may still require observation and faculty presence based on training regulations and preferences.

**Fig. 7.6** Program completion checklist from the Bronchoscopy Education Project's Introduction to Flexible Bronchoscopy curriculum

*validity*, Downing and others consider construct validity (a test measuring what it is supposed to measure) as the whole of validity and validity evidence as both case and time specific.[15]

The Bronchoscopy Education Project stresses the importance of using a mastery training paradigm, whereby the eventual expected score on an assessment reflects 100% correct responses because operators should ideally be able to master each of the constituent elements of a safe and effective procedure in order to achieve and document competency. The main variable that distinguishes different learners is the slope of the curve, i.e., the time each learner requires to reach a particular educational objective [46]. Different facets of the project, including introduction to bronchoscopy, endobronchial ultrasound, bronchoscopy in the intensive care unit, and interventional bronchoscopy curricula, can be integrated in part or in whole into ongoing training programs. A program completion checklist helps document a learner's participation as shown in

[15] In other words, the evidence presented to support or refute the interpretation assigned to assessment that can be used for one test administration and is not necessarily applicable to a different test administration (see Downing [45, page 22–23]).

this example pulled from the Introduction to Flexible Bronchoscopy Program (Fig. 7.6).[16]

## The Ethics of Teaching

"We're Doctors" proclaims actor Harry Connick Jr. portraying Dr. Dennis Slamon[17] in his plea for continued research funding in the Lifetime television movie *Living Proof* (Dan Ireland, 2008), about the discovery of epidermal growth factor Her2 and subsequent development by Genentech of the antibreast cancer drug Herceptin. Perhaps this simple statement, more than any other, justifies taking a new look at how bronchoscopy is both taught and learned.

As medical practitioners dedicated to the health and well-being of our patients, it is paradoxical that for the past 40 years, patients have suffered the burden of bronchoscopy-related training. As availability to technology and computer-based learning increases around the world and the cost of using alternative learning materials such as instructional videos, training models, and simulation decreases, however, educational processes and philosophies inevitably change. Learners are already less dependent on rote memorization, referring frequently to web-based instruction, digital textbooks, electronic information delivery systems, and social communication media available through their computers and handheld mobile devices.

Those interested in the advantages of "scaffolding," a process by which instructional techniques, materials, and other resources are used to structure programs that are conducive to a learner's more rapid ascent of the experience curve, can excitedly revisit ways to package and deliver educational materials. The world is rapidly becoming a global village. By altering our views and practices, health-care education can better reflect society's adoption of new technologies and fulfill an increasingly verbalized directive for provider competency, accountability, professionalism, and expert medical procedural practice.

Much of the intrinsic value physicians accord to medical education is derived from knowing that jobs are well done and that patients are well served. In this sense, both consequentialist (to reduce suffering and avoid retribution) and nonconsequentialist ethical arguments (duty, obligation, and the respect of principles such as beneficence or justice) enhance intrinsic motivation and prompt learners freed from the classroom and the patient's bedside, to improve their skills and knowledge by accessing educational resources using new technologies. Resistance to this shifting paradigm is futile in light of the increasing availability of learning materials on the Internet. Learners cannot be denied access, nor be restrained from obtaining varying points of view regarding a certain procedure or technique. Because access is often free, teachers, rather than being fearful of their loss of power and control, should view them as shortcuts to the learning process. Embracing the digital age and encouraging learners to access these resources fosters dialogue and debate.[18] Faculty can thus use face time with learners, whether online or onsite, more productively to enhance understanding, rectify erroneous interpretations, and teach how to *think* and *process* information.

Curiously, doctors are unfairly expected to be good mentors and effective instructors without ever having learned to teach. As mentioned earlier, this presumption is, for the most part, absent in other areas such as public school, sports, or music education and represents, in my opinion, a significant shortcoming of our academic institutions and profession. Very few bronchoscopists have been offered seminars specifically designed

[16] While user instructions, checklists, and assessment tools are provided in the Bronchoscopy Education Project Faculty Development Training Manual, they can also be obtained from various professional societies (such as the ASER and WABIP) and at www.Bronchoscopy.org.

[17] Currently director of clinical/translational research, UCLA Jonsson Comprehensive Cancer Center

[18] Tinsley and Lebak expanded on Vygotsky's contructivist theories, describing a zone of reflective capacity in which adults increased their ability for critical reflection through feedback, analyses, and evaluation of one another's work in a collaborative environment (see Lebak, K. & Tinsley, R. Can inquiry and reflection be contagious? Science teachers, students, and action research. Journal of Science Teacher Education;2010:21;953–970).

to teach educational methodologies [47], team dynamics, communication techniques, leadership, presentation skills, or conflict resolution. Even fewer have received formal instruction in behavioral psychology or learned to evaluate and relate to students with different individual propensities for learning.[19]

*When learners teach: the journey from novice to mastery and back again.*

For those interested in teaching, a fascinating yet challenging journey lies ahead. Physicians already adept at bronchoscopic interventions but less knowledgeable about education can experience the thrill and insecurity of becoming novices again. In addition to renewing interests in bronchoscopy-related knowledge and techniques, teachers can find out more about how social media facilitates communication with a new generation of learners at a time that is most convenient for both. We can become skillful using programs and devices for editing audio and video files, creating e-books, constructing learning platforms, and delivering educational materials. We might also explore websites like Coolmath, SuccessMaker, and Khan Academy to experience how interactive online programs effectively encourage learning.[20] During our quest we will learn more about ourselves, and while not quite identical to Dorothy's journey along the yellow brick road to Oz, we will also become increasingly knowledgeable of five structural elements crucial to the educational process: curricular design, content development, instructional methodology, teaching techniques, and flexible assessment tools that accurately measure what is learned and identify what remains to be taught.

> "In learning you will teach, and in teaching, you will learn"
> From *Son of Man* (1999), lyrics by Phil Collins

## The Future Is Now

In this chapter, I provided a brief overview of curricular structure and delivery; described an example of a structured instructional program, that is, the WABIP-endorsed Bronchoscopy Education Project; explained how assessment tools and checklists are used to help guide the educational process; and argued that an ethics of teaching justifies the paradigm shift from a "see one, do one, teach one" bronchoscopy education model to one where learner-centric behaviors are the focus and target of a laddered learning philosophy. By freely using footnotes and supplemental tables, I tried to clarify terminologies and help enhance the reader's knowledge and understanding of educational processes (Fig. 7.7).

Change is a slow process and, by definition, incites resistance. During the last few years, however, and even since the last edition of this textbook, we have witnessed the enthusiastic adoption of new educational philosophies and innovative teaching modalities. Assessment tools and checklists are increasingly advocated, and physician-educators, recognizing that wearing a white coat in and of itself does not make one an "educator," are obtaining advanced degrees in education. Programs are being designed and implemented to help bring a more uniform approach to the bronchoscopy educational process, including translations of key texts and videos (Fig. 7.8), official endorsements of structured training modalities by national and international bronchology organizations, and introduction of new assessment tools in other fields of interventional pulmonology (such as the UGSTAT developed and officially endorsed by the TSANZ [48]). Consistent with the move toward increasing use of artificial

[19] Fenstermacher and Soltis describe a humanistic teaching approach, whereby teachers strive to impart knowledge within an environment in which learning has personal meaning for the learner. By adopting various teaching techniques, facilitator (*coaching*), executive (*modifying the curriculum based on review of assessment results*), or liberationist (*fostering discovery and creativity*), for example, liberationist educators, might alter their teaching methods on the spot according to the medical learning environment and to fit the many different ways individual learners learn (italics are mine).

[20] David Ausubel (1918–2008) in his meaningful reception theory where, contrary to rote memorization or discovery learning based on problem-solving, one's knowledge of new material is enhanced if the material is related to relevant ideas within the learner's existing cognitive structure (http://tip.psychology.org/ausubel.html, downloaded December 27, 2010)


**Fig. 7.7** Examples of translations of *The Flexible Essential Bronchoscopist* in Italian and Romanian

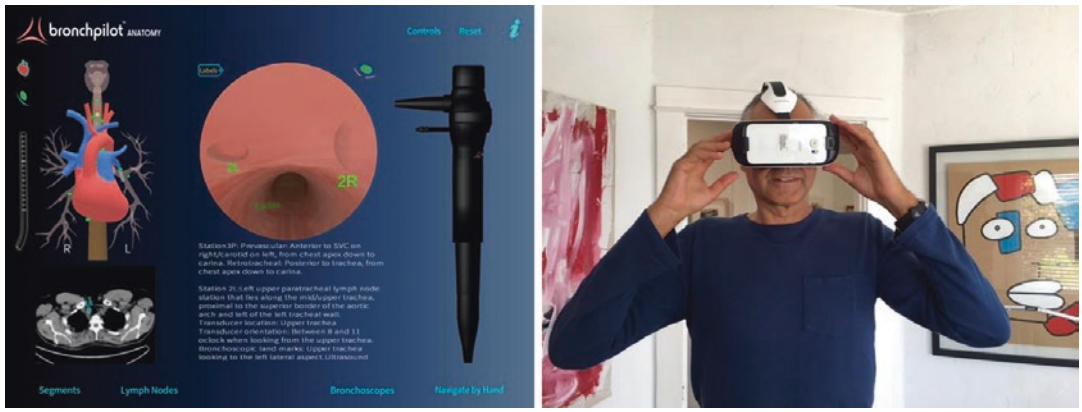



**Fig. 7.8** Example of the *Sharp Visions Software* iPad-based BronchPilot Anatomy and Samsung-based BronchPilot Virtual programs help bring individualized learning to the forefront of the educational process

intelligence, long-distance learning, inverted classroom teaching modalities, and advancing technology, educators are also working toward greater democratization, making learning materials globally available and accessible regardless of one's place of work or practice. An example of using these new technologies is the WABIP-endorsed BronchPilot Anatomy program that is an iPad-based learning modality, whereby learners can drive a flexible bronchoscope through the airways while simultaneously accessing 3D reconstructions of airway and mediastinal anatomy. The Samsung-based platform used for the new BronchPilot Virtual program is another step forward, using fully immersive virtual reality that allows the learner to virtually "be the bronchoscope" examining the airways through a self-guided tour (Fig. 7.8). These new teaching modalities, accompanied by more accepted and conventional (how times change, for just a few years ago these modalities were considered to be innovative and new) methods providing access to Internet-based learning materials and interactive presentation-like programs, provide learners of the future with a veritable *Bronchoscopy University* at

their fingertips. That future, most excitingly, is already upon us, beckoning teachers and learners alike to become agents of change in a world where step-by-step, one person at a time, can indeed change the world.

**Disclosures** Henri G. Colt, MD, is Chairman of the World Association for Bronchology and Interventional Pulmonology and is also the founder of Bronchoscopy International, a nonprofit group of professionals dedicated to the design, development study, and global dissemination of educational materials benefiting bronchoscopists and their patients. Dr. Colt has no financial or commercial conflicts of interests with any of the companies whose websites are listed in the text or footnotes.

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