Lap Ki Chan
Wojciech Pawlina

Editors

Teaching Anatomy

A Practical Guide

Second Edition

Springer

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Preface

Seven years ago, when we began work on *Teaching Anatomy: A Practical Guide*, we wondered how the book would be received by the academic community. After all, there were already a large number of books offering tips on university teaching and also a few good books on teaching in medical programs. There was even a high-ranking journal dedicated to the field of anatomy education. Over time, the positive reception the book has received and its download figures have told us that there is a strong demand for concise, practical guidance on teaching anatomy.

Seven years is a long time in this fast-paced era. We have seen the introduction of so many novel ideas and practices in active learning pedagogies, faculty development, engagement of the public, ethical use of human bodies, assessment, development of core syllabi, and the application of technology in anatomy education, to name a few.

We therefore felt that there was a need to update the book. In the second edition of *Teaching Anatomy: A Practical Guide*, there are 17 completely new or rewritten chapters, and many chapters that were in the first edition have also been updated, for a broad survey of the field of anatomy education.

The aim of the book remains the same: to offer practical advice to teachers, both novice and experienced, to help them face the diverse and ever-changing educational situations that they commonly encounter, amid their diverse responsibilities. Theories are introduced to help teachers adapt to their local teaching contexts. The writing has deliberately been kept simple and concise, so that anatomy teachers without training in the field of education can easily understand the materials and transform them into actions to help their students learn.

The COVID-19 pandemic is one of those changes in educational environments faced by anatomy teachers. Suddenly, we all have to teach anatomy online. We hope this book can offer some ideas and practical advice to help the anatomy teaching community face the challenge together.

Macao SAR, China	Lap Ki Chan
Rochester, MN, USA	Wojciech Pawlina
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About the Editors

Lap Ki Chan is an anatomist and medical educator, with a background in orthopedics and physical anthropology. He received his medical degree from The University of Hong Kong and his PhD in physical anthropology from Duke University. He completed his training in orthopedics and moved into medical and anatomy education soon after that. He spent 12 years at the Li Ka Shing Faculty of Medicine, The University of Hong Kong, where he served as the lead of the Interprofessional Team-Based Learning Program, the coordinator of the Body Donation Program, deputy director of the Bau Institute of Medical and Health Sciences Education, and assistant dean, among other responsibilities. He is currently a professor in the Department of Biomedical Sciences, director of the MBBS program, and the head of Medical Education Unit, at the Faculty of Medicine, Macau University of Science and Technology, Macao Special Administrative Region of the People's Republic of China. His research interests include innovative pedagogies in anatomy education, problem-based learning (PBL), team-based learning (TBL), interprofessional education (IPE), and faculty development. His teaching excellence has been recognized by such awards as the Thomas Henry Huxley Instructorship from Duke University, Outstanding Teaching Award from The University of Hong Kong, and the Bronze Discipline Award (Life Sciences) in the Quacquarelli Symonds (QS) Stars-Wharton Reimagine Education Awards. He served as a visiting professor at Zhongshan School of Medicine and Hainan Medical University and as an associate editor for *Anatomical Sciences Education* from 2013 to 2019. He has served as the educator for the Asia Pacific region for the AO Foundation (Arbeitsgemeinschaft für Osteosynthesefragen) since 2011.

Wojciech Pawlina is an anatomist and medical educator with the background in obstetrics and gynecology. He earned his medical degree from the Copernicus Medical School in Krakow, Poland, where he was appointed as instructor in the Department of Descriptive and Topographical Anatomy. He completed his residency in Obstetrics and Gynecology. Since 1986 he worked as a Postdoctoral Associate at the University of Florida College of Medicine in Gainesville before joining the faculty of the Department of Anatomy and Cell Biology as an Assistant Professor. In 1999 he joined Mayo Clinic, where he is now appointed as a Professor of Anatomy and Medical Education at Mayo Clinic College of Medicine and Science in Rochester, Minnesota. He is past Chair of the Department of Anatomy (2005-2019) and past Director of the Procedural Skills Laboratory (2007-2019). He also served as Assistant Dean for Curriculum Development and Innovation at Mayo Medical School (2007-2013). He has extensive experience in teaching gross anatomy, histology, and embryology to undergraduate, medical, dental, and health care professions students, as well as residents and fellows. He received numerous teaching awards from both the University of Florida, Mayo Clinic, and professional anatomy associations. His research interest in medical education is directed towards strategies of implementing innovative teaching methodologies, teaching professionalism, leadership, and teamwork in early medical curriculum. He is an author of several histology and anatomy textbooks including the *Histology: A Text and Atlas with Correlated Cell and Molecular Biology*. He serves on several editorial boards of scientific journals and is also the Editor-in-Chief of the *Anatomical Sciences Education*, a journal of the American Association for Anatomy.

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Elements of Successful Adult Learning

1

Lap Ki Chan and Miriam Uhlmann

This book is mostly about how teachers can design teaching and learning activities that engage their learners, so as to give them the best anatomy learning experiences. The activities may take many forms, in various settings, and use different methods and tools. Despite these variables, there are some common elements that may lead to better learning experiences. This chapter discusses these elements in general.

To understand the elements, it is important to know how adults learn. Adult learning theory (also called "andragogy"), in the tradition of Malcolm Knowles [1], is defined as "the art and science of helping adults learn." It is based on four assumptions about adult learners:

1. Adults need to know why they need to learn something.
2. Adults need to learn experientially.
3. Adults approach learning as problem-solving.
4. Adults learn best when the topic is of immediate value to their training or work.

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Knowles [1] contrasted andragogy with pedagogy, which he defined as "the art and science of teaching children" (note that it is different from the general usage of the term nowadays) wherein the learners are assumed to be more dependent on the teachers in determining what and how they learn, have little personal experience to bring to the learning process, have learning needs largely determined by someone other than themselves, and are more subject centered. However, andragogy and pedagogy should be considered as two separate sets of assumptions that can sometimes be applied to learners of any age under different situations [1].

For adults to learn successfully, educational activities usually need to match their learning needs, motivate by triggering their internal drivers, provide clear goals or outcomes that they are expected to achieve, engage through active learning, stimulate reflection, and create connections with existing experiences. One element that is missing in adult learning theory is feedback, which will also be discussed in this chapter.

Based on Needs

A theory of motivation based on human needs was described by Abraham Maslow and is known by many as Maslow's pyramid/hierarchy of human needs [2]. This defined the term "need" in a broad general sense of human biological and

Fig. 1.1 The elements of needs. (Adapted from Fox and Miner [3])
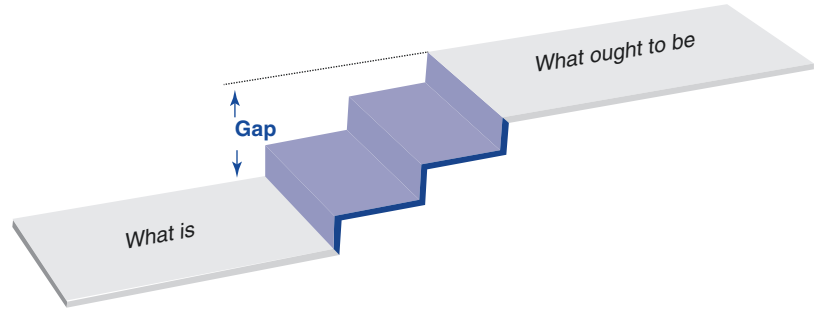
Table 1.1 Advantages/disadvantages of several need assessment methods

Method	Advantages	Disadvantages
Informal discussion	Convenient, inexpensive, rich in details	Lack of methodology, interviewer bias
Formal interviews	Standardized, quantitative, and qualitative information	Needs trained interviewers, costly
Focus group discussions	Efficient, learn about group behavior, qualitative data	Needs skilled facilitator, time, and financial costs
Questionnaires	Standardized questions, quantitative and/or qualitative data, easy to use (especially online), large samples possible	Question-writing skills needed, response rate issue, time intense for data collection and analysis
Direct observation	Best method for assessing skills and performance	Time-consuming, development of guidelines
Tests	Objective measure of knowledge or skills	Requires time, effort, and skill to construct valid test questions

Adapted from Kern et al. [4]

psychological requirements. The relation to education was described by Knowles in 1980 [1]: "These basic needs have relevance to education in that they provide the deep motivating springs for learning, and in that they prescribe certain conditions that the educators must take into account if they are to help people learn… An educational need, therefore, is the discrepancy between what individuals (or organizations or society) want themselves to be and what they are; the distance between an aspiration and a reality."

In other words, the educational need can be described as a gap between the present level of an ability (what is) and the desired level of the same ability (what ought to be) required for effective performance as defined by the learners, their organization, or society (Fig. 1.1).

Clarification of who the target learners are, their needs, and their environment is crucial to assure that learning takes place. Kern et al. [4] outlined several methods to assess learners' needs (Table 1.1).

Motivation

Motivation to learn arises from an educational need. Perception plays a major role in motivation and "…is the cornerstone of understanding why health professionals may have different levels of motivation related to similar topics and programs…" [3]. It is important to understand that the gap that affects each learner's motivation is always the gap between the perceived present level of ability of the learner and the desired level of ability and that the extent of discrepancy one perceives between these two affects the extent to which one is motivated to learn. The interactions between perceived and actual needs are summarized in Fig. 1.2.

The best situation is where we find a high perceived need and a high actual need, which results in the learner being highly motivated to learn. On the other hand, very large discrepancies are associated with a high anxiety level, which may lead to feelings of aversion rather than attraction and

Fig. 1.2 Perceived vs. actual needs. (After Fox and Miner [3]). ∗Not extremely high

Actual needs

*High**   *Low*

Perceived needs

*High**

Low

	High*	Low
	High motivation	Inaccurate self-perception
	No motivation; no learning	No need for learning
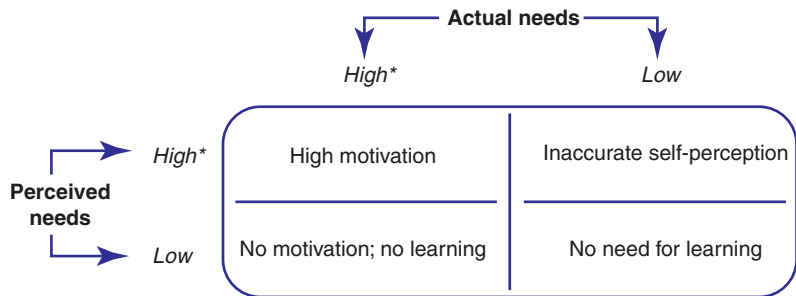
therefore a lack of motivation to learn. The most difficult situation is when learners believe that their performance is close to the standard but it is not, so the perceived need is low, but the actual need is high. In such a situation, the learners will not see any need to learn. The question is now how we can motivate these learners.

For adults, it is also important to be self-directed and to decide how they want to close an identified gap. Fox and Miner stated that "Motivation to participate in a specific learning activity will be greatest when the physician perceives strong or many goals, that those goals are important, that participating in the specific learning activity is personally satisfying, and that participating will result in achieving goals" [3].

For practical application, it is crucial to consider the following two points to motivate your learners:

1. Help your learners to realize their gaps in knowledge and performance by, for example:
   - Online self-assessments: Based on your defined outcomes, ask your learners about their perceived present level and their desired level. This can easily be done with an online survey tool. It is important that learners can see their results to recognize their gaps.
   - On-site small group discussions: During small group discussions, you can find out about the present level of knowledge, and you can help learners to understand where they are and where they should be. This is important in situations where learners think they already know a lot (although

they in fact do not) and would therefore not be highly motivated to learn.
   - Reflection (see also section on "Reflection"): Reflective practice helps learners to identify their gaps.
2. Help your learners to stay motivated by using a variety of teaching methods:
   - Use interactive methods for teaching such as interactive lectures and small group discussions.
   - Use new technologies to allow for self-directed learning, e.g., provide online resources such as readings or recorded lectures/webinars.
   - Provide learners with clear goals and outcomes.
   - Provide time and opportunities for reflection.
   - Blend traditional strategies with technology, e.g., self-assessment tests can be completed online and linked to discussion forums.

Outcome Driven

Many teachers declare the objectives before starting a teaching and learning activity. However, these are often the objectives of the teacher: "in the next hour, I am going to tell you ABC, then do DEF…." Such objectives may give learners an idea of what the teaching/learning process will be like. A clear articulation of the learning product, i.e., what the learners are expected to be able to do after the activity, would be more helpful to learners. These expectations, written from the

Fig. 1.3 Miller's pyramid. Framework for clinical assessment. (After Moore [7])
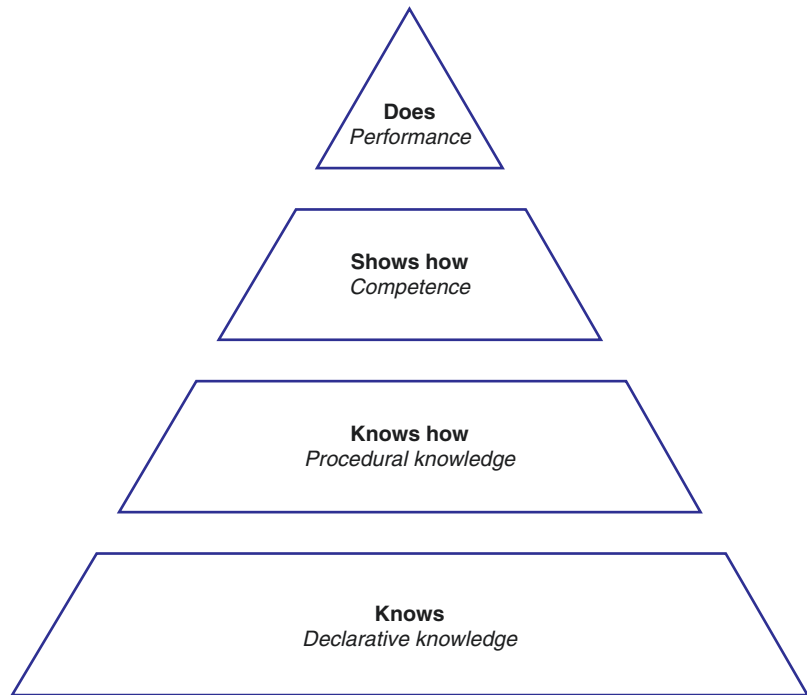
perspective of the learners, are called the intended learning outcomes.

There are several models to help teachers to develop learning outcomes. One is the SOLO (Structure of Observed Learning Outcomes) taxonomy [5], which describes several levels of complexity in the learner's understanding of a subject: prestructural (learners have unconnected information), unistructural (learners are able to make simple and obvious connections between facts), multistructural (learners see more connections but miss the significance to the whole), relational (learners appreciate the significance of the parts to the whole), and extended abstract (learners make connections beyond the subject and are able to generalize). Another model is the revised Bloom's taxonomy [6], which identifies six subcategories in the cognitive domain of learning activities: knowledge, comprehension, application, analysis, synthesis, and evaluation. Whether these six subcategories are hierarchical is debatable, but the subcategory "knowledge" here is defined as remembering and recalling (not knowledge in the general sense) and is usually considered the simplest level of intellectual activ-

ity. Miller's pyramid can also help teachers to formulate learning outcomes for their learners (Fig. 1.3) [7]. The pyramid shows the ideal stages of the development of clinical competence but can also be applied to learning in other areas. The first stage is that the learner knows what to do, and then he/she knows how to do it (i.e., he/she can describe the process but might not be able to do it). The next level is that the learner shows how it can be done in a safe environment, and the highest level is to apply it in actual practice. Similar to Bloom's taxonomy, Miller's pyramid also distinguishes learning that consists of memorizing facts (declarative knowledge) from learning that enables one to apply procedural knowledge in real-life situations.

After teachers have decided on the intended learning outcomes, they plan backward. They need to decide on the teaching/learning activities that will best help learners achieve the outcomes. They also need to decide on the assessment methods and standards with the intended outcomes in mind. Such an alignment of teaching/learning activities and assessment with the outcomes is called constructive alignment [8] and will be

Fig. 1.4 Aligning teaching/learning activities and assessment tasks with the intended learning outcomes

Teaching/learning activities ← **Intended learning outcomes** → Assessment tasks
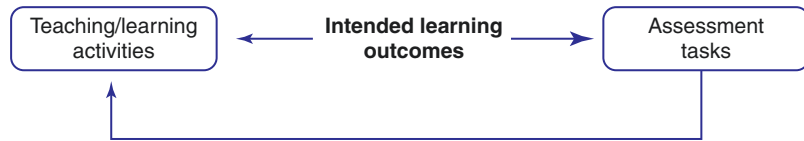
discussed in much greater detail in Chap. 3. If the outcomes are not met by the learners, the teachers may need to reconsider and adapt the teaching/learning activities and the assessment the next time they engage in the same activity, until the intended learning outcomes are achieved to a satisfactory level (Fig. 1.4).

In an outcome-based approach to learning, the intended learning outcomes take a central role. If the outcomes are not properly articulated, it will not be clear what the teaching/learning activities are trying to help the learners to achieve and what the assessment will be measuring. Thus, the articulation of the intended learning outcomes must be carefully done. Each outcome should begin with a verb that describes an observable and assessable action. The action indicates not only whether the learners are able to do certain things but also at what level they are expected to do it after the teaching/learning activity and under what conditions. For example, "describe" and "hypothesize" are appropriate verbs in outcomes since they both indicate not only whether the learners are able to understand certain content but also the levels the learners are expected to understand the content (lower level for "describe" than "hypothesize"). Assessment can also be focused on these actions. On the other hand, "understand" will not be an appropriate verb, because it is not observable and can only be indirectly assessed. If it was used in an intended learning outcome, the teacher may have difficulty designing the appropriate teaching/learning activity that will help the learners to achieve it, because it is not clear how much understanding is expected of the learners. The learners will also not know how, and to what level, they will be assessed on that outcome.

An outcome-based approach sets clear goals for learners. If the learners perceive a gap between their current level of ability and the goals, they will be more motivated to take part in the learning activities if they believe the activities have

been designed to help them achieve the goals. An outcome-based approach also helps teachers and administrators to cooperate to achieve the same goals, especially if the activity involves more than one teacher. It ensures that the right products are delivered. It is particularly important in the healthcare field because the amount of knowledge learners are required to know is rapidly expanding, while the length of healthcare training programs remains more or less the same [9]. An outcome-based approach ensures that the teaching/learning activities in a program will produce graduates with a set of intended competencies. This approach also encourages debate over the set of intended competencies because the teachers now need to explicitly articulate it [10, 11]. Doing so also enhances the transparency and quality assurance of healthcare training programs.

Active Learning

There is evidence that adults learn better with active learning, which can generally be defined as a learning process in which the learners are engaged in meaningful activities in the classroom and are mindful of what they are doing [12, 13].

The design of a teaching and learning activity determines the tasks that the learners need to engage in and how much active learning is possible. A traditional lecture, which is delivered in a unidirectional manner without interactions between the teacher and the learners, is often used to illustrate what learning is like when active learning is absent. In this kind of learning, the learners passively receive knowledge in a form already determined by the teacher. There are no tasks that the learners need to be involved in. In fact, the learners do not even need to be there for the lecture to take place. In active learning, the learners do not just sit and passively

receive information. They are engaged in such activities as discussion in small groups, think–pair–share activities, short writing exercises, debate, or gaming. Some of these activities can be integrated into lectures, thereby introducing some element of active learning into this relatively passive form of teaching and learning. But the lecture format makes these active learning opportunities difficult. Other activities that have been specifically designed to stimulate active learning include collaborative learning [14], cooperative learning [15], and problem-based learning [16], and active learning can be integrated into most other activities, including anatomical dissection (see Chap. 26).

Tasks that stimulate active learning are those that encourage learners to take ownership of the learning, which stimulates them to think critically and creatively in order to accomplish certain tasks. By engaging in these tasks, learners reflect on their prior or newly acquired knowledge, identify gaps in their knowledge, seek out relevant information, assess current problems, analyze facts and opinions, etc.

Although the main responsibility of learning rests with the learners in active learning, the teacher also has a very important role to play. The teacher should cease to be the "sage on the stage" as in a lecture and should become a "guide on the side" by providing a safe and inquisitive environment for the learners to explore and construct knowledge. A friendly and supportive environment encourages the learners to articulate their thoughts and to ask and answer questions in front of others without the fear of feeling embarrassed when they make any mistakes.

Reflection

People learn from experience by reflecting on it. Reflection is thus an integral part of learning. Before a meaningful discussion can proceed, "reflection" must first be defined because this term is used in everyday life and has different meanings in specific circumstances. Moon [17] defined it as "a form of mental processing with a purpose and/or anticipated outcome that is applied to relatively complex or unstructured ideas for which there is no obvious solution," while Boud et al. [18] defined it as "a generic term for those intellectual and affective activities in which individuals engage to explore their experiences in order to lead to a new understanding and appreciation." A more inclusive definition is given by Sanders [19]: "Reflection is a metacognitive process that occurs before, during and after situations with the purpose of developing greater understanding of both the self and the situation so that future encounters with the situation are informed from previous encounters." It is thus considered a process of thinking about thinking (metacognition) that involves not only the acquisition of new knowledge or skills but also an understanding of both the self and the situation, so that the learner will respond differently in future encounters.

The significance of reflection can be described using Kolb's cycle or the learning cycle [20]. The cycle consists of four stages (Fig. 1.5). Experience is just one of the four stages, and it alone is not sufficient for learning to occur. One needs to reflectively observe the experience ("reflective observation") and then formulate and integrate the new "skills, knowledge, attitudes and values with the learners' cognitive framework" [21] ("abstract conceptualization"). Based on the new cognitive framework after reflection on a previous experience, the learner will respond differently when he or she encounters similar situations in the future ("action"). The new response is itself an experience that the learner can reflect on, leading to further modification of the cognitive framework.
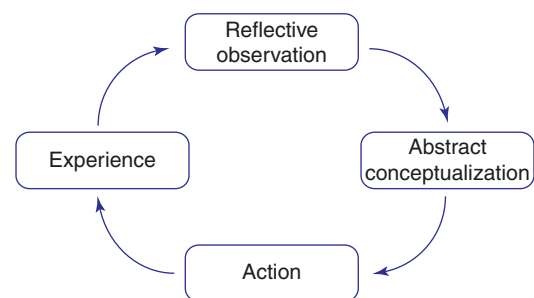

Fig. 1.5 Kolb's cycle. (After Kolb [20])

Learners going through the stages in Kolb's cycle are more likely to achieve deep learning because numerous links are formed between the new facts and ideas and their existing cognitive framework, in contrast to surface learning, in which new facts and ideas are isolated and unconnected [22]. The linking process also gives more meaning to the new knowledge, skills, attitudes, and values by relating them to the larger context.

Given the important role of reflection in learning, it is surprising that it does not spontaneously occur as often as desired and needs to be actively promoted. Moon [23] pointed out that learner reflection can be promoted when the tasks are challenging and ill structured (e.g., real-life examples), demand ordering of thoughts (e.g., following exposure to disorganized data), involve evaluation, and require integration of the new into previous learning. Chapter 26 illustrates how teaching and learning around anatomical dissection can be structured to promote reflection.

Feedback

Feedback is an essential part of medical education. It is "…specific information about the comparison between a trainee's observed performance and a standard, given with the intent to improve the trainee's performance" [24, 25]. It helps learners to maximize their potential at different stages of their lifelong learning path, raise their awareness of strengths and areas for improvement, and identify actions to be taken to improve performance. Therefore, the purpose of feedback is to improve performance [26] and reflection [25], not to criticize or judge.

A common model for giving feedback in clinical education settings was developed by Pendleton et al. [27]. Pendleton's rules consist of the following steps:

1. Check if the learner wants and is ready for feedback.
2. Allow the learner to give comments/background to the material that is being assessed.
3. The learner states what was done well.
4. The observer states what was done well.
5. The observer states what could be improved.
6. The teacher states how it could be improved.
7. An action plan for improvement is made together.

Pendleton's rules are structured in such a way that the positives are highlighted first (steps 3 and 4) in order to create a safe environment. In addition, step 3 forces the learner to reflect on his/her action. This is followed by the observer reinforcing these positives and adding some more if needed. "What could be done differently?" is then suggested, first by the learner and then by the observer. Again, it gives the learner the opportunity to reflect and to decide what to do next time. The advantage of this method is that the learner's strengths are discussed first. Avoiding a discussion of weaknesses right at the beginning prevents defensiveness and allows reflective behavior in the learner. The most crucial step is step 7, the action and follow-up plan, where the learner agrees with the observer on changes he/she will make for the next time.

Although this model provides a useful framework, there have been some criticisms of its rigid and formulaic nature, and a number of other models have been developed for giving feedback in a structured and positive way. One of these is the "sandwich" model, which starts with identifying the learner's strength, is followed by identifying the learner's areas in need of development, and concludes by reinforcing the strengths again.

Elements of Effective Feedback
- Provide a culture of giving feedback between learners and teachers. Feedback should be given *frequently*.
- Give feedback only when asked to do so or when your offer is accepted.
- Schedule formal feedback sessions that are convenient for the learner and the teacher, and adequate time should be given for both parties to prepare. Give feedback in a *timely* manner (not too soon or too late after the event).
- Select a location that is as private as possible.
- Measure the learner's performance against *standards* and well-defined goals and objectives.
- Provide *specific* and *accurate* information, including examples, not generalizations.
- Focus on the *positive*.
- Focus on *behaviors* that can be changed, not personality traits.
- Be *sensitive* to the impact of your message. Feedback is for the recipient, not the giver.
- Consider the content of the message, the process of giving feedback, and the congruence between your *verbal and non-verbal messages*.
- Encourage *reflection*.
- Be clear (have a goal) about what you are giving feedback on, and link this to the learner's *overall development* or intended program outcomes.
- Do *not overload*—identify two or three key messages to outline at the end. Be sure that the learners themselves identify the changes they want to make.

Summary

To promote effective learning, teachers need to understand the needs of learners and to motivate them by enabling them to perceive any gaps that exist between their present level of ability (what is) and the desired level (what ought to be). Learners can be motivated to learn better if they are informed regarding the specific learning outcomes of the activities and how achieving these outcomes will help them to bridge their gaps. Teaching and learning activities and assessment methods and standards should all be designed to help learners achieve these outcomes. Learners should be actively engaged in the learning process, instead of passively receiving information. They should be given frequent, accurate, and specific feedback at the appropriate time and be given time and opportunities for reflection.

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Learners of a New Generation

Camille DiLullo

It has been proposed that learning is expedited when clearly defined "learning outcomes" are stipulated in advance. This concept and an approach for implementation are more fully addressed toward the end of this chapter. To exemplify the process, I am providing two outcomes you should expect to attain after completion of this reading. The anticipated outcomes to be acquired are the ability to (1) identify issues that can impact learning of the next generation and (2) coordinate content delivery that can facilitate next-generation learning.

The Learner Persona

Differentiate the Constituents of Multigenerational Learning Cohorts

Learner cohorts in higher education are more likely to be comprised of individuals from multiple generations as compared to the learner cohorts in K-12 education which are predominantly composed of individuals from a single generation. Whether a particular cohort is comprised of learners from one or more than one

generation, it can be predicted that individual learning cohorts will include people with varied learning characteristics. Strauss and Howe [1] defined distinguishing characteristics for specific generations of the twentieth century in the USA. The authors proposed that identifiable generational traits are in part shaped by global, national, and societal events that occur during the time period of the previous generation. It is likely that generalized traits of individual generational cohorts from other countries can also be defined but will vary based on their respective national and societal events. When examining charts that delineate generational descriptions, individuals commonly feel they do not personally possess every characteristic assigned to their particular generation or alternatively that personality traits assigned to previous or later generations are more apropos. Appreciation of how your personality reflects the attributes associated with your own generation can help elucidate the premise that learners within any generational cohort are not a clonal population. The exercise provided in Table 2.1 is designed to help you ascertain how in synch you believe your personality traits are with those categorized for a single generation. Peruse the characteristics listed in Table 2.1 for four American generations. If you are an American, select the generational cohort to which you belong. If you are not part of an American gen-

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Table 2.1 Attributed generational traits

1925–1942 silent generation	√	1943–1960 baby-boom generation	√
Adaptive		Antiestablishment	
Cautious		Confident	
Conformist		Entrepreneurial	
Due process-oriented		Free-spirited	
Fair		Idealistic	
Hard-working		Individualistic	
Mediator		Independent	
Nonviolent		Personal growth	
Reserved		Revolutionary	
Risk-averse		Self-directed	
Socially conscious		Self-indulgent	
Solitary		Self-motivated	
1961–1981 generation X	√	1982–2003 millennial generation	√
Cynical		Accepts authority	
Detached		Achiever	
Determined		Civic	
Enigmatic		Considered special	
Informal		Family-oriented	
Pragmatic		Happy	
Quick		Pressured	
Reactive		Optimistic	
Realistic		Protected	
Self-protective		Self-assured	
Self-reliant		Service-minded	
Street-smart		Team player	

eration, select the group which has a majority of traits that you consider most appropriately represent your particular generation. In the column to the right of the group you selected, check how many of the listed traits you feel characterize your persona. Now examine the traits in columns of other generational cohorts with which you did not identify. Again, in the right column, check those traits which you believe can fairly be ascribed to your persona. You may not feel strongly bound to distinctive traits attributed to the group with which you primarily identified. Alternatively, you may feel closely aligned with traits linked to other generational cohorts. Members of any generation may possess many of their generations' ascribed traits, but they are just as likely to possess traits typical of other generational cohorts.

Appreciate Individual Learner Characteristics

It is essential that we view generational traits as trends in a given learner cohort rather than as inflexible characteristics. It is incumbent upon educators to tease out what traits charged to the newest generation of learners might influence their learning keeping in mind that many of these things might impact learners of previous generations as well. Global evolution has created the culturally diverse and technologically rich environment in which the millennial generation has been raised. Millennial learners come from a multitude of cultural, religious, and socioeconomic backgrounds [2]. They have grown up in a world dominated by digital communication both in their personal lives and in their educational experience. Diversity and engagement with technology will be factors that affect the success of millennial as well as next-generation learning into the foreseeable future. Societal circumstances have also been suggested to affect millennial generation learning including the protected nature of their upbringing, the way they have all been made to feel special, the pressure they have been put under to become high achievers, and the tendency for them to engage in team activities. In our global environment of competition with goals for ever-increasing productivity and efficiency, many traits that have been ascribed to the millennial generation are likely to remain the same for next-generation learners. Despite overarching trends in generational traits, learning cohorts will encompass individuals with unique personalities. In the process of learning, that which we are inherently interested in or excited about we learn best. Guiding learners to explore new knowledge through the lens of their distinctive professional passions within real-world contexts, which I refer to as interrelational learning (IRL), will more deeply engage students in the learning process.

Much has been written regarding the transformation in learning style of the millennial generation [2–5]. Suggested learning style changes include multitasking, a preference for learning using technology and working in groups as well

as the elimination of reading. Alternative views assert that the learning style of the millennial generation may not be as radically different from previous generations as is often proposed [6, 7]. Studies have shown that many millennial learners continue to be engaged with traditional teaching methods and do read although it may be with e-books rather than textbooks [8]. While individual learners can absorb information in multiple ways, they generally demonstrate a learning style preference. In other words, they learn more easily in one particular modality as compared to others. Learners process information in one of several ways and can be defined as visual, aural, read/write, or kinesthetic [9]. Individuals will vary in their predilection for specific modalities, so within any learner cohort there will be a mix of preferred learning styles.

Support Varied Learning Styles with a Balanced Educational Approach

The recognition of different learning styles [10, 11] has advanced in tandem with the evolution of available educational resources. For centuries, learners had to adapt their learning style to the resources that were available. In the last century, resources included primarily lecture, handouts, books, films, personal notes, and a physical library. The technological explosion has exponentially increased the overwhelming array of educational resources beyond the traditional to include digital pedagogy, lecture capture, computer animation, YouTube, e-books, web searches, virtual programs, a digital library, blogs, e-communities, and so on. This vast assortment can substantially support a greater variety of learning styles. It may now be more appropriate to view the need for evolution in teaching modalities to be an outcome of the increased selection of educational resources rather than the inherent learning differences of next-generation learners. The pedagogical pendulum has for centuries been shifted toward using traditional teaching methodologies that favor aural and read/write learners. Collectively, our

expanded learning resources offer more opportunity to directly engage visual and kinesthetic learners. However, the introduction of innovative delivery methods with the concurrent elimination of traditional pedagogy could swing the pendulum to the other extreme and limit the learning environment for aural and read/write learners. Facilitation of learning must take a balanced approach in content delivery that incorporates multiple and varied learning paradigms to accommodate learners of all types. Some educators have embraced the idea that each learner should have a special curriculum designed exclusively for them to meet their particular learning needs [12, 13]. Embracing a comprehensive approach to content delivery would eliminate the need for custom learner curricula. Next-generation learners would have the opportunity to self-select instructional modalities that provide them optimum success in developing expertise.

Ensure Learner Competence with Innovative Technology

Millennial generation learners sometimes referred to as digital natives [14, 15]—individuals whose development has been infused with technology—have had extensive experience with digital exploration, gaming, and communication and are purported to be adept with user-friendly digital devices. Despite the pervasive use of technology by this generational cohort, data indicates that their proficiency with commonplace digital devices does not necessarily translate into an aptitude for educational technology [16, 17]. Educators should not presume that all next-generation learners, let alone learners from previous generations, will be skilled in the use of educational technology such as integrated educational content platforms, anatomical simulators, and virtual anatomy programs. Sufficient instruction must be available to appropriately prepare learners in the use of technology that is employed to deliver content. Time management is crucial to millennial generation learners who feel under great pressure to achieve and are always attempt-