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Article 1

Practical, Applied, and Research-Based Strategies for Physicians

Stephanie M. Williams, PennWest University, Edinboro, Pennsylvania, USA John F. Ziegler, PennWest University, Edinboro, Pennsylvania, USA

Aspiring physicians face a large amount of information that must be learned and retrieved in real time. The skills that helped medical students reach residency may not be the enough to succeed as a physician. For example, like many students, cramming the night before an exam probably helped achieve a satisfactory score. Unfortunately, cramming does not require that the information be retained and applied overtime. The content acquired in medical school is cumulative, that is, the information learned remains relevant months and even years later. Not only does content need to remembered, the knowledge must be constantly updated as new research makes some information more relevant and other information less important. Finally, the stakes as a physician are high. Forgetting a critical piece of information will not result in a lower test score, it can seriously harm patients. This article is a practical approach to teaching medical doctors, based on a literature review, including practical, scientific, and applied research and strategies ways in which teaching can be done that result in depth of learning in the resident.

Article 2

Using the Lessons of Learning Science to Improve Medical Education

Jason DeGiovanni, State University of New York, Buffalo, New York, USA Mattie Rosi-Schumacher, State University of New York, Buffalo, New York, USA

Objective: This review synthesizes information from original research in the field of learning theory and the psychology of learning in order to provide evidence-based study methods to adult learners in the field of medicine.

Methods: A literature review was conducted and results were synthesized in a narrative fashion. Results: Deeper levels of analysis produce longer-lasting memory, therefore, the concept of creating a "desirable level of difficulty" when it comes to study material and methods has been shown to promote learning. When the learner uses a higher subjective level of effort in processing information, they can maximize the efficacy of their studying efforts. This review describes how memory encoding can be enhanced by applying several theories of learning psychology including the generation effect and the interleaving effect. The use of mnemonics, the "memory palace," and handwritten notes have also proven useful to enhance information recall. Methods that promote long-term learning including the spacing effect and delayed repetition are reviewed. Learning theory shows that the most effective learners use self-testing and forced recall to retain more information with limited study time.

Conclusions: The application of these learning methods may help to improve information retention and productiveness among adult learners.

Article 3

The New Normal—Virtual and Hybrid Presentations: Developing Content, Designing Slides, and Delivery Guidelines

Jackie L. Gartner-Schmidt, Carlow University, Pittsburgh, Pennsylvania, USA

Virtual and hybrid presenting are not new, but they are new to many more people since the COVID-19 pandemic. Although some people may long for the past in-person conferences and presentations, the new normal is here like it or not. If you were an *excellent* in-person presenter and have not modified your presentation approach, you may now be an *average* virtual/hybrid presenter. If you were a poor in-person presenter before, well, now your audience is not listening to you. If you want to present in this new space, you need to be good at it. Surprisingly, virtual and hybrid presenting is not so dependent on all the new technical and software bells and whistles. The virtual medium is shining a light on those who never fully learned the basic foundations of excellent presentation effectiveness in the first place: *developing* a solid story with one clear focus, *designing* slides that visually communicate your story, and *delivery* skills that connect with your audience. Bottom line, the purpose of a presentation is the same whether in person, virtual, or hybrid: communication. The difference is that we must adapt our slides and delivery and hone our clear story for ultimate engagement because our audience is our presentation's most valuable stakeholder.

Article 4

The Smart Use of Smart Technologies in Teaching and Learning: Where We Are and Where We Need to Be

Patricia A. Alexander, University of Maryland, Baltimore, Maryland, USA

Brian Pettitt-Schieber, Albert Einstein College of Medicine, Bronx, New York, USA Andrew Steehler, University of Pittsburgh Medical Center, Erie, Pennsylvania, USA

In this article, the current state of learning and teaching in medical education and residency are described. Following these characterizations, consideration is given to changes that are worth exploring in the habits of mind and habits of action medical students and residents exhibit to deepen their learning and improve their performance. Relevant transformations in instructional practices in medical school and residency are also overviewed that can contribute to more effective learning environments. The role that technology plays in current learning and teaching practices and the role smart technologies can play in supporting needed changes are also addressed.

Article 5

An Introduction to the Cornell Note System

Manick Saran, University of Pittsburgh Medical Center, Erie, Pennsylvania, USA

Introduction: The success of note writing has been continuously researched for decades since the days of Plato. Students now have access to books and notes on computers, tablets, and even phones. A few ways students can take notes are by using premade handouts, "Chalk Talk" lectures with faculty, and using prescribed note-taking strategies. Here, we discuss one such strategy, the Cornell Note System

Methods: An updated review of the original Cornell Note system originally outlined in *How to Study in College*

Conclusion: The outline and unique aspects of the Cornell Note system are discussed and how it can be incorporated into the modern-day curriculum

Article 6

Spaced Effect Learning and Blunting the Forgetfulness Curve

Yael Wollstein, University of Pittsburgh, Pittsburgh, Pennsylvania, USA, Noel Jabbour, University of Pittsburgh Children's Hospital, Pittsburgh, Pennsylvania, USA

Article 7

Building Surgical Expertise through Deliberate Practice

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We are grateful to Dr. Jack Anon who proposed this anthology concept to us as a way in which we could unite two worlds, teaching and learning, from two perspectives, educator and physician.

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The Attending Physician Educator

Jack Anon, MD

Keywords
residents, doctor, learning, future

Doctor (n.) directly from Medieval Latin *doctor*" teacher, adviser, scholar," in classical Latin "teacher," from *docere* "to show, teach. Medical knowledge has been expanding exponentially. The information gained today by the physician in training will be a fraction of what will be discovered in the next 10 years. Additionally, new technologies will continue to require the modification and learning of surgical techniques to better serve our patient needs.

The current postgraduate medical education process has, however, lagged behind the vast changes in our field. This is challenging, as the field of education has ALSO grown by leaps and bounds. New approaches to teaching and new concepts in learning have taken over the world by storm. Many universities of higher learning have responded to the challenges presented by the young adult learner. Yet, in our world of medicine, residents are subjected to the same teaching style that their professors learned by, as did their professors before them. The teaching physician has many hats to wear—patient care giver, author, researcher, reviewer, and educator. There are resources to assist in all these areas but teaching. There are no "HOW TO" books on the education of resident physicians.

Thus, this supplement on "Best Practices in Teaching and Learning for Resident Physicians" was developed. The initial idea came from my personal experiences as a teaching doctor. I realized that I my MD degree was NOT an educational degree. I reached out to my local teaching university Penn West Edinboro, finally connecting with Stephanie Williams PhD and John Ziegler D. Ed. And what a connection. Never in my career have I worked with 2 more dedicated individuals. Together, we formed a team of professionals willing to meet the goal of developing manuscripts designed to help teach our residents. We included seasoned experts and residents in training as contributors. The inclusion of residents was key, as who better to help discuss teaching methods than the recipient! The biographies of these individuals speak for themselves. I am so honored to have worked with our team. I cannot thank them enough for their commitment to this project and dedication to their fields.

We consider this Supplement as a start. It is our goal to continue to improve the field of physician resident education. Further articles on this topic are planned for future issues of ENT JOURNAL. So stayed tuned!!

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Practical, Applied, and Research-Based Teaching Strategies for Physicians

Stephanie M. Williams, and John F. Ziegler

Abstract

Aspiring physicians face a large amount of information that must be learned and retrieved in real time. The skills that helped medical students reach residency may not be the enough to succeed as a physician. For example, like many students, cramming the night before an exam probably helped achieve a satisfactory score. Unfortunately, cramming does not require that the information be retained and applied overtime. The content acquired in medical school is cumulative, that is, the information learned remains relevant months and even years later. Not only does content need to remembered, the knowledge must be constantly updated as new research makes some information more relevant and other information less important. Finally, the stakes as a physician are high. Forgetting a critical piece of information will not result in a lower test score, it can seriously harm patients. This article is a practical approach to teaching medical doctors, based on a literature review, including practical, scientific, and applied research and strategies ways in which teaching can be done that result in depth of learning in the resident.

Keywords

brain-based learning, effective teaching strategies, resident learning, barriers to learning

An examination of learning today provides clarity of the challenge's educators in higher education face. Content knowledge and delivery, two variables in effective teaching, if done well, result in the highest impact to learning.[1] In higher education, the transition from straight lecture format to co-construction has been slow, although recognized as a concern for many years.[2,3] For professors of higher education, the traditional lecture-style delivery has lost its effectiveness, thus requiring a pedagogical shift from lecture to a shared concept of learning.

As discusses this challenge to instruction and stresses that educators must pay attention to learning and its approach.[1] The need for instructional change has become more apparent within the past several years, with a more student-centered focus as the foundation for depth in learning. A five-year teaching experiment led a research team to conclude that inquiry is a valuable strategy to assist students in becoming more engaged and active in learning.[4]

Faculty at higher education institutions are changing the instructional delivery of content, and more universities are shifting from primary lecture format to a blended learning strategy.[5,6,7] The shift in the role of higher education prepares students to learn and to adapt existing knowledge. The result is the students serve as critical and productive participants, allowing co-construction and management of learning.[8] Teaching and learning in contemporary higher education are a shared process with both professor and student owning the responsibility with successful learning outcomes.

Higher education institutions, particularly, the medical education community, require students to learn a large amount of material with limited time. In this case, residents are responsible for much of their learning. As reported by students and research, lecture and textbook dissemination of material are not adequate. Every time you learn something new, you change the brain—the residue of your experiences is stored.[9] Learning must be meaningful and individualized for each learner. The authors noted in order for mastery to occur, both

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possession of ready knowledge and the conceptual understanding of how to use it are required.

Brown, et al state that the good news is we now have uncovered simple and practical strategies that can be used, throughout life, to learn better and remember longer.[9] This will add balance to the concern that many non-education professors are teaching, most often from how they were taught or how they best learn.

Brain-Based Research and Learning

Effective teaching facilitates transference of knowledge to long-term memory (Van Lehn, 1996). A meta-analysis by Chernikova et al (2020) identified effective strategies as highlighted. Feedback maintains lecture, PowerPoint and textbook reading are not successful strategies. Highlights of the meta-analysis as related to the current study are listed below:

- Students acquire high levels of expertise in complex problem-solving tasks if they have sufficient prior knowledge and engage in an adequate amount of authentic practice related to the profession (Barab et al, 2000).
- Real-life practice without systematic guidance is not sufficient. Prior to working with real-life patients, the resident should have ample prior practice experience. In medical education, simulations are used to support diagnostic competencies for the perspective doctor (Cook, 2014; Cook et al, 2013, Hegland et al, 2017). Simulations provide the opportunity for individualized learning to occur, which is not readily available in a life-event situation.
- Simulations are used in high education settings to facilitate a deeper understanding of concepts and problem-solving (D'Angelo et al, 2004; Wu and Anderson, 2015).
- A scaffolding framework supports individualized learning based on the amount of knowledge each student demonstrates. Tabak and Kyza (2018) suggest scaffolding is a support that shifts control over the learning process from learner to teacher.

Residents in the medical profession are required to be prepared through demonstration of specific competencies. Critical thinking, problem-solving, communication, and collaborations are valuable required skills. Well-structured scenarios can include the required skills, thus providing a resident with ample learning opportunities.

Early educators once thought that intelligence is fixed and remains virtually the same through someone's entire life. More recent discoveries reveal that physical changes take place in the brain during learning. When someone practices certain skills, they find it easier over time to carry on improving those abilities. Learning has been demonstrated to improve resiliency, working intelligence, and brain function. The evidence thus far suggests that teachers who do use the principles of brain-based learning as the foundation for an engaging curriculum and creative environment can improve the efficiency and speed of their students' learning.

The core principles of brain-based learning follow. Each principle lays out a formula for better retention and learning among students.

- Health and Exercise: The more active and engaged students are physically, the better their learning outcomes. This requires more than a midday recess or a walk between classes. Allowing students to take walking breaks during lessons and throughout the day, for example, revitalizes students, increases their attention span, and better prepares them to retain information.
- Positive Emotions: The happier students are, the more they are willing to learn and think effectively. Affirmations from the teacher are one way to raise student self-esteem.
- Group Work: Working in teams with classmates allows students to learn from one another. Collaborative environments can help them retain information they may not have accepted or understood from the teacher.
- Peer Teaching: When students teach materials to their peers, it helps them retain that same information. This can be done in small groups or through presentations.
- Practice: Learning through repetition and trial and error is more effective than simple memorization. Students will gain a better understanding of the subject through practice, rather than just memorizing the details.
- Limited Lectures: Only 5–10 percent of information is retained during a lecture, according to Swan.[10] Making lessons largely discussion-based promotes student learning.
- Meaningful Information: Students are more likely to remember information if they are engaged with the lesson. By applying the material to their lives, students will find it meaningful. For example, a lesson on economics could be related to smartphone ownership.
- Written and Verbal Information: Having students both write and verbalize information will help move it from their short-term memory to their long-term memory.
- Stimulation: Catching students' attention through humor, movement, or games stimulates their brains' emotional center. In turn, this increases students' engagement and processing of information.
- Less Stress: Stress chemically changes the brain. In a calm classroom environment, students have the

opportunity to perform at higher levels.

Learning Styles Revisited

Educational psychologists have moved from cognitive styles and how people think to the idea of learning styles and how people learn.[11] The basic idea is very attractive. We know that a particular piece of instruction might be effective for some students, and not for others, so it seems plausible that if the instruction was specifically designed to take into account a particular student's preferred learning style, then it would be more effective for that student. This is what psychologists call the general learning-styles hypothesis—the idea that instruction students receive will be more (or less) effective if the instruction takes (or does not take) into account the student's learning-style preferences.

Within education, a version of the learning styles known by psychologists as the *meshing* hypothesis has been of particular interest: the idea that students will learn more if they receive instruction that specifically matches their learning-style preferences. In other words, visual learners will learn better if they receive instruction that emphasizes visual ways of presenting information, and auditory learners will learn best by listening.

In their review of research on learning styles for the Association for Psychological Science, Pashler et al[12] came to a stark conclusion: "If classification of students' learning styles has practical utility, it remains to be demonstrated." (p. 117). Pashler et al pointed out that experiments designed to investigate the meshing hypothesis would have to satisfy three conditions:

1. Based on an assessment of their presumed learning style, learners would be allocated to two or more groups (e.g., visual, auditory, and kinesthetic learners).
2. Students within each of the learning-style groups would be randomly allocated to at least two different methods of instruction (e.g., visual and auditory-based approaches).
3. All students in the study would be given the same final test of achievement.

In such experiments, the meshing hypothesis would be supported if the results showed that the learning method that optimizes test performance of one learning-style group is different than the learning method that optimizes the test performance of a second learning-style group. In their review, Pashler et al[12] found only one study that gave even partial support to the meshing hypothesis, and two that clearly contradicted it.

The fact that there is currently no evidence that knowing students' learning styles helps design more effective instruction does not mean that learning styles will never be useful in the future. Some psychologists are likely to continue to look for new ways to look at learning styles, even though there are at least 71 different learning-style classification systems already in existence.[13]

Over the last 30 years, psychologists have found that performance on a learning task is a poor predictor of long-term retention. More precisely, when learners do well on a learning task, they are likely to forget things more quickly than if they do badly on the learning task; good instruction creates "desirable difficulties" for the learner.[14] In Daniel Willingham's memorable phrase, "memory is the residue of thought."[15] By trying to match our instruction to our students' preferred learning style, we may, in fact, be reducing learning**.** If students do not have to work hard to make sense of what they are learning, then they are less likely to remember it later.

Attempting to synthesize such a large and complex body of research is a large undertaking, but an important "takeaway" from the research on learning styles is that teachers need to increase their awareness of individual learning styles if only to avoid the trap of teaching in the style they believe works best for them. As long as teachers are varying their teaching style, then it is likely that all students will get some experience of being in their comfort zone and some experience of being pushed beyond it. Ultimately, we have to remember that teaching is interesting because our students are so different, but only possible because they are so similar. Of course, every student is a unique individual, but it is extraordinary how effective well-planned group instruction can be.

Based on some assessment of their presumed learning style, learners would be allocated to two or more groups (e.g., visual, auditory and kinesthetic learners). Students within each of the learning-style groups would be randomly allocated to at least two different methods of instruction (e.g., visual and auditory-based approaches). All students in the study would be given the same final test of achievement. In such experiments, the meshing hypothesis would be supported if the results showed that the learning method that optimizes test performance of one learning-style group is different than the learning method that optimizes the test performance of a second learning-style group. In their review, Pashler et al found only one study that gave even partial support to the meshing hypothesis, and two that clearly contradicted it.[12]

The fact that there is currently no evidence that knowing students' learning styles helps us design more effective instruction does not mean that learning styles will never be useful in the future—absence of evidence is not the same as evidence of absence. Some psychologists are no doubt likely to continue to look for new ways to look at learning styles, even though there are at least 71 different learning-style classification systems already in existence.[13] However, it could be that the whole idea of learning-styles research is misguided because its basic assumption that the purpose of instructional design is to make learning easy may just be incorrect.

Over the last 30 years, psychologists have found that performance on a learning task is a poor predictor of long-term

retention. By trying to match our instruction to our students' preferred learning style, we may, in fact, be reducing learning. If students do not have to work hard to make sense of what they are learning, then they are less likely to remember it in 6 weeks' time.

Attempting to synthesize such a large and complex body of research is almost certainly a fool's errand, but it seems to me that the important "takeaway" from the research on learning styles is that teachers need to know about learning styles if only to avoid the trap of teaching in the style they believe works best for them. As long as teachers are varying their teaching style, then it is likely that all students will get some experience of being in their comfort zone and some experience of being pushed beyond it. Ultimately, we have to remember that teaching is interesting because our students are so different, but only possible because they are so similar.

Evidence-based teaching strategies

An evidence-based teaching strategy is an instructional approach supported by research. However, research shows that some strategies have more impact than others. These evidence-based teaching strategies are grounded in solid research.[16]

This list of teaching strategies support:

- Hard research, rather than anecdotal case studies or untested theories
- Impact on student results that it is substantially higher than typical strategies
- Used on a wide range of subject areas and in all year levels

Strategy 1: Clear Lesson Goals

Clarity is crucial. The effect that clarity has on the learner is 32% greater than the effect of holding high expectations for every student (and holding high expectations has a sizeable effect). Clear lesson goals help you (and your students) to focus every other aspect of your lesson on what matters most.

Lesson goals state what you want your students to:

- Know and understand
- Be able to do

Strategy 2: Show and Tell

The second evidence-based teaching strategy in this list is "show and tell." You should start most of your lessons with some show and tell. Your lesson goals clarify what you want your students to know and be able to do by the end of the lesson. Now, you need to tell them what they need to know and show them how to do the things you want them to be able to do. Show and tell is the essence of the I Do phase of the I Do—We Do—You Do model. Put simply:

- Telling involves sharing information or knowledge with your students
- Showing involves modeling how to do something.

Strategy 3: Questioning to Check for Understanding

After informing students what they need to know, you need to check their understanding before moving on. You can do this using:

- Random sampling
- All student response system

Random sampling involves asking a question, pausing, and then randomly choosing a student to answer. The pause is to allow all students to think of their answer. And, the random sampling can be as simple as names out of a hat. Other popular techniques include popsicle sticks in sand and an online name picker. By using random sampling regularly, students get used to having to have an answer ready in case you select their name. By asking a small number of questions about the content you have just shared and randomly selecting students to answer them, you can get a reasonable estimate of the class's understanding. The other option is to use some form of all student response system. These systems include the following.

Strategy 4: Summarize New Learning in a Graphical Way

Graphic outlines include things such as mind maps, flow charts, and Venn diagrams. Graphic outlines help learners to:

- Summarize what they have learned
- Understand the interrelationships between the aspects of what you have taught them

Discussing a graphical summary is a fantastic way to finish off your show and tell. You can then refer to it one more time at the end of your lesson. Studies show that it doesn't seem to matter who makes the summary graphic, be it the instructor or the learner, provided the graphic is accurate. Discussing a graphical summary is a fantastic way to finish off your show and tell. You can then refer to it one more time at the end of your lesson.

Strategy 5: Plenty of Practice

As the saying goes, practice makes perfect. Practice helps students to retain the knowledge and skills that they have learned during your show and tell. Therefore, you need to choose practice tasks related to your lesson goal. Doing so also

gives you another opportunity to check for understanding. You can then use this opportunity to:

- Re-explain things to the class or groups
- Offer personalized feedback to individual students

However, research also shows that students do better when you give them multiple opportunities to practice spread out over time. So, you need to build in opportunities to practice past material either as part of the lesson or stand-alone sessions.

Strategy 6: Provide Your Students with Feedback

Feedback is the breakfast of champion learners, and it is the breakfast served by extraordinary teachers around the world. Any teachers who seriously want to boost their children's results should start by giving them plenty of feedback.

Giving feedback involves telling a student:

- How they have performed on a particular task
- Along with ways that they can improve.

Feedback is different than praise. Praise focuses on the learner rather, but feedback focuses on what your learner did. It provides your students with a tangible understanding of:

- What they did well
- Where they are at
- How they can improve

Strategy 7: Be Flexible About How Long It Takes to Learn

The idea that given enough time, every learner can learn is not as revolutionary as it sounds. It underpins the way we teach martial arts, swimming, and dancing. It is also the central premise behind mastery learning, a technique that has the same effect on student results as socio-economic status and other aspects of home life. When you adopt mastery learning, you differentiate differently. You keep your learning goals the same but vary the time you give each learner to succeed. Within the constraints of a crowded curriculum, this may be easier said than done; however, we can all do it to some degree.

Strategy 8: Productive Group Work

Group work is not new, and you can see it in every classroom. However, productive group work is rare. This is because some students do all the work and all the learning, while others do very little at all. There are several reasons this can happen, but two of the main ones are that some students are more:

- Eager than others
- Competent than others

To increase the productivity of your groups, you need to be selective about the:

- Tasks you assign to them
- Individual role that each group member plays
- Only ask groups to complete tasks that group members can achieve successfully
- Ensure each group member personally responsible for one step in the task.

For example, group work requires students to reflect on prior knowledge, to elaborate upon this knowledge, and to generate new knowledge based on discussions, reflection, and elaboration.[9] Group work allows depth of knowledge to occur on an individual level. In an interview with Biology Professor Wenderoth, study groups redefined as testing groups, resulted in students discussing a question together. In other words, students test one another on points that are not clear. The emphasis in this group work is on exploration, understanding, and individualizing the learning.

Strategy 9: Teach Strategies Not Just Content

You can increase how well your learners do in any subject by explicitly teaching them how to use relevant learning strategies. When teaching students to:

- Write you often teach them strategies such as making a plan and checking for transition words.
- Read you often teach strategies that will deepen their comprehension.
- Mathematics, you often teach them problem-solving strategies.

From assignments and studying to characterization, there are strategies that will help your learners perform better. And, just as with content, you need to:

- Tell learners about these strategies
- Show them how to use them
- Give them guided practice and feedback before asking them to use them independently.

Strategy 10: Nurture Meta-Cognition

Many teachers believe they are encouraging students to use meta-cognition when they are not. Often, they are just asking their students to use strategies. For example:

- Making connections when reading
- Self-verbalizing when solving problems

Such strategies are useful. However, on their own, they are not meta-cognition. Meta-cognition involves thinking about your options, your choices, and your results. And it has an even larger effect on student results than teaching them strategies. When using meta-cognition your students may think about:

- What strategies they could use (options)
- What strategies they will use (choices)
- How effective their choices were (results)
- Whether to continue with or change their chosen strategies

Educational techniques: current trends and best practices in teaching effective teaching and learning strategies

Conceptualizing

McTighe and Silver, reference conceptualizing as a way for students to think big, by using factual knowledge to construct larger concepts and understandings and individualize constructed knowledge.[17] This process of forming learning from observations and connections relies on instructor planning and presentation. Specific tools incorporated into lessons aide the learner.

A pre-organizer, such as a conceptual map, allows the learner to view the process and understand connections in learning.[17] Before beginning a new topic, the professor makes connections to the last topic and builds a map of where the current topic will end. This emphasizes student-centered learning by allowing the student to construct new knowledge, based on prior knowledge, with the end in mind. Concept mapping allows the learning to frame learning around the core content, resulting in connections.

Differentiated instruction

Effective teachers are mindful of each student in their classroom, background, ideologies, learning styles, and beliefs. This awareness allows the professor to construct knowledge based on each individual student. The method allows the professor to respect all individuals, display sensitivity and maintain open communication via individualized feedback. Examples of ways to differentiate instruction may include but are not limited to self-evaluation, reading articles and writing, checklist, informal cooperative learning (small group work), oral presentations or discussion, viewing videos, use of social media, collaborative learning, etc.

Essential questions

When the content is framed with a few open-ended questions, students can make meaning or "uncover" the content on an individual basis.[18] The open-ended questions allow the student to construct meaning, thus allowing the professor to teach for understanding.

Experiential learning cycle

The four stages in this learning cycle encompass actual experiences, reflective observation, abstract conceptualization, and active experimentation. This model recognizes the variety of student learning styles and Tulbure (2012) discusses the value of the professor matching content delivery to student learning styles. In Tulbure's sample, the Educational Sciences registered the highest academic achievement when a problem-solving strategy is applied. Previous studies had shown these types of students excel when learning through project-based scenarios, open-ended problems, investigations, simulations, role-plays, and discussions.[19,20]

Lecture

Lecture can be highly successful if done is small bursts. These lecture bursts deliver key points in a short period, specific to the attention span of the audience. Typically, a lecture burst is no more than 20 minutes. A successful strategy when applying the lecture burst is to grab the student's attention with a question or activity to focus attention on the topic. Throughout the lecture, a professor should check for understanding by posing questions on content delivered thus far. The check for understanding applied by hand raising, writing a one-minute reflection on learning thus far, or sharing knowledge with a partner. All of the checks for understanding are low anxiety induced ways to maintain a pulse on student's grasp of the delivered content.

Predicting and hypothesis

When professors' work to engage learners, by implementing predicting and hypothesis strategies applied in all levels of learning, learners are able to construct the knowledge as a process. By using these tools, the learner is more likely to stay engaged in the content. McTighe and Silver[17] discuss "hooks" such as What if, Yes, but why? Questions that puzzle and data that teases, discrepant events, inductive learning, and the crystal ball strategy.

Inquiry

Situational, problem, project are forms of inquiry learning and according to Tomlinson et al,[18] Justice et al conclude inquiry learning methods encourage student to become self-directed learners and therefore, more engaged. These methods of active learning allow the students to question a scenario (situational, problem, project, inquiry) based on preconceived ideas, thus motivating the student to learn the concept.

Student learning becomes guided by a student-centered approach, allowing the student to make meaning of each concept based on prior knowledge. The key to learning in this instance is the students must find value in the posed scenario. The professor guides the student to the knowledge based on student view. Students must be engaged in questioning their preconceived ideas so they can reach a higher level of understanding. These active learning strategies can be alone or collaboratively in small groups.

Reflection

Brown et.al. discuss reflection as several cognitive activities that lead to stronger learning (p. 27).[9] Brown lists these activities as "retrieving knowledge and earlier training form memory, connecting these to new experiences, and visualizing and mentally rehearsing what you might do differently next time." In the case of a medical doctor, it is especially important to build upon prior learning and visualize the concepts in action. Practice is an important tool for learning and retention including effortful retrieval, repeated retrieval, self-testing, and corrective feedback are valuable tools.[9]

Additional tools and strategies

The whiteboard, document reader, PowerPoint, flowchart, visuals, and manipulatives are tools used with any teaching strategy.

Residents and learning

Table 1 lists proposed teaching strategies from the medical teaching faculty and second-year resident feedback on the effectiveness of each strategy. All strategies are reflective of best practices, although several are not student-centered; bringing into the forefront the lack of empirical evidence that supports learning. Much of what teachers have been doing is not serving learners in their quest to truly learn. Learning is misunderstood.

As noted in Brown et al,[9] surveys of college students confirm highlighting, underlining, and sustained poring over notes and tests are the most-used study strategies, while the authors point out that it makes sense to read the text one, and again after a meaningful lapse of time. This is one example of a widely used strategy that with a little tweaking, becomes very meaningful to learning.

Furthermore, students need to self-reflect on their own learning. They need to know personal strengths and weaknesses to determine personal study methodology. Students do not quiz themselves and tend to overestimate mastery. This case is similar when re-reading notes and texts. There is a false sense of true learning, solidifying the fact that students need to self-reflect on weaknesses and study strategies.

As noted by a second-year resident, Dr. Jason Degiovanni, "the resident learning experience as a junior resident is much different than a senior resident and evolves as the resident progresses."[21] A junior resident, Dr. Joseph Derbyshire, who is learning the vocabulary and language of the specialty and the comments in Table 2 reflect those of Dr. Derbyshire in the second year of residency.[22]

A fifth-year resident, Dr. Joe Derbyshire, shares many views of the second-year resident, as noted in Table 2. However, the fifth-year resident elaborates on the importance of on-the-spot decision making based on what was learned and retained during the prior years of residency. As noted by a fifth-year resident,[22] "during this arduous cycle there is presentation of new information, repetition of old material, and opportunities to educate others. In an ideal world every individual would learn and retain information the same way, so a single syllabus would be needed. Unfortunately, this does not exist, and we live in a world where education is performed in multiple different avenues."

It is apparent through limited resident feedback that residents learn best with active learning where connections are made and information is dispersed in connected ways, such as mini-readings prior to a lecture, question banks that are built upon for board practice, and podcast assignments to name a few.

Table 1. Junior Resident Feedback.

Typical Strategies	Second-Year Resident Feedback	Second-Year Resident Comments
Textbook reading	Ineffective strategy student loses focus	Offer this strategy to seniors
Question banks	Typical strategy	Provide limited question banks to prepare for Boards
Case studies	Best if it is a case the resident experiences of current cases	Live-event participation of case studies are most effective to allow for questions in residency
Podcasts	Effective; can listen and drive; effective use of time	Performed well on tests when supplemented with podcasts
Co-resident discussions on specialty relevancy	Varied success	Works best with co-resident in same specialty and current research cases and about pathology; research mentors are exceptionally valuable for growth

Table 2. Senior Resident Feedback.

Typical Strategies 5th Year	Resident fifth-Year Feedback	Resident fifth-Year Resident
Lecture	Engage via learning styles resident responsible for learning	Active participation is most effective use of different approaches to lecture: mini-readings and questions to ponder prior to the lecture with key points highlighted
Textbook reading	Mundane, but necessary	Informs and supports live-event learning
Co-resident discussions on specialty relevancy	Varied success Effective; can listen and drive; effective use of time	Elder residents can guide and share Pertinent information to younger resident's specialty relevancy
Case studies	Bullet key points	Use points to ask questions to residents during live-event learning; provides emotion to the learning and results in depth of learning; active participation is most successful

Techniques for improving memory

Is it possible to improve memory? Creating an online calendar that sends notifications to your phone can provide reminders of appointments and meetings. Creating daily to-do lists can help remember important tasks that need to be completed. But what about the important information that you need to retain long-term? There are a number of memory techniques that can effectively increase memory and improve recall.

Focus your attention

Attention is one of the major components of memory. In order for information to move from your short-term memory into your long-term memory, you need to actively attend to this information. Try to study in a place free of distractions such as television, music, and other diversions.

Avoid cramming

Studying materials over a number of sessions gives you the time you need to adequately process information. Research has continuously shown that students who study regularly remember the material far better than those who do all of their studying in one marathon session.

Structure and organize

Researchers have found that information is organized in memory in related clusters2. You can take advantage of this by structuring and organizing the materials you're studying. Try grouping similar concepts and terms together, or make an outline of your notes and textbook readings to help group-related concepts.

Utilize mnemonic devices

Mnemonic devices are a technique often used by students to aid in recall. A mnemonic is simply a way to remember information. For example, you might associate a term you need to remember with a common item that you are very familiar with. The best mnemonics are those that utilize positive imagery, humor, or novelty. Come up with a rhyme, song, or joke to help remember a specific segment of information.

Elaborate and rehearse

In order to recall information, you need to encode what you are studying into long-term memory. One of the most effective encoding techniques is known as elaborative rehearsal. An example of this technique would be to read the definition of a key term, study the definition of that term, and then read a more detailed description of what that term means. After repeating this process a few times, you'll probably notice that recalling the information is much easier.

Visualize Concepts

Many people benefit greatly from visualizing the information they study. Pay attention to the photographs, charts, and other graphics in your textbooks. If you don't have visual cues to help, try creating your own. Draw charts or figures in the margins of your notes or use highlighters or pens in different colors to group-related ideas in your written study materials.

Relate new information to things you already know

When you're studying unfamiliar material, take the time to think about how this information relates to what you already know. By establishing relationships between new ideas and

previously existing memories, you can dramatically increase the likelihood of recalling the recently learned information.

Read out loud

Reading materials out loud significantly improves your memory of the material. Educators and psychologists have also discovered that having students actually teach new concepts to others enhances understanding and recall. Use this approach in your own studies by teaching new concepts and information to a friend or study partner.

Vary your study routine

Another great way to increase your recall is to occasionally change your study routine. If you're accustomed to studying in one specific location, try moving to a different spot during your next study session. If you study in the evening, try spending a few minutes each morning reviewing the information you studied the previous night.

Barriers to Learning

Face to face classes, as opposed to virtual, provide students with the best tools to maximize learning (Lazaro, et.al, 2021). However, lecture while reading PowerPoint slides and assigning large amounts of textbook reading have been identified as prime barriers to resident learning in a traditional learning setting. In this case, Lazaro et al reference students as "expected to have the initiative for their own education and to take charge in their learning process."

Limited time for physical exercise is an often not discussed as a barrier to learning. Chimitz et al State that "test scores are highly impacted be increasing physical activity." Given the fact that medical residents work long hours, attend resident classes, and are required to read volumes of textbook material in preparation for boards, leaving very limited time for physical activity.

Poorly constructed scenarios that may have unclear goals; possess multiple solutions, solution paths, or no solutions; or represent uncertainty about which concepts, rules, and principles are necessary for the solution or organized steps (Funke, 2006; Shin et al., 2003).

A medical professor has the task of developing and asking the right questions for inquiry learning to be successful. This proves to be a barrier to learning in that a majority of medical professors are not well-versed in the pedagogy of teaching. Alford, Justice et.al noted that while important, very few works publish the how to develop a good question.[4,23] It is the job of the professor to lead the students to think, process, learn, and apply knowledge.

A challenge to learning, and therefore, a barrier, is the amount of retained information in comparison to the amount of content taught. Ebbinhaus initially identified retain information as the "Forgetting Curve" and determined that information is not retained unless it is reviewed over and over.[24]

Conclusion

This paper began by searching for a practical approach to teaching aspiring medical physicians that increases both the quantity and depth of learning. We suggested that this goal largely depends on the delivery of content through evidence-based teaching strategies, brain-based research, and best practices in teaching and learning while acknowledging growth through the transference of knowledge to long-term memory. The literature review captures part of this cycle.

With each period of educational research new topics emerge and continue the pedological discourse while re-energizing the desire to make a difference through a renewed focus on the instruction and the learner. At the same time, certain barriers exist across the entire continuum, pushing and pulling the conversation in new as well as familiar directions. Some topics covered in this article noticeably shaped the field, while others reached out to focus on new learner centered audiences.

Teaching and learning are an important aspect of the medical profession. Recognizing readiness, relevant research, existing barriers, and learning styles will help the profession be successful in achieving doctors capable of learning and applying what they have learned. Through it all, however, continuous learning does not stop; there will always be learners in need of greater retention and instructors willing to explore pedagogical strategies that increase the effectiveness of the teaching and learning process.

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Using the Lessons of Learning Science to Improve Medical Education in Otolaryngology

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Abstract

Objective: This review synthesizes information from original research in the field of learning theory and the psychology of learning in order to provide evidence-based study methods to adult learners in the field of medicine. **Methods:** A literature review was conducted and results were synthesized in a narrative fashion. **Results:** Deeper levels of analysis produce longer lasting memory; therefore, the concept of creating a "desirable level of difficulty" when it comes to study material and methods has been shown to promote learning. When the learner uses a higher subjective level of effort in processing information, they can maximize the efficacy of their studying efforts. This review describes how memory encoding can be enhanced by applying several theories of learning psychology including the generation effect and the interleaving effect. The use of mnemonics, the "memory palace," and hand-written notes have also proven useful to enhance information recall. Methods that promote long-term learning including the spacing effect and delayed repetition are reviewed. Learning theory shows that the most effective learners use self-testing and forced recall to retain more information with limited study time. **Conclusions:** The application of these learning methods may help to improve information retention and productiveness among adult learners.

Keywords

learning theory, psychology of learning, adult learning, memory retention, long-term memory, otolaryngology education

Introduction

In learning theory, the concept of a "desirable level of difficulty" for learning is supported by research findings that deeper levels of processing lead to better memory encoding and therefore enhanced learning. These levels of processing model were described by Fergus Craik and Robert Lockhart in 1972, which describes memory recall of stimuli as a function of the depth of mental processing.[1] Craik and Lockhart categorized stimuli as structural (e.g., is the word in capital letters?), phonemic (e.g., does the word rhyme with deep?), semantic (e.g., what does the word mean?), or personal (e.g., how does the word relate to you?). Their study found that deeper levels of analysis produce longer lasting memory. Medical professionals in training have the particularly burdensome job of needing to memorize vast amounts of information in a relatively short period of time, and thus, identifying strategies to maximize learning is of particular interest. The following text will review several methods to improve studying, learning, and memory recall based in psychology and social sciences research.

Methods

A literature review was conducted of published articles and original research regarding learning theory and the psychology of learning. The outline for the information herein was adapted from a lecture by Dr. Daniel Oppenheimer, PhD.

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Results

One way to enhance memory encoding is known as the generation effect.[2,3] This is when participants are forced to actively produce material during learning activities, which is later shown to improve memory performance. When compared to simply reading words, generating target words was shown to activate broad neural networks involving the prefrontal and posterior cortex and led to significantly improved memory retrieval.[4] These findings explain the benefits of the mnemonic technique for active learning: to organize material and improve recall. Mnemonics help to create cues to help remember things using imagery, spatial cues, rhymes, rhythms, or pre-set lists. An example of a mnemonic device is known as the method of loci. This technique relies on spatial relationships between locations on a familiar route or rooms in a familiar building (e.g., "loci") to arrange and recollect memory content, colloquially known as a "memory palace."[5,6] The technique is practiced by linking the key ideas of a subject to mental images and associating them with specific locations. This method has been in the press for allowing seemingly impossible feats such as one individual's memorization and recitation of over 65,536 digits of pi.[7] In the context of medical education, companies such as Sketchy Medical® and Picmonic® have developed study tools for students using visual images and story scenes to enhance recall. The rising popularity of these learning aids suggests they have been an efficient method for many students.

It has been shown that long-term learning is promoted when learning events are spaced out over time, rather than presented in immediate succession. This is known in psychology as the spacing effect.[8–10] Research aimed at studying this effect has classically divided participants into two groups with the same curriculum but different learning schedules: massed (i.e., immediate succession of material and learning events) or distributed (i.e., material and learning events separated by a defined amount of time). Study subjects are then asked to recall words or material that they had been presented earlier. Results consistently demonstrate distributed or spaced learning schedules are associated with greater long-term memory retention and higher performance.[10] The decline of memory retention over time is described by the "forgetting curve" hypothesis, which describes the percentage of memory retention as a function of days (Figure 1).

When material is reviewed (studied) at regular intervals after a period of forgetting, this reinforcement allows for more long-term memory retention. This theory supports the principle that allowing time between study sessions will increase effectiveness rather than increasing the time of one concentrated period of study (Table 1). The optimal time for spacing review sessions is over several weeks, allowing for delayed recall and memory reinforcement. If this is not possible, single-session spaced learning patterns are also helpful (e.g., interspace 20 minutes of study, with 10 minutes of rest, and repeat). The application Anki® is one tool students can use to practice spaced repetition through the use of user-made flashcards. A new application called OtoRecall® is specific to otolaryngology residents-in-training, with pre-made flashcards in question-and-answer format including the option to focus on a specific subspecialty area.

Another method to increase memory retention during a single study session is described by the interleaving effect.[11] This theory describes studying multiple topics in one session by alternating between them (e.g., 20 minutes otitis, 10 minutes laryngitis, and back to 20 minutes otitis). Psychology research has demonstrated that this type of studying improves discriminative contrast between different categories, while studying each concept in separate blocks emphasizes the similarities within each category.[12] Less inter-related topics can also help to increase the level of processing during studying by engaging an individual's attention by switching topics. Interleaved study also helps to provide temporal spacing between repetitions of each category, which has been shown to enhance long-term memory.[13] Within the field of otolaryngology, this method may be particularly useful given the diversity of anatomy and associated pathologies encountered within different regions of the head and neck.

Retrieval practice or testing at intervals during a learning period has also been found to increase long-term memory.[14–16] Psychology research has shown that testing does not merely measure outcomes but can be used as a tool to change outcomes. The purpose of formative tests is to aid in one's learning, while by contrast, a summative test is used to evaluate what one has already learned. Learning theory would advocate for students' own self-testing via forced recall or educators promoting recall via formative testing. Recalling information via testing helps the subject to recall information, increase the level of processing, and encode information more deeply. Research shows that taking a test can have a greater positive effect on future retention of that material than spending an equivalent amount of time restudying the material.[16] In both medical school and residency, it is the authors' experience and belief that learners rely heavily on question banks for self-study. This provides an objective measurement of knowledge, but more importantly, allows for the opportunity to target specific areas of academic weakness. Several different question banks exist for use by learners within the subspecialty of otolaryngology, some of which include OTO Quest® offered through the American Academy of Otolaryngology-Head and Neck Surgery and BoardVitals® offered through the Accreditation Council for Continuing Medical Education (ACGME).

The concept of cognitive disfluency describes an individual's processing of new information along a continuum, from very fluent (with great ease) to very disfluent (with great difficulty).[17–19] There are several types of fluency including perceptual, linguistic, retrieval, embodied, and spatial. People tend to prefer learning fluency associated with ease of processing; however, disfluency in learning theory has been shown to produce superior learning due to the difficulty of processing information that increases attentiveness.[20,21] This so-called disfluency effect therefore

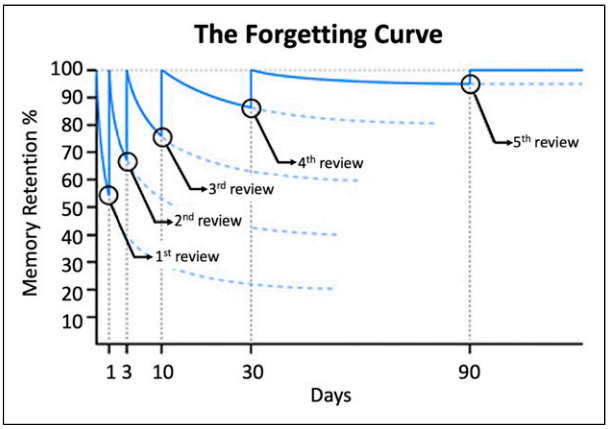

Figure 1. Forgetting Curve hypothesizes the decline in memory retention over time. Memory retention is longer when the information is reviewed regularly and at intervals.

Table 1. A hypothetical study schedule that allows time for scheduled sessions at regular intervals after a period of forgetting, which has been shown to promote long-term memory retention.

Time Until Test	1st Session	2nd Session	3rd Session
1 Week	Today	Tomorrow	Day before the test
2 Weeks	Today	In 1 week	Day before the test
1 Month	Today	In 7–10 days	Day before the test
6 Months	Today	In 3–5 weeks	Day before the test

represents a "desirable difficulty" as referenced earlier in this article, by manipulating the subjective level of effort in processing without altering the objective material. One study showed that presenting material in a format that is slightly harder to read (e.g., changing the font or format and using bold or italics) can significantly improve students' retention of material by leading to a deeper processing of more distinctive and atypical stimuli (fonts).[20]

The modern classroom must adapt to advancements in technology. The laptop computer has greatly revolutionized education. However, this has also changed the way students think, and these changes can both reinforce the learning goals of the classroom or undermine them. Specifically, regarding note-taking, typing allows the student to write quickly and transcribe verbatim notes more mindlessly. Handwriting, in contrast, forces the student to use shorthand, differentiate key points, and paraphrase in one's own words. One study showed that during recall of conceptual information, verbatim notes taken on a laptop were shown to result in lower scores on subsequent recall testing when compared with students' scores who took handwritten notes.[22] In a secondary experiment in which students were able to take notes on the two mediums and then subsequently had the opportunity to study their notes before their performance was tested, handwritten notes and studying were shown to be superior to typewritten notes and studying in overall scores, factual recall, and conceptual recall.[22] Facilitating a deeper depth of processing and learning disfluency will aid in the goal of students to retain learning material.

Conclusions

The application of theories founded in the psychology of learning including the generation effect, retrieval practice, and cognitive disfluency may help to improve the information retention and productiveness of adult learners.

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The New Normal – Virtual and Hybrid Presentations: Developing Content, Designing Slides, and Delivery Guidelines

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Abstract

Objective: To outline best practices for virtual and hybrid presentation effectiveness. **Methods:** Retrospective review of recommendations from world experts in how to develop a solid story, design slides that visually communicate, and improve delivery skills that connect with the audience. Virtual and hybrid presenting is not as strongly dependent on all the new technical and software means as supposed. Presentation basics remain critical. **Result:** Best practice in presentation effectiveness will statistically decrease the incidence of and risk factors for Nodding-off Episodes per Lecture (NOELs). **Conclusion:** The future of presenting is here, and it is mostly online. Mastering the presentation basics and understanding the limitations and opportunities for this new virtual/hybrid presentation space will allow presenters the reach and influence their message deserves.

Keywords

presentation, slides, PowerPoint, delivery, story, hybrid, speaking, virtual, delivery

Introduction

Here is the typical *old* presentation scenario: just before getting on the plane to your face-to-face conference, you pull together what you can fast, such as articles, figures, data, and already used slides. You end up with a flood of jumbled messages, a "noisy" slide deck, and no clear point to your presentation.[1] Although the incidence of and risk factors for Nodding-off Episodes per Lecture (NOELs) has previously been documented, in the *new* normal virtual/hybrid presentation space, a subpar presentation that you may have gotten away with before in a conference auditorium falls flat.[2] Not only must you engage *both* a virtual and live audience at once, but you are also presenting to audiences with drastically shorter attention spans. To make situations worse, your subpar presentation will probably be recorded for an archived webinar to be viewed again and again. Said differently, the "presentation effectiveness" stakes just got higher! Never has there been a better time to go back to the basics of creating fabulous presentations. Namely, *developing* a solid story with one clear focus, *designing* slides that can been viewed from mobile-to-desktop screens, and increasing *delivery* skills because soft skills are more essential than ever for connecting communicators with their audiences virtually.

Hybrid presenting—simultaneously engaging audiences online and face-to-face—is the *new* normal.[3,4] The management consulting firm, Gartner Inc., estimates that by 2024, only 25% of business meetings will happen in person.[5] While some may hope for a return to in-person presentations, hybrid and virtual presentations are here to say.[3] However, on average, when 568 participants were surveyed in how satisfied they were with virtual presentations being a replacement for in-person presentations, the result was 5.97/10 (1 = not satisfied; 10 = very satisfied).[3] Clearly, presenters need to up their game. No longer can simply sharing your screen in a virtual presentation, using your old slide deck, and reading from your

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presentation notes cut it. In a virtual or hybrid environment, audience engagement is key.

Developing a Solid Story

People listen to stories. They are engaged by them. So, tell a story with your science. Do not make your audience have to work to understand. Often, they are either tired, told to be there, or bored with your topic. In academic medicine, presenters often use the standard manuscript template to present their research: introduction, objectives, methods, results, and conclusion. Here, presenters are being "reporters" rather than "interpreters" of their important work. This report of information is too easily translated into PowerPoint's default title-bullet format. In fact, approximately two-thirds of the slides in science and engineering contain bulleted lists.[6] If there is anything that will sabotage audience engagement, it is developing a presentation using this tactic. Bulleted lists of information are the antithesis of developing a story. As Tingley Presentations so clearly asserts, although PowerPoint is bundled in Microsoft, "**PowerPoint is *not* word,"** yet most people put a wall of bulleted words on a slide.[7] Garr Reynolds calls that a *slideument* because the slides look like a written *document*.[8] "**PowerPoint is not Excel,"** yet most people put tons of data on one slide.[7] Edward Tufte calls that "chart junk."[9] "**PowerPoint is best used for visual storytelling**."[7-12]

Because both live and, particularly, virtual audiences have shorter attention spans and increased distractions, developing a powerful story is key for audience engagement. Regrettably, most academic presentations take a Subject Matter Expert (SME) approach rather than a Story Driven Approach (SDA).

There are many excellent templates for developing a solid story that can be translated into a presentation. All of them involve developing your presentation story *before* you open a PowerPoint file.[1,10,12-14] The best first steps are often pen to paper (or napkin), mind maps, or post-it notes to organize your thoughts (Figure 1). Figure 2 represents a glimpse into my story development for a TEDx Talk ® that I did in 2018.[15] Next, 3 story development techniques will be highlighted.

First, Cliff Atkinson outlines the Beyond Bullet Points story template and how the first 5 slides of a presentation lay the groundwork.[12] All 5 slides are used to engage the audience by starting to weave a succinct story which is appropriate for most 5–10-minute scientific podium presentations. *The Hook* is the first thing you say to grab your audience's attention, such as a statistic, anecdote, intriguing quotation, or relevant fact. *The Relevance* is what you say to ensure your audience pays attention. Relevance said differently is the What's-In-It-For-Me (WIIFM) factor that every audience member asks themselves. *The Challenge* is how you define a specific challenge that your audience faces. *The Desire* is what your audience needs as they face the challenge. *The Map* is the pathway for your audience from overcoming the challenge and achieving their desire. This part is really the bulk of your presentation.[12] These first 5 slides lay the foundation for your podium presentation. You may still use the component parts of a manuscript outline but now they are woven into a story about your research versus a cookbook recipe of what you did and what you found.

To further develop an effective presentation, you must distill your story to a single, connected throughline—a thread. Each slide must transition to another slide with your thread.[16] Nancy Duarte, in her powerful book, *Resonate*, writes about the "Big Idea" the one key message you want to communicate to your audience.[10] What's the one thing you want your audience to remember? Kurnoff and Lazarus (2021) offer a simple path to creating your big idea by recommending that every piece of information in your presentation—no matter how minor—must connect to your big idea.[1] Commonly, presenters often struggle with "infobesity." They want to tell the audience everything they know and get it all in within the average length of a presentation. Doing so, audiences will often disengage. This is especially important in virtual presentations. As Brene Brown recommended after doing her TED Talk, "Plan your talk. Then cut it by half…cut it another 50%."[16]

Second, Duarte coined the term Duarte Presentation Sparkline ™ as a visual representation of how a story line moves up and down between *what is* and *what could be* used at the beginning, middle, and end of a story[10,17] (Figure 3). This convincing structure incorporates cinematic and literary storytelling techniques for creating and resolving tension.[17] Third, Gallo writes that all of Steve Jobs presentations had a hero (protagonist), villain (antagonist—who poses a problem), and moral to the story [a call-to-action (CTA) what you want the audience to do after listening to you] Figure 4.[13]

Designing Slides for Your Visual Story

If one big idea per your presentation is the recommendation, there is a comparable suggestion for designing slides. **One idea per slide.** However, most presenters allow their slides to "script and shield" them. They continually look back at their slides to prompt them thereby losing connection with their audience. Subsequently, text remains the single most mishandled aspect of presentation design.[18] As Edward Tufte says: "Presenters love PowerPoint as it is easier for themselfish! It is not about convenience for the presenter: it's about the audience understanding content."[19]

A little bit of history of PowerPoint is needed here. PowerPoint® was designed in 1986 by an entrepreneur, Robert Gaskins, and a computer programmer, Dennis Austin.[20] The inventors created the default slide templates to mimic the most popular format of that time, which were overhead transparencies, namely, a title at the top, a bulleted list below, and an optional graphic.[12] The defaults were not founded on any research concerning presentation effectiveness.[20] But if the main point of any presentation is "to explain, inspire, inform, or persuade, whether in business, education or on the public stage," then research related to PowerPoint presentations is in

Figure 1. Do not go to slide software first to develop your story but rather pen to paper.

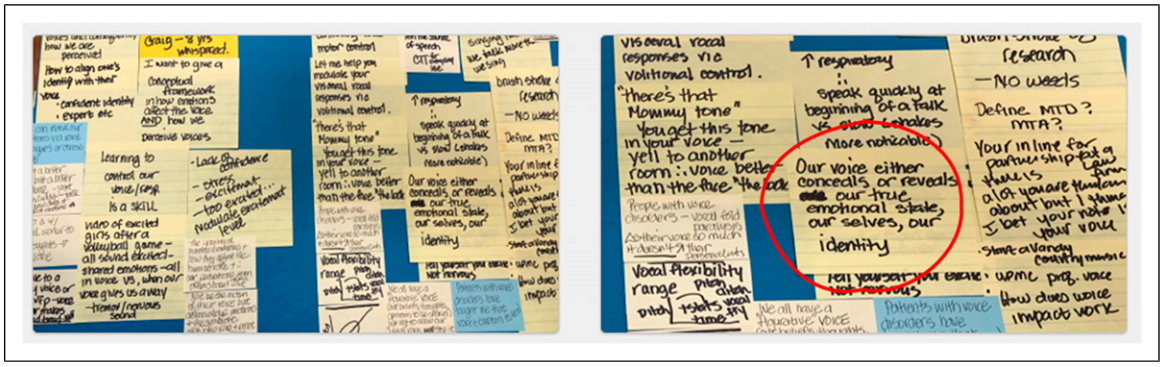

Figure 2. Story development example: post-it notes used to develop Gartner-Schmidt's TEDx talk (2018).

order.[16] However, there is a paucity of research-based guidelines on how best to use the PowerPoint software, which enjoys approximately 95% of the marketplace.[21]

Much of what we do know is based in multimedia learning, which can be translated to presentations with slide decks.[22] If audiences try to process too many written words and spoken words simultaneously, cognitive overload occurs resulting in decreased comprehension.[23] Combine this with the reality that we read faster than we listen. If you design a slide with a wall of words on it, you have essentially rendered yourself, as the presenter, irrelevant because people will read your slides versus listen to you. This dual-coding principal was used by Richard Mayer, who is a pundit on research in multimedia learning, who, along with Paivio, found that audiences retain information best when words and relevant pictures are used rather than words alone.[22,24] Richard Mayer is a professor of psychology who has dedicated his life to educational psychology and multimedia learning. His numerous experiments are grounded in cognitive theory of how people learn from graphics and words, which he calls the Cognitive Theory of Multimedia Learning.[22] Humans possess 2 qualitatively different channels of processing material—one for visually based representations and one for verbally based representations.[22,24]

Multimedia presentations, which most PowerPoint presentations are, foster generative processing by making it easier for audiences to build connections between words and pictures.[22] Nancy Duarte calls slides "glance media" as an audience should be able to quickly ascertain the meaning of a slide in ~ 3 seconds.[11] An analogy is that slides should be like billboards—simple words, relevant graphics, easy to understand message as you drive by at 60 miles an hour. An alternative explanation to keeping slides simple is a principle borrowed from more technical fields such as acoustics or electronic communication and is called signal-to-noise ratio (SNR).[8] As it relates to slide design, SNR is the ratio of relevant to irrelevant elements and information on a slide. The goal is to have the highest SNR as possible on your slides. Low SNR is often seen when communicating data on slides. For example, one can easily degrade the visual message by including irrelevant grid lines, keys, ambiguous labels, icons, and employer logos on slides (Figure 5). Bottom line, if the visual components of a slide do not reflect the one big idea of the slide, remove it. A slide represents valuable real estate—use it wisely to reinforce your content.

Mayer outlines 5 principles and ways to reduce extraneous processing in multimedia learning.[22]

1. Principle of Coherence – reduce extraneous words, sounds, or graphics.
2. Principle of Signaling – highlight important words or graphics.
3. Principle of Redundancy – delete redundant captions from narrated animation.

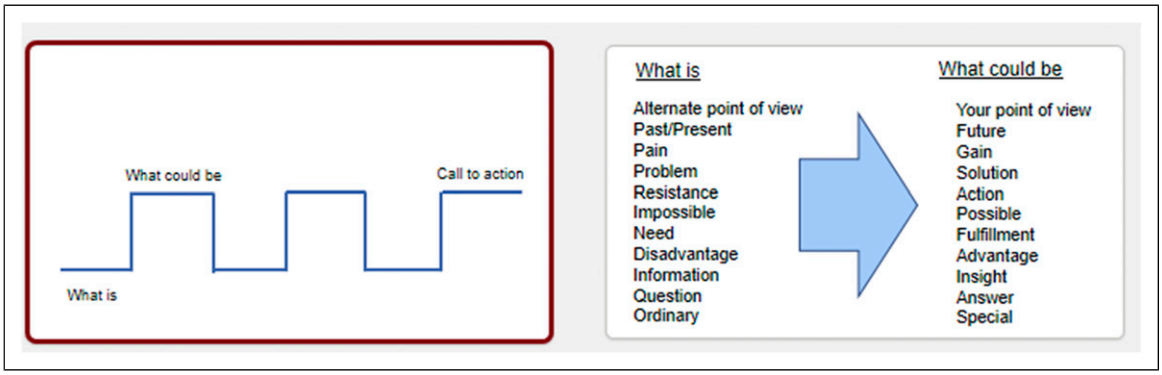

Figure 3. Story development example: Duarte presentation sparkline ™.

Figure 4. Story development example: the villain, the hero, and moral to the story.

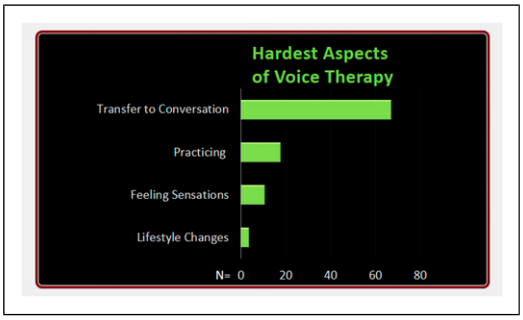

Figure 5. Example of a chart with all extraneous detail (i.e., grids and label keys) removed.

4. Principle of Spatial Contiguity – place essential words next to corresponding graphics on the screen.
5. Principe of Temporal Contiguity – present corresponding words and pictures simultaneously.

Using some of Mayer's principals from multimedia learning, Garner and Alley (2013) compared learning outcomes in 110 engineering students who viewed a technical presentation in which the slides either included or breached the multimedia learning principles.[25] Participant revealed superior comprehension for the assertion-evidence slide design group as well as lower perceived cognitive load than the group that used PowerPoint's default design for slide creation (e.g., Topic-subtopic default setting of PowerPoint) (Figure 6). In addition, there was stronger retention at a delayed post-test with the assertion-evidence slide design. This type of slide design that incorporates some of the multimedia learning principles is called the Assertion-Evidence (AE) slide design.[20] The AE slide design is defined as a slide with a full sentence headline stating the main message of the slide (the assertion), supported with visual evidence (e.g., a photo, graph, chart, etc.) (Figure 7). Bulleted lists are not used in the AE slide design format. The AE slide formats have also been shown to influence the presenter's understanding of presentation content.[26,27]

Many other presentation consultants and authors adhere to this recommendation for using concise, yet informative headlines on slides followed by meaningful visuals. When writing the headline of a slide, write complete sentences that orient your audience to what the slide is about.[1,6,12,20,27] This technique also alerts your audience if they get distracted. Reading a headline that says: *Methods…* means nothing to the audience. Rather a headline that says: *Phonatory aerodynamics in connected speech were gathered from 150 equally numbered healthy males and females in three different age groups* (and then supplementing with visual evidence such as icons, a chart of the data, etc.) is much more communicative. (Figure 8).

It comes as no surprise, then, that your slides' headlines should drive your choice of visuals. A word of caution, images that are literal are often much more powerful than metaphorical images. In addition, do not use clip art; it tends to be dated.[7] Last, full edge bleeds are recommended for graphics so that the graphic bleeds to the edge of the slide, which allows the slide to have no margins[18] (Figure 9).

As previously mentioned, the presentation industry largely dissuades use of traditional bullets because they do not adhere to one thought per slide, can clearly turn into a "wall of words," and typically sabotage a story throughline.[4,12,28] However, sometimes they are appropriate if they are concise and "chunked"[18,28] (Figures 10 and 11). Rick Altman

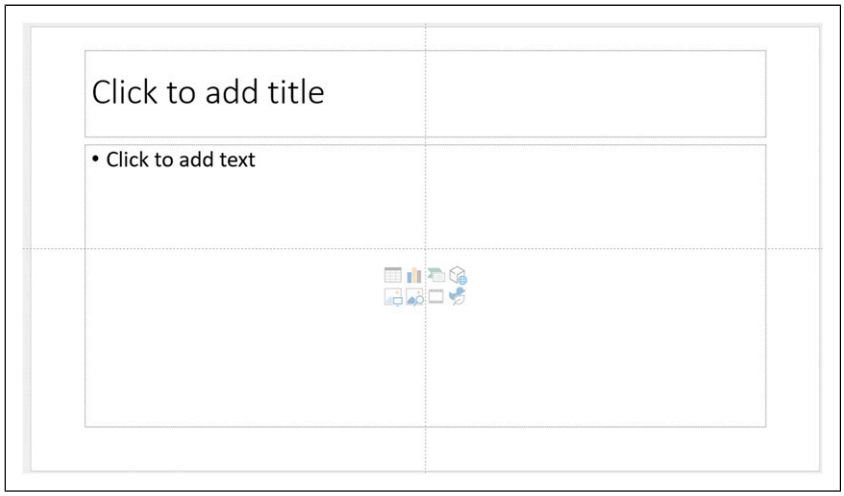

Figure 6. Topic-subtopic bulleted list default from PowerPoint.

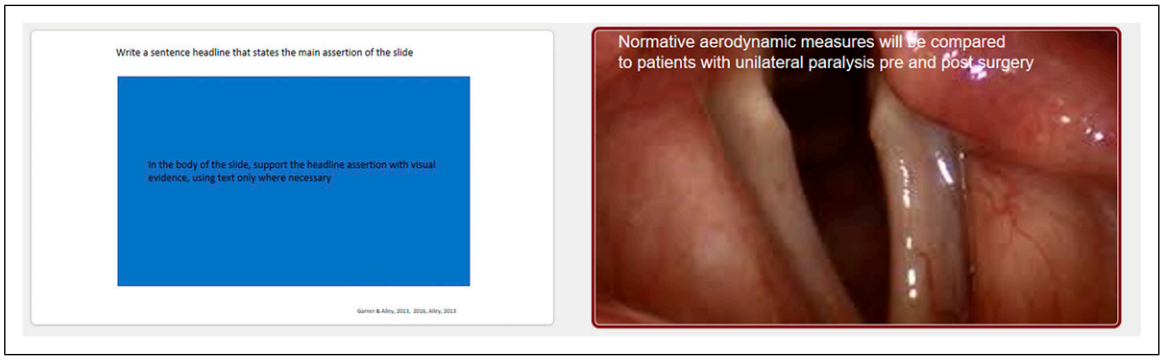

Figure 7. Example of an assertion-evidence slide design.

(2019) refers to The Three-Word Challenge: *trying to reduce every one of your bullet points to three words or fewer.*[18] This technique is especially pertinent for virtual presentations. Recently, Nolan Haims has released *The Better Deck Deck* offering 52 alternatives to bullet points organized into ideas for text, shapes, images, and diagrams.[28]

Last, a section on Slide Design would not be complete without recommending a book, known as the *template Bible*, by Swinford and Terberg (2021), which guides presenters and designers in building PowerPoint® templates, as they are the backbone of great slide decks and ultimately presentations.[29] The authors guide readers in such items as applying settings (e.g., theme colors and fonts) to a new blank PowerPoint file, formatting the slide master (e.g., grids, logos, placeholders), configuring the PowerPoint default slide layouts, creating custom layouts, finalizing the template structure, and then ultimately saving the final template for individual or group use.[29] As presenters, we are not wed to the default PowerPoint templates. Although they are incredibly useful, we can customize our own templates which can make us stand out as presenters. Last, most people have no idea how much time can be saved when using a properly developed template.

The Delivery

The virtual reality is this: your laptop and audio/visual equipment convert and compress your audio and video into digital bits that travel through cyberspace to reach your end viewer.[17] Therefore, technology adds layers between you and your audience. This trip can dilute your virtual impression by making your audio and video less vibrant than real life.[17] Investing in a fast computer with extra processing speed, a professional microphone, external camera, and a direct link from the computer to highest-speed internet (i.e., use an ethernet cable) is well worth the investment.[17]

One of the advantages of virtual presentations is intimacy between the presenter and the audience. First, you are much closer in proximity to your viewers (e.g., a couple of feet away from their monitor). Second, you are usually in a more familiar setting for your viewer, be it their home or office, which can make the viewer more relaxed than in a huge auditorium or conference room. A more intimate setting mixed with direct eye contact by looking into the camera means you are perceived as speaking directly to the viewer. That intimacy is not achieved from behind a podium on a stage. If speaking at a

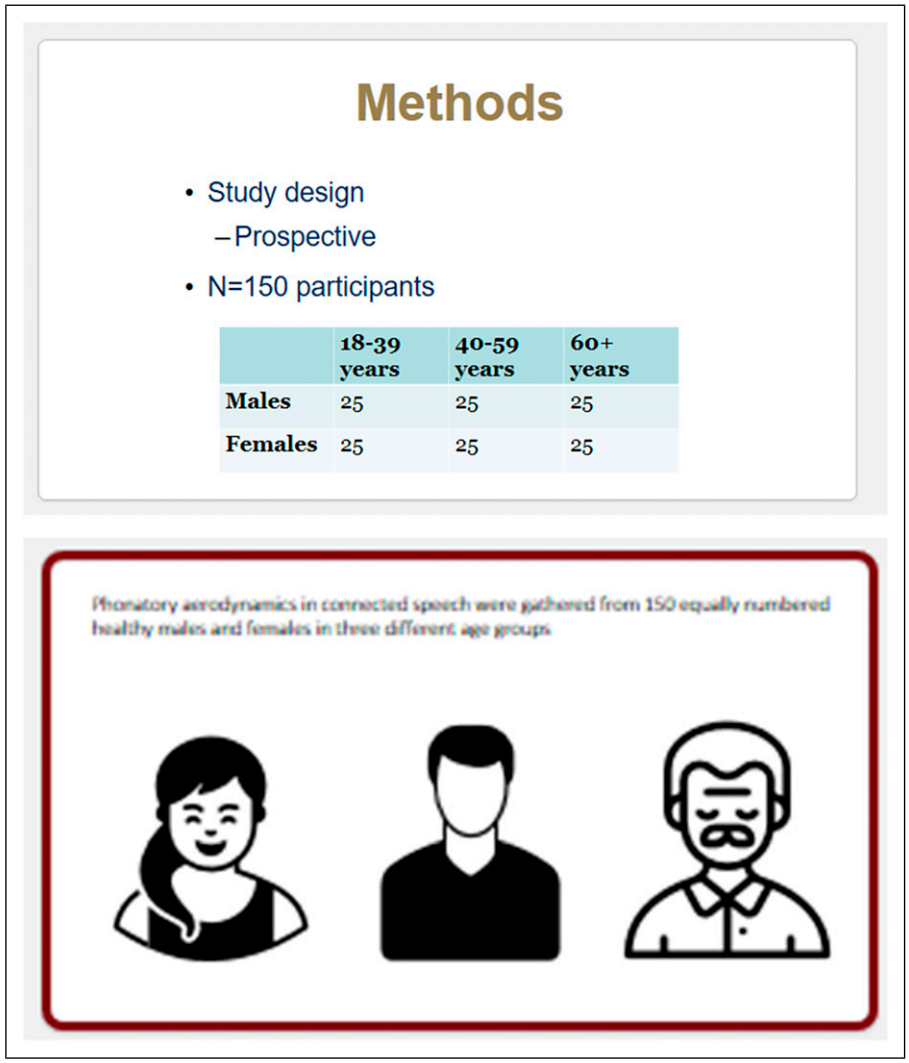

Figure 8. Example of a pre-post assertion-evidence slide design using full sentence headlines.

Figure 9. Example of full bleed graphics.

hybrid event, it's vital to schedule times during your podium presentation to look directly into the camera at your virtual audience. Training to look directly into the camera should not be ignored. It is not natural to look into the camera, but just like TV actors who transition from stage to camera, learning to do so is time well spent. Remember, the camera is the "eye of the audience."[17]

Virtual proximity also makes the face plainly visible. Presenters should be aware of any grimaces, frowning, or furrowed eyebrows while speaking and listening as they can be perceived negatively in a virtual presentation.[17] The nuances of these facial expressions are not as evident in a live stage presentation.

Another aspect of the delivery that is given more importance in the virtual space is our voice. Voice is the new body language in virtual and hybrid presentations.[30] In fact, all we have is voice and video in the virtual medium.[31] However, virtual audiences may often minimize the speaker's video which dictates the voice becomes the primary communicator. Because of potential audio distortion, articulatory precision is important when talking. In addition, while your microphone may record your audio clearly, your audience's equipment may be of lower-fidelity, or their environment could be noisy.[17]

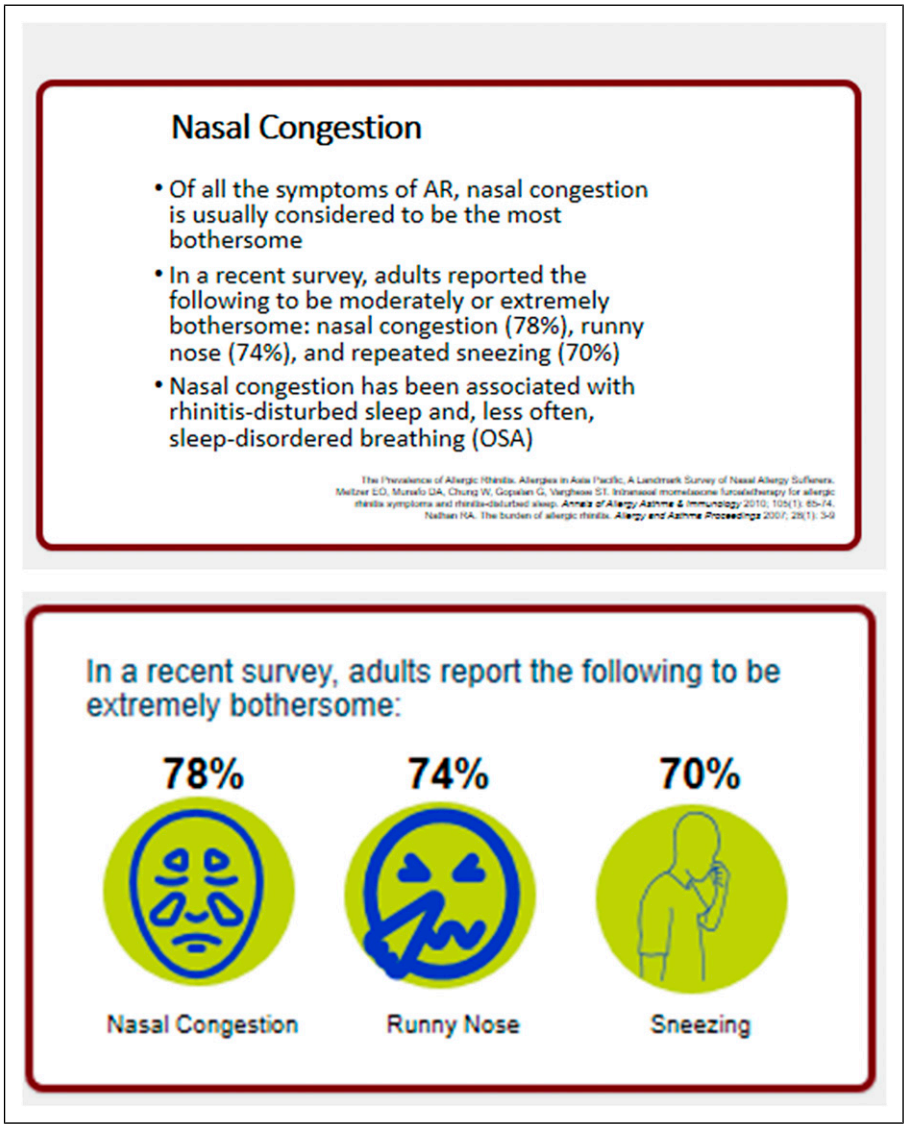

Figure 10. Example of pre-post make-over using chunking technique.

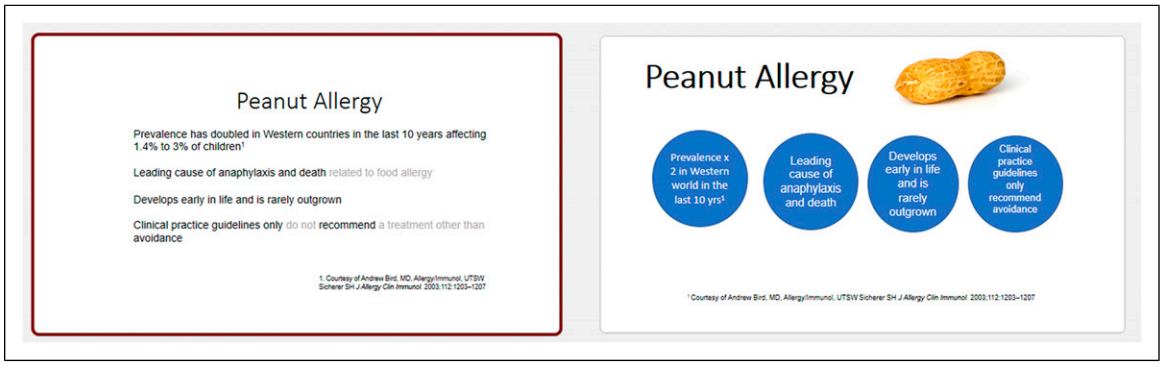

Figure 11. Example of pre-post make-over using chunking technique.

Some of the tenets of a novel voice therapy program—Conversation Training Therapy (CTT)—designed for patients with muscle tension dysphonia and/or vocal fold lesions (e.g., nodules) can be easily applied to the professional speaker.[32-34] Clear speech, prosody (pitch inflection), projection, and pauses while talking are dramatically important, especially in virtual and hybrid presentations. Clear speech (e.g., articulatory precision, use of crisp consonants, etc.) has been thoroughly studied in the literature as increasing intelligibility, vocal intensity, voice quality, pauses, pitch inflection, decreasing speaking rate, as well as decreasing vocal fry.[35-38] Patterns of stress, intonation, and pausing are also key voice and speech techniques used while delivering presentations. Pausing, for example, allows listeners to process what you have said and anticipate what you will say. Newspapers use white space, so readers are not overwhelmed with a lot of visual words. Pauses provide "auditory white space" so that a listener is not overwhelmed with aural words. This is particularly true because live stream virtual presentations are known to have an approximate 4 second lag time for an audience.[39] Indirectly tied to increasing the pauses in your delivery is making sure your rate of speech is not too fast. Communicating into a camera allows for little audience feedback for the presenter, which can be nerve wracking, especially when making an odd glance at the chat feature, which can accelerate anxiety and correlates to increased rate of speech and increased pitch of the voice. Listeners, whether virtual or not, will perceive anxiety from the speaker when this occurs.[40] In sum, look into the camera, decrease rate of speech, increase pauses, use clear speech, and increase prosody are key delivery guidelines for virtual/hybrid presenters.

Conclusion

The *new* normal will include some form of virtual communication (e.g., virtual or hybrid). Following the strategies discussed can help in crafting a compelling story, designing a visual story with a slide deck that compliments the content, while delivering the presentation with energy and enthusiasm. Duarte Inc. has used this motto for years: "Never deliver a presentation you wouldn't want to sit through." They have since added this important admonition for our times: "Never deliver a virtual presentation that is less engaging than it would have been in person."[17] Final word, for those interested in learning more about best practices in presentation effectiveness in this new normal, please go to the online portal *Presentation Guild* and hybrid *Presentation Summit* conference.[41,42]

Author Note

Jackie Gartner-Schmidt, Ph.D., CCC-SLP, ASHA Fellow is an Associate Professor at Carlow University in Pittsburgh, PA. Previously, she spent 20 years as the codirector of the University of Pittsburgh Voice Center. Dr. Gartner-Schmidt's 25-year clinical and research focus specializes on care of the professional voice, as well as the clinical effectiveness of voice therapy and respiratory retraining. She is founder and codirector of one of the largest voice therapy conferences in the nation, the Voice Therapy Conference (VTC). She frequently presents nationally and internationally. In 2018, she presented a TEDxTalk® on "How Our Voices Reveal Anxiety". Dr. Gartner-Schmidt also has a passion to transform how professionals present – to make presenters as effective and accomplished in front of audiences as they are in their work. Voice Now, LLC was created in 2013 for that purpose.

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The Smart Use of Smart Technologies in Teaching and Learning: Where we are and Where we Need to be

Andrew J. Steehler, MD[1], Brian Pettitt-Schieber, MD[2], and Patricia A. Alexander, PhD[3]

Abstract

Objective: The advantages and popularity of technology among learners have vaulted it to the forefront of medical education. The current state of learning and teaching intertwined with technology in medical education and residency is described. Following these characterizations, consideration is given to changes worth exploring in the habits of mind and habits of action that medical students and residents exhibit to deepen their learning and improve their performance. **Methods:** Review of literature was conducted to summarize relevant transformations in instructional practices in medical school and residency that can contribute to more effective learning environments. **Results:** Learners have different approaches that will include differing uses of technology. Technology encourages multitasking, information overload, and the increasing prevalence of invalid information. Implementing bite-sized learning approaches, problem-based or case-based formats, questions, and alternative hypotheses encourages learners to channel technological innovations into their own styles of learning. **Conclusion:** To build knowledge in the technological era of learning, do not take learners' digital readiness for granted. Approach technology as a tool to be wielded when required and *not* as a crutch.

Keywords

technology, teaching, education, residency, adult learner

Introduction

Graduate medical education programs seek to educate adult learners from diverse backgrounds efficiently and effectively. Although technology plays a critical role in learning and teaching practices, the inadequate use of smart technologies may have an inverse effect on the intended outcomes. Technology today has many applications to facilitate reading and learning from texts, yet the availability of these digital tools does not guarantee their efficient or effective use. Technology may widen the differences in adults' approaches to learning, and an adult learner must be digitally ready and confident in their online skills to accurately distinguish between trustworthy and untrustworthy online information.

The growing presence of technology in education has also burdened the adult learner with information saturation. In this article, these dilemmas surrounding the advent of technology in medical student education and residency are discussed in an effort to work toward a more effective and equitable learning environment.

Part I: Where are Learners Today?

Graduate medical education programs have a difficult task undertaking the teaching of adult learners who come to the experience from diverse backgrounds. Each residency program must tailor to the needs of its trainees, keeping in mind that the approach to learning can differ greatly between individuals at the same level of training. For example, adult

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learners often differ in the environment in which they prefer to learn (e.g., group learning vs. independent study) and in their preferred study medium (e.g., digital or print style).[1,2] Some learners respond well to simulation tasks, while others learn better by watching their teachers work clinically on real patients. Advancements in technology have widened the differences in adults' approaches to learning by broadening the options they have for gathering information, acquiring knowledge, and honing their skills.[3] However, the overreliance on or misuse of technology has been criticized as a crutch.[4] For better or worse, both teaching and assessment have gravitated toward technology. Standardized assessments, question banks, virtual lectures and conferences, flashcards, e-books, online simulations, and more have saturated the market for medical students. In this article, we attempt to answer the question: *Is technology always the best resource for learning, and how can it be best utilized?*

Massive amounts of information are consumed daily during residency. Residents must find an effective way to manage that deluge of information if they are to learn what is essential and not find themselves swept away. Residents are often responsible for self-teaching. Yet, without guidance, even these mature students may find themselves ill-equipped to cull key concepts or critical content from all the online information they encounter.[5] It may seem unnecessary to teach adult learners who have grown up with digital technologies how to engage with them more effectively, but in actuality, these individuals are not always as efficient with digital mediums as they suppose themselves to be.[6,7] They may be facile at maneuvering through the latest technologies, tech features, and apps, but they still require instruction that focuses on evaluating, synthesizing, and integrating the information they locate online.[8,9] They also can be susceptible to biased, inaccurate, and intentionally misleading content populating digital media.[10]

In understanding where the learner is with respect to the efficient use of smart technologies, we must take into question the concept of digital readiness. According to a recent PEW report,[3] *digital readiness* includes 3 tenets. First, the adult learner in residency must have *digital skills* capable of initiating useful online sessions and browsing resources and various databases. Second, *trust* is a vital component when determining the accuracy of information online.[8] Finally, *use* determines the degree to which the adult learner can carry out tasks with the digital tools at their disposal. Technology today comes equipped with a large array of tools not available in the print-only world that can facilitate reading and learning from texts, including apps for annotation and notecards, digital glossaries, and tools for collaborating.[11] Yet, the availability of these many digital tools does not ensure their smart use. Therefore, while it may seem counterintuitive, learners require strategic guidance if they are to engage efficiently and effectively with digital texts and tools in a manner that promotes comprehension and retention.[12,13] Those strategies may include monitoring one's understanding, reading more slowly, periodically stopping to reflect on or ask questions about what was read, annotating digital texts, and writing down on paper key points or questions.[13,14] "Digitally Ready" adults must be confident in their online skills, accurately distinguish between trustworthy and untrustworthy online information, and have enough familiarity with technology to utilize its advantages.[4]

In residency, there are often competing demands and, consequently, decreased time for reflection and engagement with material, which can lead to burnout (Figure 1).[15] Virtual lectures have recently increased in popularity. COVID-19 pandemic forced physicians to rapidly adapt and integrate new technologies into daily practice and into medical education.[16,17] For instance, recent studies on virtual lectures during the COVID-19 pandemic found that one of the significant downfalls of a virtual curriculum was the loss of student–faculty interaction.[16-18] One technique that might help maintain connections between students and faculty during online lectures is the use of polling systems like Poll Everywhere®. These systems can also allow teachers to quickly gauge students' understanding of key points in the lectures before moving on. Real-time polling could also serve as a catalyst for class discussions of issues.

The infrequent assessments that are part of medical school programs do not and cannot cover all the material residents are expected to learn. Thus, medical students and residents want to self-assess frequently to monitor their progress and keep content fresh in memory.[19] For that reason, these learners often spend a good amount of their personal funds on question banks and other daily forms of self-assessment. However, some useful simulations and scenario-based tools (e.g., Step 3 CCS case simulator software) are simply out of reach financially and technologically for many students.

Part II: How are Learners Being Taught?

Even though reading from a textbook has gained a reputation as an "old-school" style of learning, it is still considered a tried-and-true staple of learning in residency. One study by Singer and Alexander explored the differences in comprehension of 90 undergraduate students who read both digital and print versions of news articles and book excerpts on topics of childhood ailments.[2] Not surprisingly with millennials and subsequent generations that have grown up with Internet access and smart devices, survey results demonstrated a significant preference for digital text. Students additionally felt they understood the material better when reading digitally. Paradoxically, when those undergraduates were asked to recall key points linked to the main idea and other relevant information of the passages, their comprehension was significantly better when they read the printed and not the digital text—evidence that these students were poorly calibrated.

What makes learners comprehend and interact with various educational mediums differently? Singer Trakhman proposed that underlying differences may be the result of navigational

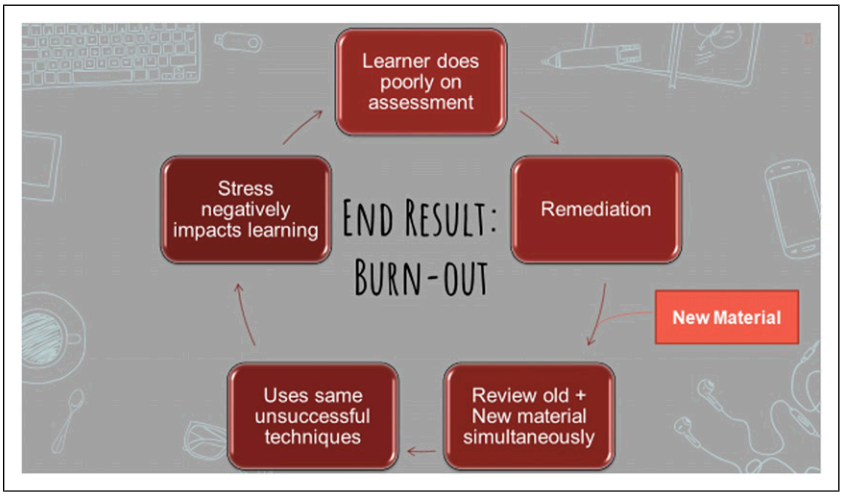

Figure 1. Burnout cycle experienced by too many medical students and residents.

issues with the document.[14] For example, research has shown that effective readers use the location of information on the printed page to prompt their recall.[20,21] When reading digitally, this sense of location is disrupted due to scrolling; in fact, scrolling itself negatively affects comprehension performance.[22] Another factor that affected digital reading performance across several studies was reading time.[22] Specifically, students were found to read significantly faster on screen than on print, which could mean that they were not paying close attention to the content when they were online. In a person-center analysis that looked at an array of navigational behaviors students exhibited during digital reading in relation to comprehension, they identified 4 distinct learner profiles:[23]

1. Regulators—those who exhibited a reliance on deeper processing behaviors (re-reading, moving purposefully back and forth in the text, and posing questions).
2. Gliders—those who moved through the text fluently, albeit linearly.
3. Plodders—those who moved linearly through text but at a noticeably slower pace.
4. Samplers—those who only selectively exhibited deeper processing behaviors (searching through texts for specific sentences or phrases that might help them answer the main idea and key points).

Regulators and Gliders registered the best comprehension scores and were better calibrated than Plodders and Samplers both in print and digitally. Depending on their online reading profiles, medical students and residents may likewise find their comprehension of digital texts negatively affected.

In addition, despite its notable advantages, technology can be a significant distractor. According to Matei, who monitored phone use with the RescueTime app, the average person spends more than 3 hours per day on their cell phone, not including television and laptop use time.[24] The act of using personal devices for learning creates the unintended consequences of distraction and impulse to multitask (e.g., checking emails, text messages, and social media). These distractions are often misrepresented as *multitasking*. Despite what the label suggests and what many students believe, multitasking is detrimental to learning since no one can perform 2 tasks simultaneously unless one of those tasks is entirely habituated (e.g., brushing teeth and walking). Numerous research studies have established this fact and have shown that technology encourages multitasking.[25-27] The impetus for such multitasking often involved such tasks as responding to incoming text messages and e-mails or checking in with social network sites.[27]

The growing presence of technology in graduate medical education has thus become a double-edged sword. The adult learner is now burdened with information saturation, the proliferation of misleading and malicious online content, the struggle to use valid evidence to support claims, and the tendency to treat complex issues in an overly simplistic fashion.[5] The high workload of graduate medical education training fosters an environment that encourages multitasking and technology can contribute to constant distractions.[28] Nonetheless, despite such pitfalls technology has become an essential tool in residency training.[29] It provides easy access to limitless resources, surgical videos, anatomy software, and spaced repetition notecards. Vula, an open-access atlas designed to provide free otolaryngology operative information to the developing world, and other resources can be invaluable sources of critical information in a timely and affordable manner. Similarly, social media in medicine (e.g., MedTwitter) has been shown to increase publication citations and is helpful for staying in-the-know on medical guidelines and updates. As technology developments continue to transform the delivery of clinical medicine, so too will it continue to impact the manner in which medical students and residents become doctors.

Part III: What Transformations in Learning are Needed?

When we juxtapose the demands placed on medical students and residents with the ways in which they are being taught, it is evident that the conditions for optimal learning and performance rarely exist. Thus, to function in these non-optimal conditions, many students revert to an information management mindset instead of investing in knowledge building.[30] *Information management* is a general approach to learning that entails doing what is minimally necessary to get through the array of assigned tasks or responsibilities. Often that means that students work to acquire whatever knowledge or skills they see as needed in the short term, focusing on the content they view as pertinent to the tasks upon which they will be judged. Because information management is so heavily tied to tasks and responsibilities that may be short-lived, retaining what is learned through this approach can be problematic. When the tasks and duties are completed and the demand is no longer pressing, the associated learning can fade from memory.

In contrast to information management, *knowledge building* is an approach to learning whereby the students are invested in acquiring knowledge and skills that *they* consider valuable and essential for their current and future success.[30] As shown in Figure 2, what content draws their attention and time during learning is based on what they perceive as important and credible information. The understandings they acquire are intentionally and strategically linked to prior learning forming an interconnected, principled body of knowledge that is apt to endure in memory and be more readily retrievable when the need arises. Moreover, that principled body of knowledge allows learners to critically judge the information they subsequently encounter in print, online, or in lectures. Knowledge builders do not simply accept what they see or hear at face value—they weigh its veracity and usefulness.[31]

One reason for the prevalence of the information management approach to learning, even among very capable individuals, is that the educational system does not teach students how to be knowledge builders. On the contrary, the nature of school at all levels is too often about covering as much content as possible and focusing on test performance as indicators of success.[30] Mature learners like medical students and residents, therefore, need to rethink the very mindset and work habits that proved success throughout much of their prior educational experience. Although the mental effort and strategic processes involved in knowledge building may initially be unfamiliar and more time-consuming than those aligned with information management, their repeated use can lead to habits of mind that are second nature and that will serve medical students and residents throughout their careers. Further, this personal investment in knowledge building will be invaluable for anyone who hopes to become highly competent or even an expert in the medical profession.[31] In fact, there is no other path to high competence or expertise in any complex field.

But how does one become better at knowledge building? There is no singular answer to this important question. However, we can offer some guidance in that regard:

- Think of your professional training as interconnected and a process of expertise development that requires time and personal investment that cannot be rushed.
- Operate with a knowledge building mindset and be aware of *when*, *where*, and *why* you shift to information management.
- Self-test understanding frequently as you are learning to identify content that requires reinforcement.
- Learn to question and challenge information as it is encountered; healthy skepticism leads to deeper learning

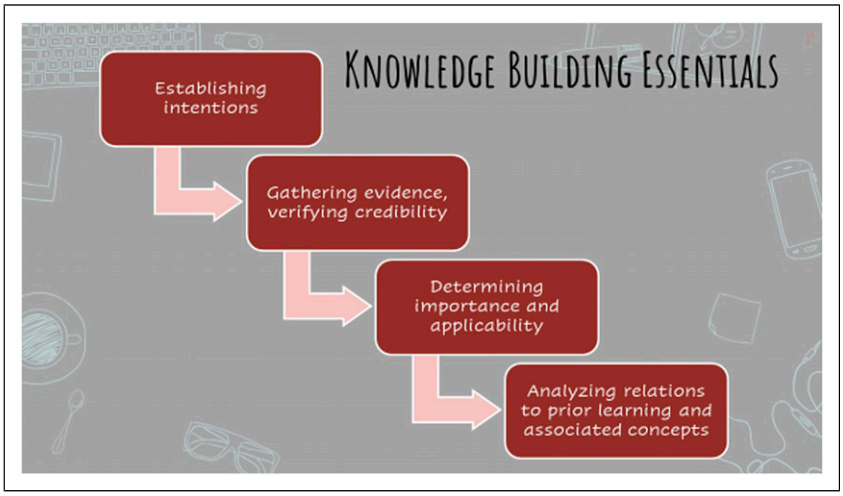

Figure 2. Characteristics of knowledge building.

- Employ technology to assist in structuring what you read, heard, or view into meaningful chunks (e.g., illness scripts; iconic images; families of cases).
- Learn to bootstrap your knowledge by forming connections between new topics, subjects, procedures, and what you already know. In effect, hone the ability to reason relationally.
- Find ways to apply new learning to relevant tasks or problems.[30,32]

Before we leave this topic of information management and knowledge building, it is important to establish that both these approaches to learning are necessary within professional education. Heavy demands will inevitably be placed on medical students and residents. Given the overload of information and high workload in medical school and during residency, it can be easy to revert to information management. Nonetheless, there is a time and place for information management even as students are striving to become knowledge builders. The key for these learners is to be aware and intentional about when, where, and why to engage in information management or knowledge building and to use technologies wisely to assist in these processes.[32]

Part IV: What Transformations in Instruction are Needed?

If, as we have suggested, the tendency for information management to take hold in learners at all academic levels is attributable in part to their educational experiences, it is worth considering what changes in those experiences should occur if knowledge building is to be promoted. Here, we will consider several practical guidelines.

- Teach ***more*** about ***less***.

It has been said that school curricula are a mile wide and an inch deep, and each year the material to be taught and to be learned grows.[33] This reality leaves teachers who feel obliged to "cover the content" doing little more than just mentioning everything and not really teaching anything. Mentioning puts the onus on learners who often lack sufficient background and guidance to fill in the informational gaps the best they can.[34] However, if knowledge building is the goal, then it is essential for teachers to be far more selective in what content they highlight and they need to allow more time for their students to reflect on and apply what they are learning.

- Treat the ***instructor–learner relationship*** in residency as a ***medical apprenticeship***.

Apprenticeships have existed for centuries as a way for master craftsmen to pass along their collective wisdom to promising newcomers. These master craftsmen would model some portion of a complex task and then diligently observe as the apprentice tried to replicate that process. Feedback and more modeling might follow until the apprentice was able to execute that piece of the task well. This cycle would repeat as each new element was added. In much the same way, attending physicians and instructors working with residents should see themselves in the role of master craftsmen who model and guide their apprentices. As such, they need to be cognizant of their residents' strengths and needs, ensure these apprentices have ample opportunities to practice under their careful supervision, and offer whatever instructive feedback is required.[35]

- ***Signal*** what is particularly ***important*** for learners to know and be able to do.

When new topics or procedures are being presented to medical students and residents, it is not only helpful to teach more about less but also to signal specific elements of the content that deserves greater attention from those learners. The research on information processing has shown the value of signaling for acquiring and retaining information.[36] Signals can be trigger words like *first*, *principal*, or *essential,* or they may take the form of bolded or italicized words and phrases, summaries, or other visual cues. When lecturing, instructors should also intentionally signal when information warrants increased attention. Periodically summarizing or restating what has been shared can also reinforce key ideas. Another way instructors can help learners navigate the flow of information is by providing them with an online advanced organizer that lists the main points or terms to be covered. Students can then use the organizer for notetaking (e.g., reMarkable 2 or other tablets).

- Incorporate ***bite-size approaches*** that combine learning and doing.

Another practical step that instructors can take to guide students' learning is to restructure the body of content around a topic into smaller bite-size segments interspersed with opportunities to practice and apply the just-taught subject matter.[37,38] The micro-lessons can make effective use of technology to present supportive videos, application materials, or mini-assessments. These bite-size approaches also allow for small group interactions where critical content can be discussed, rehearsed, and possibly extended.

- Consider ***problem-based***, ***case-based*** formats to deepen learners' knowledge.

A substantial number of medical programs internationally have taken an alternative approach to manage the extensive body of knowledge and skills that medical students and residents must master.[39,40] Traditionally, instruction unfolds by first building up students' foundational knowledge and skills and then applying the acquired content to cases. In problem-based or case-based learning that script is flipped. Specifically, learners are first presented with a medical

problem or case to be solved and then they go about building the knowledge and skills the solution requires. Even if a program is not formalized as problem-based or case-based, it is possible to introduce mini-problems or cases into the content.

- Use instructional time to ***build on*** what students ***learn independently.***

It is increasingly common for medical students and residents to engage in self-teaching of instructional content through the use of online videos, simulations, mini-assessments, and the like. Although there can be a great variability in students' ability to self-teaching, there is evidence that this process can result in at least moderate gains when compared to in-person instruction.[41] Yet, self-teaching does not have to be an all-or-nothing proposition for medical students and residents or their instructors.[41] Instead, in keeping with other practical guidelines we offered such as teaching more about less, bite-size lessons, and problem-based approaches, medical students and residents should be encouraged to learn the more basic information on their own or in groups before lectures. The lecture can then move beyond this more readily acquired content to delve into more nuanced, integrated, and complex subject matter that benefits from instructors' experience and expertise. Instructors and residents could even work together to compile quality resources that students could use for self-teaching.

- ***Welcome*** students' ***observations***, ***questions***, and ***alternative hypotheses***.

One final guideline we would offer as a step toward transforming learning environments that foster information management into educational experiences that promote knowledge building relates to more open channels of communication. Medical students and residents should feel that their experiences, inquiries, and insights are valued parts of the instructional discourse. By not just allowing students' observations, questions, and alternative hypotheses into the learning environment during training but welcoming those contributions, the understanding and curiosity of medical students and residents can be fostered.[42] Furthermore, it is through these interactions that instructors can be better informed about what their students know about the subject matter at hand and what alternative perspectives they may have to offer.

Conclusion

The advantages and popularity of technology among learners have vaulted it to the forefront of medical education. Learners have different learning approaches that will include differing uses of technology. Technology encourages distraction and multitasking, which can negatively impact learning. Learners do not often learn efficiently or effectively due to information overload and the increasing prevalence of invalid information. We must do better in the assessment of the true state of learners' knowledge with the understanding that information management and knowledge building are both effective tools in their own right. Our assessment of knowledge should gauge the ability to analyze and solve problems from a background of previously learned principles. To build knowledge in the technological era of learning, do not take learners' digital readiness for granted. Approach technology as a tool to be wielded when required and *not* as a crutch. Implementing bite-sized approaches, problem-based, or case-based formats and welcoming observations, questions, and alternative hypotheses will encourage learners to channel technological innovations into their own styles of learning.

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An introduction to the Cornell Note system

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Abstract

Objective: The success of note writing has been a topic of research dating back to the days of Plato. Students now have access to complete libraries of books and notes on computers, tablets, and even phones. Modern note-taking methods use premade handouts, "Chalk Talk" lectures with faculty, and prescribed note-taking strategies. Here, we discuss one such strategy, the Cornell Note system. **Methods:** This is an updated review of the original Cornell Note system originally outlined in How to Study in College. **Results:** A detailed outline of how to construct and use Cornell Note System and how to apply to medical training. **Conclusion:** The outline and unique aspects of the Cornell Note system are discussed, along with how this system can be incorporated into the modern-day curriculum.

Keywords

COVID-19, head and neck, laryngology, otolaryngology

Introduction

Throughout history, people have strived to possess more knowledge than their prior generations. This continuous advancement of knowledge has led to novel techniques focused on memory and learning. Centuries ago, writing notes became the basis of learning, and that basis has continued to advance to this day. The process of note writing dates to the time of Plato, in his theory of Anamnesis in which he discusses the hypomnema, translated in English as "reminder, copy, or note."[1] The question of whether note writing is effective has been researched numerous times over the past several decades, though the answer isn't as simple as one might imagine.[2] In general, students who take notes do perform better on examinations than students who only listen.[2] However, the nearly universal indicator of success is whether those students review the notes they take.[2]

Note writing has evolved dramatically since the days of Plato with technology continuously expanding at an unprecedented rate. Students now have access to books and notes on computers, tablets, and phones. Imagine Plato having access to every resource in the world in his hand, at a moment's notice. The dramatic rise in the availability of literature has also allowed students to take their notes "on the go." Nowhere is this more apparent than in medical education. A study published in 2019 involving medical students who were provided iPads for study use, showed that the two most common uses of these iPads were note taking and information seeking on the internet.[3]

Approaches to note taking continuously evolve and as medical trainees seek to retain knowledge from lectures, textbooks premade handouts, "Chalk Talk" lectures with faculty, they turn to various prescribed note-taking strategies. Here, we discuss one such strategy, the Cornell Note System. The Cornell Note System was developed and used by students locally until it was published in the first edition of *How to Study in College*[4] written by Cornell University Professor of Education Walter Pauk in 1962. In addition to Walter Pauk, Ross J.Q. Owens was instrumental in the early use of the Cornell System.

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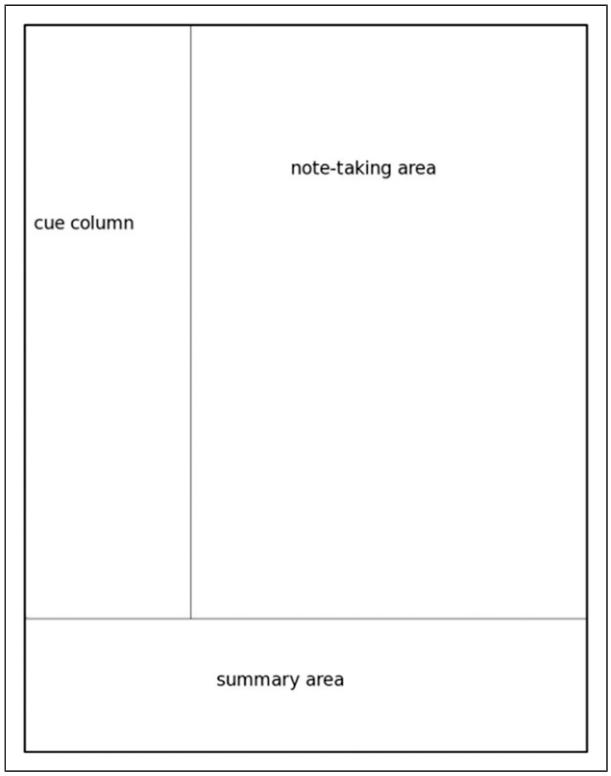

Figure 1. A representation of the Cornell Note layout is depicted here.[4]

Methods

This is an updated review of the original Cornell Note system originally outlined in *How to Study in College*.

Results

The Cornell Note system utilizes a unique layout in that it takes a single sheet of paper and separates it into three distinct sections.[4] The sections are labeled the "cue column," "the note-taking area," and the "summary area."[4] In the updated edition of the Cornell Notes, Owens describes the measurements of each section as such: "To do this, draw a horizontal line two inches from the bottom of the page. Next, up at the top of the page, draw a vertical line two-and-one-half inches from the left side and extend it down to the line for the summary area. This is the cue column, a simple but powerful area upon which much of the success of the Cornell System rests."[4] This layout is shown in Figure 1 and can even be found as a premade setting in new tablets, such as the Remarkable 2.[5]

This method is more involved than simply taking notes. It is a system designed to master knowledge acquisition. The three sections each serve their own unique purpose. The note-taking area is reserved for note writing in the form of quick bullet points, graphs, drawings, and definitions.[4] This section is reserved for what the professor says and what is put on the board, with a goal of capturing the gist of what is said along with the important details.[4] The cue section is arguably the most important section of the entire system. In this section, the note writer adds a question for each note written in the note-taking area that will help them remember or organize the material.[4] This concept is akin to Jeopardy, where contestants answer a question with a statement, except in this instance the note writer answers a statement by developing a question. In the final section, the summary section, the note writer encapsulates the details from the notes section into a few sentences that paint the big picture.[4] The object of this section is to answer the question, "What is this page all about?"[4] When the note writer finishes writing or reviewing the notes section from a lecture, the summary section helps to provide an aerial view of what this set of notes is all about. While taking facts and digesting them into knowledge can be challenging, this is a vital step in the Cornell Note system and should not be skipped.

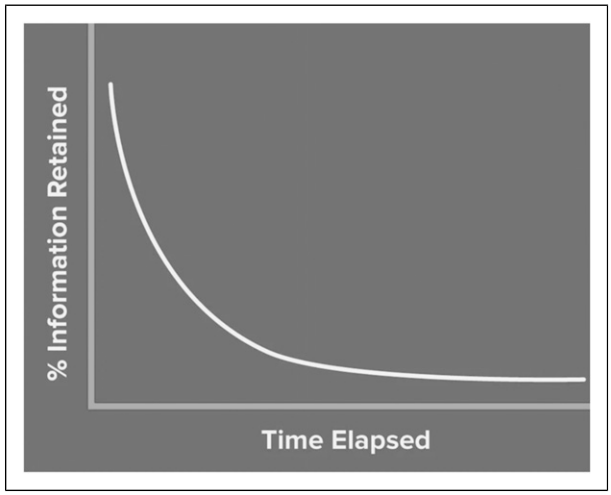

Figure 2. This figure, representing Ebbinghaus Forgetting Curve, was taken from the Mind Tools Content Team.[6]

This system is designed to allow students to reflect on the material and quiz themselves on the material both throughout the lecture and while reviewing the notes post-lecture.[4] The Cornell Method provides a functional mini quiz that can be taken by placing blank sheet of paper over the note-taking area, exposing only the cues. The note writer then goes down the list of cues and quizzes themselves on the respective notes that accompany each cue. This reciting method provides instant feedback and motivation to continue. This activity allows the note writer to actively reflect on the information instead of passively reading it. The summary serves as a reflection of the key ideas for each page of the Cornell Notes.

Discussion

In 1885, Professor Hermann Ebbinghaus hypothesized that the course of memory over time and in studying his hypothesis, plotted the rate of his personal memory decline over time. This

curve is now known as the "Ebbinghaus Forgetting Curve (Figure 2)."[6]

Ebbinghaus showed that over time, facts without meaningful attempts at retention are forgotten at a significant rate.[6] This curve demonstrates several key fundamentals and helps explain why traditional note writing may fail students. First, the steep slope of the initial curve shows that once notes are written down, the process by which they are forgotten begins almost immediately. If medical trainees take notes on a chapter or a lecture and then do not attempt to reinforce those same notes, the memory of those notes fades rapidly. The Cornell Note taking system provide students with an efficient method for reviewing, or reinforcing, notes, with the use of the cue section. Students can efficiently read the questions in the cue section while asking themselves if they understand the answers to those questions. Traditional note taking is often comprised of numerous consecutive bullet points listed on a seemingly endless piece of paper. Organizing notes into specific headings using the Cornell Notes system leads to improved retention as notes are written in a logical, organized fashion.

The Cornell Note method relies on the physical act of writing notes, which may provide a conundrum when you consider that 97% of college students own a laptop.[7] So why even use the Cornell System? Studies have consistently shown that taking notes on a laptop is less effective than writing those exact same notes by hand.[8–10] The handwritten note writer physically cannot write as fast as the lecturer may talk; on average a person talks about ten times faster than they can write.[11] This speed discrepancy in one reason why handwritten notes are so successful. The note writer must comprehend what the lecturer is saying, and translate that into a handwritten note, all while the lecturer is continuously presenting new information. This ability to synthesize, record, and continue to collect new information simultaneously requires cognitive effort. Cognitive effort, combined with working memory, allow the note writer to effortfully summarize the lecture in their own words. As a study by Oppenheimer et al concluded, "… laptop note takers' tendency to transcribe lectures verbatim rather than processing information and reframing it in their own words is detrimental to learning."[12]

The success of the Cornell Note lies in the cue column. The cue column forces the student to go back over their notes and ask themselves what question this specific note is answering. During the note review process, the cue column oftentimes serves an entirely new function; when a student goes over the questions in this cue column separately from the notes column, that student can oftentimes recite the notes from memory without looking at the notes themselves. For example, a note saying, "The mitochondria is the powerhouse of the cell" would be accompanied by a cue saying, "What is the powerhouse of the cell?" This cue column relies on active, rather than passive, learning. Active learning is broadly defined as any instructional method that engages students in learning,

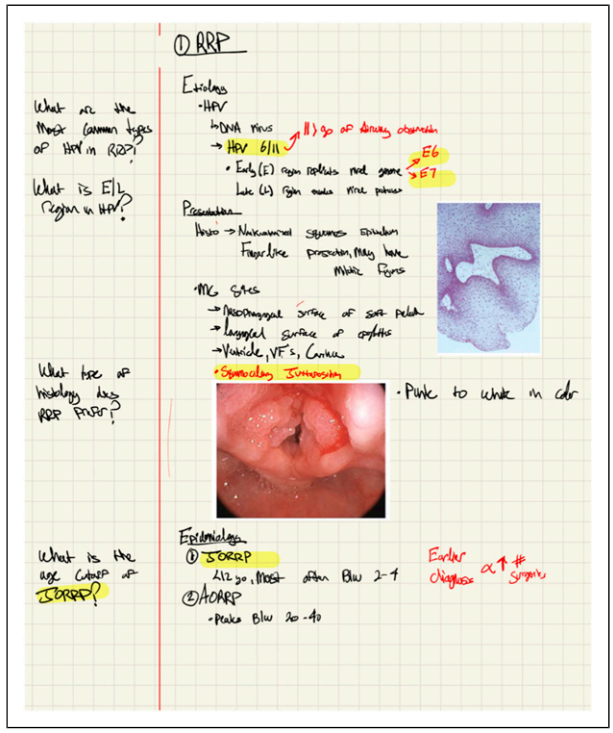

Figure 3. Author's own personal notes, showing simple and efficient use of highlighting.

while passive learning is the traditional classroom style of learning where students passively retain information that is being lectured.[13] An additional recent study showed the use of interactive engagement in a physics class allowed students to score two standard deviations higher on conceptual understanding of topics.[12]

The organizational layout of the Cornell Note system also allows students to efficiently annotate notes during the review period. Traditional forms of annotation often involve students highlighting entire passages in textbooks. This is inefficient and oftentimes unhelpful. The Cornell layout allows students to highlight a specific cue alongside the short bullet point associated with that cue.[4] This method results in minimal highlighting of only the important notes within a passage, rather than these large passages being highlighted in their entirety. This annotation process is efficient, yet effective. In Figure 3, the author provided his own notes written in the Cornell method. These notes written in the Cornell method do have areas of importance that are highlighted. Focusing on these areas of importance is efficient and often done with ease when compared to focusing on those same areas in the traditional annotation method.

To more fully explore the effectiveness of the Cornell Note system, we would like to reflect on our personal experience with strategy. The primary author of this publication utilized the Cornell Note system while studying for the Otolaryngology In-Service Training Exam. In preparing for this exam, a thorough study of the textbook, *Bailey's*

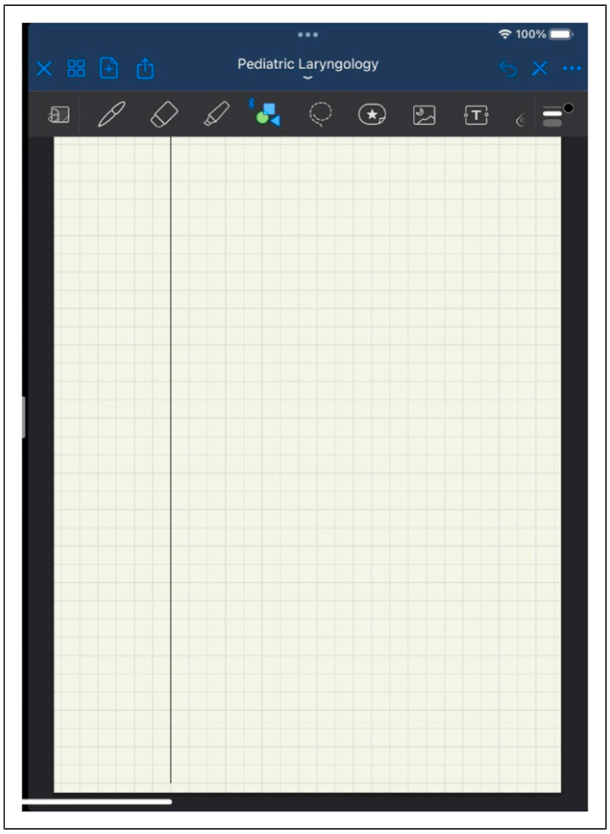

Figure 4. A representation of a modern day note-taking approach using an iPad is shown here.

Head and Neck Surgery: Otolaryngology, was completed using the Cornell Notes system in conjunction with an iPad. The iPad provided the author a means to not only read the literature but also to write notes using the side-by-side approach visualized in Figure 4. Using the Goodnotes[14] iPad application has streamlined this technique even further. Goodnotes offers a template based off the Cornell System that can be used for free. Goodnotes then saves the document and uploads it to the cloud where it can be accessed on other tablets, laptops, and even mobile phones to allow notes to be "on the go."

This approach allowed the author to increase retention by physically writing notes using the Cornell system, while simultaneously using a piece of technology available in most academic settings. Surgical residents of only a few decades ago were forced to rely on textbooks and handwritten notes to guide patient care. Given the exponential rate technology has embedded itself into healthcare and medical education, surgical residents of modern day are more dependent on technology than any prior generation. This approach demonstrates that residents can continue to utilize study methods that require the use of "pen and paper" in conjunction with modern technology. The Goodnotes cloud feature allows the notes to then be accessed easily during patient rounds or before surgical cases just as older generation of residents had done historically. This results in a more efficient and much less cumbersome way to review material that was available to previous generations of residents.

Conclusion

Students have been taking notes for hundreds of years, but we have come a long way since Plato's hypomnemata. Advances in note-taking techniques and the methods by which these advances can be coupled with modern technology have resulted in tremendous advantages for the contemporary generation of trainees. This review outlined one such advancement; the Cornell Note Taking method. This method is effective in promoting retention of learned material by relying on cues that reap the retention benefits of a handwritten note. It can and has been easily incorporated into the ever-changing technological advances in the field of education.

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Written informed consent for publication of this deemed not necessary by the University of Pittsburgh Institutional Review Board.

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Spaced Effect Learning and Blunting the Forgetfulness Curve

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Abstract

Medical education requires learners to absorb, retain, and apply vast amounts of information at every level of training. This process is constrained by the limitations of human memory, which were described by psychologist Hermann Ebbinghaus as a "forgetfulness curve." As he explained, material encountered during a lecture or study session is typically lost rapidly over the ensuing days. Ebbinghaus' solution to this problem—spaced repetition—involves revisiting studied content at multiple, specifically selected time intervals to reinforce learning and facilitate long-term retention. Using question-based repetition, as opposed to passive reading/listening modalities, can help optimize this process. Spaced learning has been used for training in multiple fields including finance, management and technology development. It has also been utilized by medical students preparing for exams and by select residency training programs. This article examines the range of ways spaced repetition has been employed in medical education, with a focus on applications in Otolaryngology training. It also discusses possible future avenues for use of this system to improve long-term retention in Otolaryngology residency and beyond.

Keywords

spaced repetition, forgetfulness curve, testing effect, undergraduate medical education, resident learning, otolaryngology training

The Forgetfulness Problem in Medical Education

From biochemical pathways to complex surgical techniques, learners at both the undergraduate and graduate levels of medical education are tasked with absorbing, synthesizing, and retaining tremendous amounts of information. As the time allotted to didactics is progressively truncated at most medical education institutions, students are faced with a shrinking window for acquiring the necessary academic knowledge while also practicing and honing their clinical skills. Additionally, with limited time to pass on huge amounts of material, medical instructors are rarely able to implement educational techniques prioritizing retention. Methods such as scaffolding, through which techniques and topics being studied are distilled into smaller components to encourage problem solving and critical thinking, frequently fall by the wayside.[1] As students strive to perform well on standardized examinations and become successful practitioners with no scaffolding and often insufficient opportunity to study, they must not only take in new information but also prevent attrition of their existing knowledge base.

Human memory has finite capacity. Psychologist George A. Miller was the first to find that humans can only keep 7 items (±2) in their short-term memory at a given time, later noting slight variations in that total number for different types of data (letters, numbers, etc.)[2] Miller's findings have filtered into many aspects of contemporary life; for instance, it's no

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coincidence that iPhone passcodes are capped at 6 digits. Retaining and recalling information for a prolonged period of time poses an even greater challenge than short-term acquisition. German psychologist Hermann Ebbinghaus investigated the "forgetfulness curve," a graphical representation of the exponential decline in information retention as a function of elapsed time.[3] Though Ebbinghaus conducted his research over a century ago, it was replicated by a group of researchers as recently as 2015 with similar results.[4] According to Ebbinghaus, the greatest drop in information retention occurs just after the new information is initially introduced. That is to say, data gathered while listening to a lecture or reading a chapter is often lost within a few hours or days of leaving the lecture hall or closing the book. By the end of the week, 90% of that material is gone.[3]

Use of Spaced Learning in Boosting Retention

While describing this grim prognosis for information retention, Ebbinghaus also offered a possible mechanism for combatting the attrition. His research showed that by revisiting the new information being studied at specific time points along the forgetfulness curve, learners can blunt its steep decline. With several well-placed reviews, nearly all of the information being learned can be retained. One review immediately following introduction of new material (ideally within 1 hour), followed by another review within the next 24 hours, then one within the next week and one within the next month are optimal for lasting retention.[3] By implementing Ebbinghaus' findings, trainees across the professional spectrum can engage in more effective and efficient learning with an emphasis on long-term retention and recall.

While reviewing information at predetermined intervals is beneficial on its own, the process of long-term data retention can be further optimized by utilizing the testing effect. This tenet of education theory contends that rereading study materials is far inferior to answering questions or otherwise actively engaging with the studied topic, with several studies demonstrating that learners who test themselves on the same material and in the same timeframes as their passively-reviewing peers perform better.[5] These studies have shown that attempting to retrieve the studied information and subsequently committing to an answer choice helps a learner recall that concept more readily when tested next.[6] Though choosing an incorrect answer may be discouraging, studies have shown that making an incorrect choice can be beneficial to long-term learning, sometimes more so than choosing correctly.[7] To glean greatest benefit from these active learning attempts learners must receive feedback on their choice, usually by reading an explanation contextualizing why the selected choice was correct or incorrect.[8] Engaging with the material in this way challenges the learners' understanding and ultimately leads to improved retention.

Repetition at predetermined time points to beat the forgetfulness curve—a strategy referred to as "spaced learning"—has been increasingly utilized as a training tool. Qstream, an application developed at Harvard Medical School in 2008, implemented this strategy while also drawing on the benefits of the testing effect by presenting users studying a given topic with questions and their accompanying explanations at spaced intervals.[9] By centering the repetition process around questions rather than text or videos, the application makes the learner repeatedly practice making an educated decision on the tested subject. Qstream and various other companies providing similar platforms for spaced learning have been adopted by industry training programs across the country. The application has been used for onboarding, expanding knowledge of company policy and processes, development for employees transitioning to expanded roles, and instruction in skills such as market analysis and sales strategy.[10] It has also been utilized alongside experiential workplace learning to enhance retention, for instance as a supplemental tool for warehouse workers' onsite logistics management training.[11] These services have been employed in the finance, medical technology and pharmaceutical spaces, with Qstream clients including Pfizer, American Express and Stryker. As of 2018, over 350,000 learners had utilized Qstream for professional development in some capacity.[12]

Spaced Learning in Medical Education

Spaced learning has demonstrated promise as a countermeasure to the forgetfulness problem in medical training, becoming a ubiquitous part of individual study efforts and formal training programs alike. A review of 120 papers on spaced learning in medical education showed that 90% had been written in the past decade, highlighting the recent rise in utilization of spaced learning in this setting. The review also showed that spaced learning has been implemented in a range of formats, including online instruction, physical classrooms, and skills training simulations for medical trainees.[13]

Spaced repetition platforms, most notably the flashcard application Anki, have become ubiquitous among medical students preparing for classroom and board examinations. The Anki application for Android phones alone has been downloaded by more than 5 million users.[14] Other programs geared towards medical learners such as BrainScape and SuperMemo are similarly using spaced repetition to promote retention, with some offering additional features including analytics on the individual's study habits and sleep patterns. Use of these programs is largely initiated on an individual basis, and multiple studies have demonstrated that students who elect to implement these programs into their study routines score higher on standardized licensing examinations.[15] However, few institutions have attempted to formalize academic use of these programs through flashcard homework assignments or school-supported decks for students to review.

To assess the possible future utility of spaced repetition instruction at the medical school level, several groups have investigated implementation of this system in clerkship training. In a study of learners on a urology clerkship, educational emails about urology topics were distributed to the group at spaced intervals. Medical students who received the emails scored statistically significantly higher on the associated end-of-year examination. Students who had completed their urology clerkship early in the academic year rather than shortly before the exam were shown to receive the most benefit from this system, further demonstrating that spaced learning is efficacious in fostering longer-term recall.[16] Another study of urology students showed that those who received adaptive spaced repetition materials—where interval length and number of repetitions were assigned based on the learner's performance—achieved similar test scores to students with non-adaptive materials, despite doing less prep work than the non-adaptive cohort. The researchers concluded that spaced repetition with adaptive characteristics was useful in boosting learning efficiency in addition to retention.[17]

In graduate medical education, spaced learning has been shown to be a useful method for improving scores on board examinations. A study of orthopedics residents preparing for their basic science examination showed a positive correlation between time spent using an Anki flashcard deck and exam performance.[18] Infectious disease fellows supplied with a Qstream deck reported high degrees of satisfaction with this learning methodology, especially as it pertained to preparing for their boards.[19] Spaced learning has also been shown to assist graduate medical learners in acquiring knowledge otherwise not emphasized in their clinical training, for instance, improving histopathology slide interpretation among surgical trainees, who rarely practice this skill in their daily activities.[20] Studies have shown that using spaced repetition for exam preparation provides greater benefit to interns compared to other residency classes, perhaps due to their comparatively limited initial knowledge base and implementation of this learning system earlier in the course of their training.[21]

While the utility of spaced learning in studies has been well-supported by past projects, there is also emerging evidence for its use in contexts beyond improved memorization. In one study, spaced repetition via regular email bulletins was used to teach residents how to provide medical students with substantive, useful feedback. The residents who received this training were shown to give significantly more frequent and more helpful feedback as reported by medical student survey responses.[22] This suggests promise for implementation of spaced repetition in areas outside of board study, with the potential to help residents and fellows continue developing their patient communication and teaching skills, as well as other core competencies not formally taught throughout the training process. Furthermore, the spaced repetition approach has also shown utility in the development of technical skills necessary for procedural specialties. A study of pediatric surgery students compared students' abilities to tie square knots on a bowel model and later on a higher degree of difficulty atretic esophagus model between those trained with spaced learning and those without. Though both groups showed overall improvement on their second assessment, those with spaced repetition training produced significantly superior sutures in terms of speed, strength and quality, and also reported less anxiety in completing the task.[23]

Spaced Learning in Otolaryngology Training

Similar to other graduate medical education settings, use of spaced repetition has shown significant benefits in Otolaryngology training. In one study, residents were granted access to an otolaryngology question bank on a spaced repetition review application prior to their in-service exam. The participating residents saw a 3% increase in score, adjusted for post-graduate year.[24] Another project at Tehran University of Medical Sciences gave residents daily multiple-choice questions that were cycled back every 10 days throughout the study period. Residents at this program scored statistically significantly higher than similar learners on their in-service test, despite not showing any significant difference from similar learners in previous years.[25] As in other procedural fields, Otolaryngology learners have also been shown to benefit from spaced repetition in developing their technical skills. One study showed that spaced practice could improve performance in physical tasks, as residents trained in basic mastoidectomy skills over the course of several short sessions showed significantly greater improvement than those who participated in one longer training session.[26] Though such studies show promise, they have primarily been conducted in small populations thus far. Further investigation is needed to better understand the efficacy and possible applications of spaced learning in both the academic and technical aspects of Otolaryngology training.

Existing educational programs within the field of Otolaryngology offer avenues for future implementation of spaced learning on a larger scale. The American Academy of Otolaryngology-Head and Neck Surgery developed an online platform for educational activity entitled OTO Logic offering nearly 1400 educational activities such as recorded lectures, interactive cases, and e-courses. The Academy has expressed its intention to continue to expand its educational programming by incorporating gamification, using competition to motivate learners to engage with their colleagues and challenge themselves.[27] Gamification in combination with spaced learning would optimize learning and retention potential, ensuring that Otolaryngologists at every experience level continue to acquire lasting knowledge.

One current feature of OTO Logic that could benefit from a spaced repetition component is OTO Quest, a question bank introduced in 2021 with over 800 questions that can be assembled into timed practice exams. These exams are tailored to fit the individual, as learner confidence in answering each

question is measured and compared to performance. The learner may later retry questions answered incorrectly or with low confidence.[28] An individual could conceivably use these settings to create a spaced learning program on their own by choosing to redo incorrectly answered questions more frequently than correct questions, but there is not currently a standardized option to do so on the platform. Integrating spaced learning more explicitly into this question bank would help learners better retain continuing medical education content long-term. Several platforms used to study for Otolaryngology examinations such as Board Vitals and DosedDaily similarly offer extensive question banks with customizable features, but no spaced learning options at this time. The time-consuming aspects of creating these banks—question development and collection—have already been done. Including an algorithm for spaced repetition of these questions should be a simple modification and could help learners better prepare for their exams and future practice.

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Building Surgical Expertise Through Deliberate Practice

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Abstract

Objective: To characterize the role of deliberate practice in the changing landscape of surgical training. **Methods:** A review examining various applications of deliberate practice was conducted, with a focus on the surgical training space and utility of this methodology in otolaryngology residency. **Results:** With many programs turning to simulation-based practice and other learning modalities based outside the operating room, deliberate practice is emerging as a promising method for more efficient and efficacious learning. **Conclusion:** Identifying and addressing weak areas, maintaining motivation to continue to grow and reach new milestones, and continually responding to external feedback from instructors can lead to improvement in a variety of skills essential for success in surgical fields. Further implementation of deliberate practice methodology could improve surgical training at all levels.

Keywords

deliberate practice, surgical simulation, surgical coaching, otolaryngology training, resident learning, self-directed practice

Acquisition of Expertise Through Deliberate Practice

Are expert surgeons born or are they made? Investigators in a wide range of fields have long sought to explain the origins of mastery, and specifically to determine whether high achievement can be attributed to innate talent or dedicated effort. To answer this question, psychologists turned to the experiences of superlative performers in disciplines spanning from athletics to art to industry. Bloom et al. examined the early careers of 120 experts across a range of fields, noting that none showed any clear early indications or inherent features that could have foretold greatness.[1] The only features that consistently predisposed experts to success were physical traits in sports, such as the significance of height in basketball stars. Studying a group of chess masters, Simon and Chase first made the claim that consistent, long-term practice—more specifically, 10,000 hours or more—was what distinguished the great chess players from the good ones.[2] Psychologist K. Anders Ericsson reached a similar conclusion, conducting a study of how violinists spent their time that showed that the better musicians were practicing significantly more and participating in leisure activities less than their colleagues.[3]

While investigating the stories of an array of experts, Ericsson noted a crucial distinction: experience and expertise are not one and the same. Achieving competency in a new skill typically requires at most 50 hours of effort, after which the action becomes rote and can be practiced and repeated without active engagement. Upon reaching this point, most learners will plateau (a state of "arrested development") rather than ascend to the elite level of an expert.[4] To describe how select individuals overcome this stagnation, Ericsson introduced the term "deliberate practice," contending that while hours spent practicing provide a trainee with experience, they may not be effective in helping to reach expert status if not utilized to their fullest potential. Ericsson suggested that in honing a new skill,

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a learner cannot simply repeat tasks with which he or she has grown comfortable. Instead, repetition must be applied to carefully selected, challenging tasks aimed at addressing the individual's specific weaknesses. To do so, learners may break complex tasks down into smaller ones that can be practiced individually and refined. Ericsson also noted that while individual practice is beneficial, receiving immediate feedback from an instructor and incorporating that feedback into the practice plans help to further optimize the process. Finally, deliberate practice hinges on the individual's motivation to learn and willingness to work methodically through challenges rather remaining stagnant at a comfortable level of effort.[5]

The effects of deliberate practice have been studied in relation to nearly every form of peak performance. An investigation of the learning environments of expert musicians showed that these performers were surrounded by a wider range of instructors and band members who could offer them direct feedback, were exposed to a more diverse pool of musical compositions during training, and were thereby challenged to actively practice different styles and techniques early on.[6] Another study examining Gaelic rugby players demonstrated the difference in attitudes toward practice between experts and competent players, with the experts describing their practice sessions as effortful rather than enjoyable and competent players being more likely to practice drills with which they were already familiar. This non-challenging practice led to mildly improved performance in the competent players but did not support long-term retention.[7] A study of the effects of deliberate practice in pilot training showed that pilots who had engaged in deliberate practice for crisis flying scenario management performed significantly better in simulations of 83 common disaster scenarios.[8] Deliberate practice in these scenarios helped the pilots not only by allowing them to run through the decision-making processes associated with possible malfunctions but also by challenging them to do so under the pressurized conditions of a true emergency.

A Paradigm Shift in Surgical Education

In his explorations of the different skills that are or could be impacted by deliberate practice, Ericsson postulated that specific areas within the field of medicine—namely, medical diagnosis, perceptual diagnosis, and surgical performance—could benefit from the effects of deliberate practice. Given the significant challenges and changes facing the surgical training field today, standardized implementation of this model could have significant benefit moving forward.

Previously based around an apprenticeship system composed of didactic teaching followed by observation and hands-on practice in a clinical setting, surgical training is now in the midst of a decades-long transformation and reprioritization. Firstly, resident work hour restrictions, while crucial to reducing fatigue-based errors and burnout, also reduce the time available for trainees to learn by participating in cases and watching how experts handle challenging situations and complications on the spot.[9] Operating room time for trainees to practice and instructors to demonstrate and teach is further limited by institutions growing progressively focused on shortening procedure lengths to cut costs. A study examining four common surgical procedures performed with and without the assistance of a PGY-3 resident found that all four types of cases took significantly longer to complete when a resident was involved.[10] In another study investigating the timing of laparoscopic cholecystectomies performed with residents, operative time was found to be increased to a similar degree across all residency years, meaning that resident participation in operative procedures is costly regardless of trainee experience level.[11] Finally, a growing focus on safety and outcome metrics has led to increased pressure on residents to gain proficiency in operative skills before applying them to procedures performed on live patients.

In a quality-control based system of healthcare administration, the lack of standardization and objective evaluation inherent in the apprenticeship model is no longer sustainable. While this model cannot be abolished outright, programs are increasingly turning to ways to supplement and alter the training process to expedite the development of surgical skills and redirect a large deal of learning time to environments outside of the operating room. Much as a novice tennis player's first volley would never take place at Wimbledon and a child picking up an instrument does not stutter through her first notes on the stage at Carnegie Hall, practice and performance are typically kept separate in high-stakes, high-skill environments. It would stand to reason that medical practitioners should follow suit and develop their skills in lower stakes environs prior to initiating human dissection. This has led to an increased focus on simulations and other non-operative training modalities. However, as with all other skill acquisition settings, for simulations to have a significant impact they must be used deliberately, especially given the limited time allotted to them in busy resident schedules.

Deliberate Practice in Surgical Education

Thus far, deliberate practice has largely been used in surgical education in the setting of simulations. In a review of 17 studies investigating the effects of deliberate practice in surgical training using simulation-based programs, all 17 showed significant improvement in performance following deliberate practice.[12] In a study of surgical residents conducting laparoscopic cholecystectomy deliberate practice using virtual reality simulation compared to a control group, 100% of participants using deliberate practice reached target quality, with only 30% of the control group attaining similar achievement.[13]

Deliberate practice has also been used to enhance hands-on training and lead to more efficient and competent surgical care among trainees. A study of fourth year medical students

learning to perform a coronary anastomosis on a porcine heart model over the course of 4 months using deliberate practice found that by the end of the study, the medical students could perform the procedure at the same level as senior general surgery residents.[14] Another study following PGY-3 ophthalmology residents introduced a novel method for teaching trainees to perform cataract surgery by breaking the procedure down into small tasks and then practicing high-difficulty skills in both the OR and simulated settings with feedback from faculty. Learners who received this training were found to be better prepared for their PGY-4 years per supervisor evaluations.[15]

While deliberate practice has been shown to provide benefit in surgical training settings, it is still only being used in a limited capacity due a lack of existing infrastructure and time constraints. Self-directed deliberate practice would seem like an ideal way to fit improvement opportunities into a hectic residency schedule; however, studies where students have been given deliberate practice work to do on their own time have found that learners view these homework assignments as burdensome rather than helpful.[16] Additionally, as this is a relatively novel premise in many institutions, faculty must be trained in how to support their residents effectively before their feedback can be truly useful. One study evaluated the way in which feedback is given to residents through the lens of deliberate practice. Finding that specific gaps in the trainees' knowledge were only highlighted in 3.9% of the feedback, the investigators suggested that acquiring more substantive feedback could better enable trainees to target their practice and eventually meet a clear "expert" level.[17]

Deliberate Practice in Otolaryngology

Otolaryngology has utilized simulation as a component of training for nearly a century, with Chevalier Jackson's "Michelle the Choking Doll" for endoscopy practice being a prominent example.[18] Given the vast range of procedure types and lack of significant exposure to otolaryngology procedures throughout undergraduate medical training at most institutions, simulations are a vital component of early residency training as PGY-1s navigate the steep learning curve. Otolaryngology is among the surgical specialties that utilize simulation-based training most broadly, with a recent meta-analysis describing over 60 different types of surgical simulators currently in use in this field.[19] However, while simulation is becoming increasingly significant in the otolaryngology residency experience, few projects have examined the use of deliberate practice using these simulations and other learning activities during training.

Several studies of mastoidectomy performance in virtual reality surgery simulation demonstrated some of Ericsson's original points. Mastoidectomy performance has been shown to typically peak early in simulated trainings, but an investigation by SA Anderson noted that with deliberate practice, dedicated trainees pushed through the performance plateau and continued to improve. They also performed better on reassessment three months after the initial training.[20] Another study found that deliberate practice with a temporal bone simulator led trainees to complete tasks faster and with a lower error rate.[21] Ahmed et al. examined the performance of trainees in deepening dissection at the sinodural angle on a mastoidectomy simulator under distracting conditions, finding that deliberate practice had a positive effect on multitasking capabilities and mitigation of the detrimental effects of distractors.[22]

Some of these studies have also highlighted areas for possible improvement of deliberate practice methodology in otolaryngology. One study postulated that the learning curve in novice mastoidectomy training, found by multiple groups to plateau at an inappropriately low level, was due to an inability to appropriately self-assess in learners at this level. The investigators went on to suggest that novices invested reduced mental effort in the tasks once they perceived themselves to have reached a level of proficiency. This led the investigators to conclude that a standardized tool for improving self-assessment among new trainees could help to prepare the learners to evaluate their efforts correctly and subsequently elevate their performance.[23] Malik et al.'s investigation of cortical mastoidectomy and facial recess dissection similarly found that self-directed simulations in the lab had a negative effect on performance, again highlighting that trainees need targeted feedback if they are to continue to progress. Additionally, trainees particularly interested in otology were found to have three times greater competency in the simple mastoidectomy tasks and ten times greater competency in difficult tasks than their peers with no specific enthusiasm for this field, reinforcing the idea that motivation and interest are key to mastery.[24] Fostering this motivation through mentorship and faculty interactions could therefore lead to improved performance in virtually any task.

Avenues for Further Implementation

Moving forward, integrating deliberate practice more formally into otolaryngology residency could help to improve outcomes, reduce financial burden, and expedite the skill-acquisition process in training. Otolaryngologists operate in four modalities: open surgery, endoscopic surgery, microscopic surgery, and robotic surgery. At the University of Pittsburgh Medical Center, a deliberate practice curriculum has been implemented to increase competence in otolaryngology trainees quickly from the beginning of their residency, with task trainers and skills assessments for each of these modalities.

At the start of intern year, new residents all participate in a one-month deliberate practice rotation, involving 2 hours of surgical simulation skills teaching with a faculty instructor. This period of training, which relies heavily on simulation using 3D-printed models and other practice modalities, helps to establish the foundations of operative skills that would

otherwise be learned in the operating room. By starting residency with this dedicated practice time, learners can enter the operating room with some experience behind them, making the learning that subsequently takes places in the operating room more efficacious and productive. This system aims to combat the learning plateau and expedite the process of gaining true competency. Implementation of this type of dedicated deliberate practice time early in residency across other programs should help to standardize the level of training in the field while also making the training process more efficient. Additionally, continuing with regular deliberate practice throughout the following years of training could help to hone existing skills and build new ones as residents progress through their training.

Elite athletes and world-class musicians never stop practicing. If they wish to continue performing at the highest level, they must continue to grow their skillset and strive to reach the next goal. Similarly, surgeons cannot achieve or maintain mastery without regular, life-long deliberate practice outside of the operating room. Thus, the application of these deliberate practice principles can and should continue beyond resident and fellow training and into the realm of faculty development and continuing medical education.

Though it may be difficult for experienced surgeons to find instructors to provide feedback, Ericsson noted that as people approach expert status, they are more capable of providing self-guidance. As such, at-home deliberate practice should be feasible in this demographic. Additionally, there is an emerging field of surgical coaching that may be utilized by surgeons to provide each other with feedback on their performance through post hoc review of surgical videos.

For surgeons of all levels, great skill is not innate. It is the product of hard work channeled into deliberate practice that enables one to push past the plateau of competency and to truly pursue mastery.

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Article 7: Building Surgical Expertise through Deliberate Practice

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