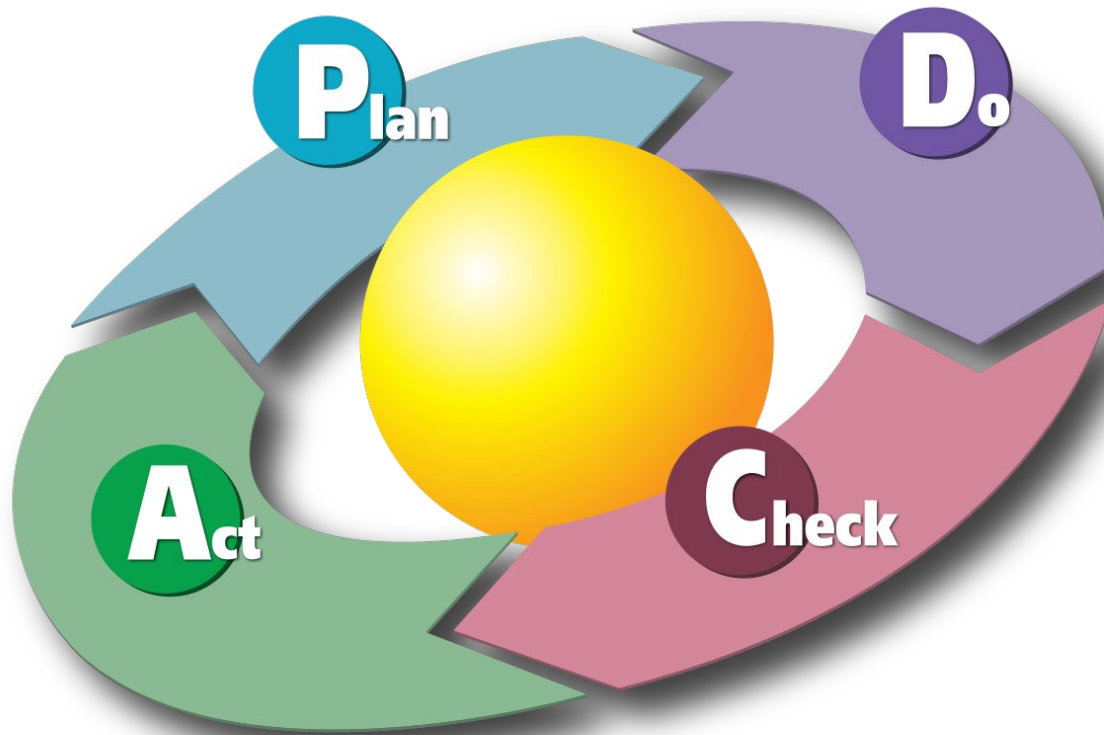


OJT Best Practices

Robert Rogers - North Carolina Standards Laboratory

The PDCA cycle

We all know this one. This is introduced to students during the Fundamentals of Metrology and was also re-emphasized during the RMAPs last year.



Here's a slightly different teaching model
with a twist:

SODO TO

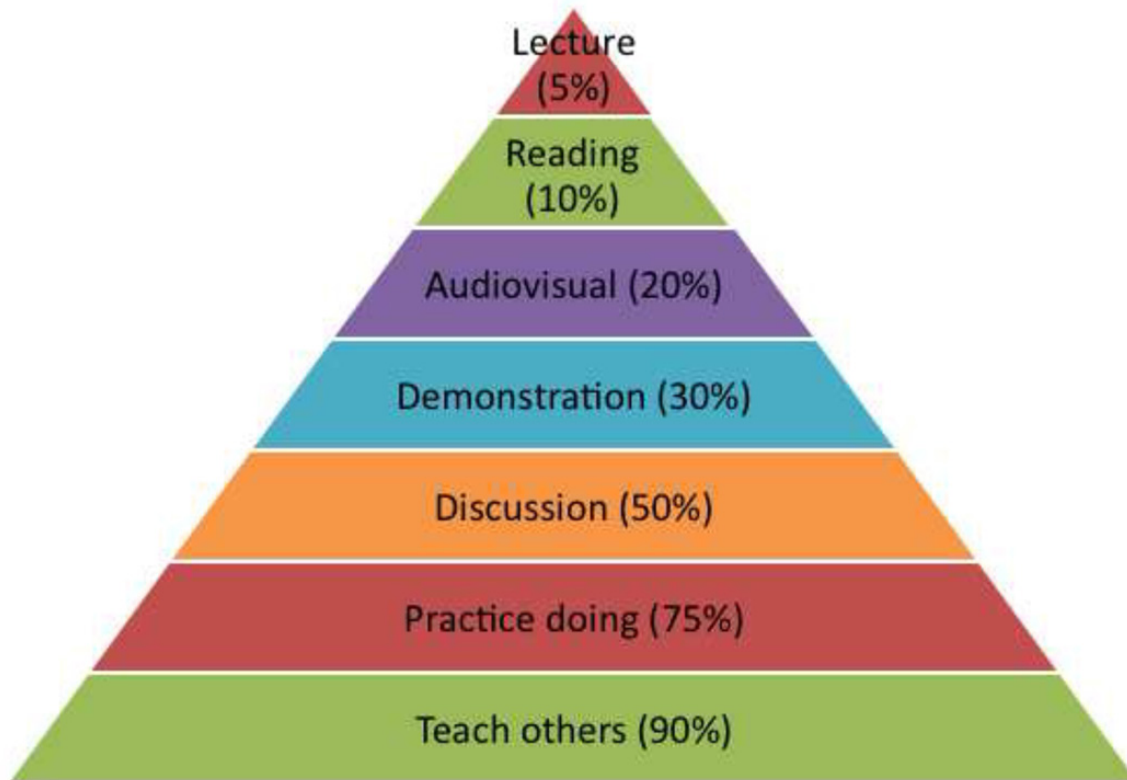
What in the world is this? A new martial arts program?
Well...Not exactly!



- ▶ SODOTO is the acronym for See One Do One Teach One
- ▶ SODOTO was originally developed in medical surgery teaching hospitals in the 1800s to improve interns' knowledge, understanding, and comprehension of surgery.
- ▶ So why does this method work?

The Learning Pyramid

The learning pyramid shows the least and most optimal methods of retaining information using passive teaching methods (lecture, reading, audiovisual, demonstration) versus participatory teaching methods (discussion, practice, teaching).



Kolb's Model of Learning by Doing



Practical Application: The Lead Metrologist Role

- ▶ In 2013 a deficiency in our laboratory was identified due to a lack of a solid training method for calibrations not taught at NIST and not readily available by alternative sources. An example of this was our Small Volume Prover program (SVP)*.
- ▶ Here's a simplified breakdown of how the program works:
- ▶ Metrologist Van Hyder had nine years of experience with SVPs. Metrologist Ashley Lessard calibrated 15 SVPs working alongside with Van during the time period of 2011 to 2013. In the SODOTO method this was the SO part.

* Now known as Dynamic Volumetric Systems (DVS)

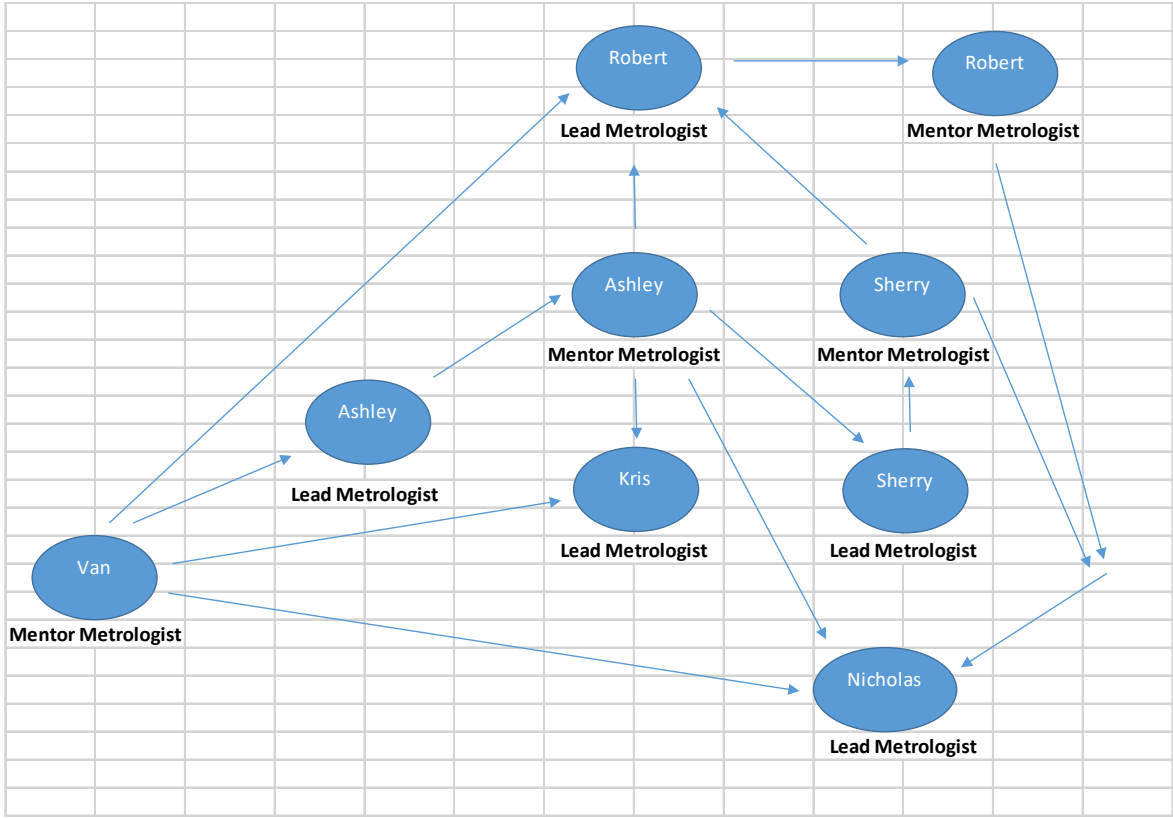
- ▶ Ashley took over as Lead Metrologist for the SVP calibrations in September 2013 and served a one-year internship until August 2014. During this time, she calibrated 15 SVPs and was the metrologist responsible for the collection and input of data, creation of the calibration certificate, and all interactions with the customer including future appointments and invoicing. This was the DO part of the SODOTO method. It is important to note that during this time the Lead Metrologist has direct access to the more experienced metrologist but as Lead is ultimately responsible for carrying out all actions. The ability to explain why you are doing what you are doing is the keystone of the TO portion of the SODOTO method. Ashley was able to explain the process of calibrating a SVP in full detail, beginning to end, satisfactorily to Van and was granted Authorized Signatory status in September 2014.

- ▶ Once Ashley completed her Lead Metrologist role Kris Simino took over as the next Lead Metrologist. Ashley took over Van's previous role and acted as the more experienced metrologist. The benefit of continuing the training in this fashion is that it forced the new Authorized Signatory to be able to answer any and all questions pertaining to the process involved. **Doing this is much more difficult than you would think!** By being able to articulate explanations and demonstrate techniques, it benefited both parties and continued to teach *both of them*.

What was the end result?

- ▶ A group of metrologists able to calibrate SVPs independently without any assistance,
- ▶ A group of metrologists able to troubleshoot potential problems,
- ▶ A group of metrologists confident in their abilities to calibrate SVPs regardless of staff presence

Flow diagram model of practical application of SODOTO





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Application of See One, Do One, Teach One Concept in Surgical Training

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Abstract

Background—The traditional method of teaching in Surgery is known as “See One, Do One, Teach One.” However, many have argued that this method is no longer applicable mainly because of concerns for patient safety. The purpose of this paper is to show that the basis of the traditional teaching method is still valid in surgical training if it is combined with various adult learning principles.

Methods—We reviewed literature regarding the history of the formation of the surgical residency program, adult learning principles, mentoring, and medical simulation. We provide examples for how these learning techniques can be incorporated into a surgical resident training program.

Results—The surgical residency program created by Dr. William Halsted remained virtually unchanged until recently with reductions in resident work hours and changes to a competency-based training system. Such changes have reduced the teaching time between attending physicians and residents. Learning principles such as “Experience, Observation, Thinking and Action” as well as deliberate practice can be used to train residents. Mentoring is also an important aspect in teaching surgical technique. We review the different types of simulators: standardized patients, virtual reality applications, and high-fidelity mannequin simulators and the advantages and disadvantages of using them.

Conclusions—The traditional teaching method of “see one, do one, teach one” in surgical residency programs is simple but still applicable. It needs to evolve with current changes in the medical system to adequately train surgical residents and also provide patients with safe, evidence-based care.

Keywords

Surgery; adult learning; see one, do one, teach one

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The adage, “See One, Do One, Teach One” is often used for medical trainees, particularly in Surgery. This saying reflects the traditional method of teaching in Surgery when trainees, after observing a particular procedure once, are expected to be capable of performing that procedure followed by being able to teach another trainee how to conduct that procedure. However, many critics have recently argued that this method is passé.¹⁻³ The main contention is that patient safety is at risk with this type of teaching because students are unable to safely perform a medical procedure after only seeing it once. Studies have shown that 28–42% of residents feel inadequately trained to safely perform various practical medical procedures such as central venous line placement alone for the first time.^{4,5} It has been reported that inadequate knowledge, experience, and/or supervision are the causes of medical mistakes.⁶⁻⁸ The 1999 Institute of Medicine report⁹ highlighting the high rate of preventable medical errors supports patients’ fear of being “practiced” on.

The purpose of this paper is to discuss how to convey the fundamental concept of “see one, do one, teach one” to be applicable in surgical training and how it can be useful when combined with adult learning principles.

History of the Surgery Residency Program

In 1890, William Stewart Halsted became the first Chief of Surgery at Johns Hopkins Hospital who transformed surgical education by creating the residency program. There was no formal training system in the United States prior to that time, so medical school graduates who were interested in becoming a surgeon were either self-trained or learned via an apprenticeship. Halsted’s model of “see one, do one, teach one” is based on acquiring increasing amounts of responsibility that culminated in near-independence. Halsted was not only interested in developing a system to train surgeons, but also in creating teachers and role models. A formal training program was the only way to ensure that surgical advancements would be passed on efficiently and effectively. Accordingly, 11 of his 17 chief residents followed in his footsteps and went on to set up residency training programs throughout the country.¹⁰

The residency program developed by Halsted essentially remained unchanged for a century. One change instituted in 2003 by the Accreditation Council for Graduate Medical Education (ACGME), the council that evaluates and accredits U.S. residency programs, limited the resident duty hours to an average of 80 hours per week.¹¹ Previously, residents routinely worked 110 hours per week.¹² Part of the reason to limit resident work hours was to ensure safe patient care from residents who were not overworked and tired. Another major change that is currently being proposed is the Next Accreditation System.¹³ The ACGME has instituted changes to the residency program through a shift from a time-based system to a competency-based system. This system assesses a resident’s progress by reaching specific milestones rather than a specific number of years in training. The ACGME project mandates that six general competencies must be mastered by certain stages in a resident’s career. The competencies include interpersonal skills and communication, medical knowledge, patient care, practice-based learning and improvement, professionalism, and systems-based practice.¹⁴ The results of this project will be important on an individual-level to determine whether residents in each specialty are meeting the milestones at the predetermined time

points. This effort will be important on a program-level to determine accreditation by determining whether the majority of residents in a particular program are meeting the required competencies at each time point.

Although the changes described above may improve the quality of patient care and the value of resident education, teaching time between attending physicians and residents is constrained by the increasing need to generate revenue.¹⁵ Increased emphasis to obtain research funding is one cause of reduced time for mentoring. Furthermore, the emphasis on operating room efficiency to improve patient care and contain costs may also constrain the time that residents spend operating and therefore limits teaching opportunities. Therefore, the much sought after efficient model of “see one, do one, teach one” may be obsolete, but the general concept of observing, performing, and teaching, can still be incorporated into a surgical residency program by adhering to certain principles of adult learning.

Adult Learning Principles and How to Incorporate Them

Studies have shown that learning is most efficient when learners are actively involved either physically or mentally in the learning process.^{16–18} This can be accomplished by writing notes or drawing diagrams while studying, asking residents appropriate questions, and engaging residents in surgery.¹⁹ The retention rate is greater the more multisensory and active a learning activity is.²⁰ Accordingly, only 5% of information is retained when it is learned in a lecture format (Figure 1).²¹ In support of the “see one, do one, teach one” method, one is more likely to learn and remember the steps of a surgical procedure if one learns it “hands on” and explains it to someone else.²⁰ For example, an attending who wants to teach trainees how to perform a face lift procedure can apply the experiential learning theory by David Kolb: Experience, observation, thinking and action.²² The trainees may be presented with a facial nerve injury complication during a face lift procedure to give the trainees relevant context or experience in needing to understand the anatomy of the facial nerve in relationship to the fascial plane of the face. The trainees will then observe the attending doing the operation (see one). After this time, the trainees will think and reflect on what they have seen and learned by doing a simulation exercise, perhaps in a cadaver workshop (do one). After achieving competency in the simulation activities, the trainees will demonstrate their competency by teaching junior trainees in real life situations under the supervision of the attending physician (teach one). Therefore, the traditional model of doing one operation to achieve competency is expanded through a number of exercises involving reflection and active learning in a continual cycle (Figure 2).

Physician-teachers can incorporate this active style of teaching by involving residents in surgery and asking them questions that are appropriate to their level of knowledge. Teaching tips and examples are given in Table 1. First, the teacher must identify what a resident already knows and can do. Teaching can then focus on the “zone of development” where the resident is “beginning to have knowledge gaps or misconceptions.”¹⁹ For example, in a rheumatoid arthritis patient who is having metacarpophalangeal joint arthroplasty, the attending could ask the resident what are the expected outcomes of this surgery? Is there a time point of rheumatoid hand destruction when this surgery is not indicated? These are challenging but nonthreatening questions to determine the student’s level of knowledge. In

the operating room, this means that teaching must be balanced between what the resident already can safely do on his/her own and what the resident can do only with assistance.¹⁹ Ideally, basic skills should be taught outside of the operating room to ensure patient safety. This can be done with surgical simulators or in a surgical-skills laboratory using cadavers. The resident should have a clear understanding of “what the operation is, why it is being performed, and the various steps of the procedure.”¹⁹ Preoperative preparation is important because it allows the student to learn successfully in the operating room by preparing the mind for the intake and organization of new information.²³ Preoperative preparation can involve watching surgical videos of the particular procedure as well as reading textbooks and journal articles for expected outcomes and possible complications. One study found that medical students who watched one or four videotapes of expert surgeons demonstrating a particular procedure showed superior levels of performance when they performed that procedure compared to students who did not watch any videotape.²⁴ Seeing an expert perform a procedure gives students a mental standard that they can compare to their own performances.

It is ideal for the resident to establish his/her own objective for the operation. This way, the resident can identify where practice is needed based on past experiences.²⁵ Setting objectives also enhances the student’s motivation.²⁶ For example, if the resident has previously performed a particular type of procedure, the attending may ask how he/she can improve upon their performance. What is left to learn? The teacher should divide each operation into steps and determine the resident’s level of involvement in each step.²⁷ It is important to remember not to overload the resident with a large number of isolated facts. The facts will be more easily retained if they are organized into a logical framework. The discussion in the operating room should focus on the learning objectives.²⁵

After the operation, in particular during the closing of the wound, the teacher and student can debrief the procedure. The debriefing consists of four elements: 1) Reflection, 2) Rules, 3) Reinforcement, 4) Correction. Reflection involves the teacher asking the resident to reflect upon his/her performance and whether the objectives were attained. The reflection phase should have a positive tone such as what did you do well and what would you do differently next time? The second element, rules, is a rule to guide future practice. This should preferably be formed by the student during his/her discussion with the teacher. For example, “How will you remember to design the appropriate incision to avoid prominent scars in a face lift operation?” In reinforcement, the teacher should reinforce what the resident did right. This reinforces the learning objectives, provides encouragement to the student to persist, and strengthens what the teacher considers valuable including the previously determined rule to guide future practice. Lastly, correction involves correcting mistakes, especially those in thinking. The teacher should address what led up to the mistake as well as how it can be avoided in the future. If a discussion of a mistake could embarrass the learner, the discussion should take place away from earshot of other personnel.²⁵ Overall, a positive learning environment must be maintained to promote learning. Excessive anxiety on the resident’s part will inhibit the ability to retain information.^{28,29}

The Importance of Mentoring

Halsted understood the importance of a mentor and stated, “We need a system...which will produce not only surgeons, but also surgeons of the highest type, men who will stimulate the first youths of our country to study Surgery and to devote their energies and their lives to raising the standard of surgical science.”³⁰ Others have reiterated the importance of mentoring and the impact of negative role models.³¹ A survey of 74 graduating surgery residents found that 73% selected the subspecialty of their mentor.³² However, developing a mentor-mentee relationship can be difficult in the current medical system where interaction time between the attending surgeon and residents has decreased, rotations change, and training occurs across multiple sites.³³ Teaching may not be a priority in some surgeons’ minds when it is time consuming and their priority is on generating revenue by seeing patients or conducting research.³⁴ In contrast to Halsted’s time when the apprenticeship model may have focused on acquiring technical skills, the modern mentor-mentee relationship often extends beyond the operating room to matters such as balancing work and life, instillation of strong values, passion for work, and a commitment to research, administration, and public health.¹⁵ In discussing a desirable plastic surgery training program, Dr. Robert Goldwyn states, “Senior surgeons owe a trainee more than imparting knowledge and teaching technique.” He goes on to say that mentors often do not form emotional bonds with mentees which could allow them to give perspectives about life outside of the operating room.³⁵

The number of residency programs offering formal instruction in teaching skills seems to be increasing.³⁶ The American College of Surgeons (ACS) hosts a “Residents as Teachers and Leaders” course that helps foster mentorship skills.³⁷ This course includes content on finding time to teach as well as how to provide feedback on performance. The ACS also offers a “Surgeons as Educators” course that emphasizes teaching skills to enhance learning in a surgical education program.³⁸ Unfortunately, there is a lack of literature specifically for mentoring in plastic surgery.³⁹ However, a liaison program offered by the American Society of Plastic Surgeons provides networking between young and established plastic surgeons.⁴⁰ The Plastic Surgery Foundation also offers a workshop for residents and junior faculty which includes the topic of how to select a mentor.⁴¹

One study found promising outcomes using peer-assisted learning.⁴² Third-year medical students were randomized to a group led either by trained fourth-year medical students or by residents and taught a structured clinical exercise in a simulated operating room. The students who were in the group led by the trained fourth-year students performed more steps correctly during the operative exercise when compared to the resident-led group. The fourth-year medical students may be more comfortable using a step-by-step approach to teaching and be able to better place the learning material in an appropriate level for learners. The learners may feel more comfortable raising areas of concern with a peer without feeling foolish.⁴³

Johnston provides specific strategies for teaching Generation X physicians.³³ Generation X generally refers to people born from the early 1960s through the early 1980s. Generation X emphasizes evidence-based medicine as opposed to the practice of their superiors. Thus,

they may question teachers and authority. Generation X wants their mentors to guide them and facilitate their skill development rather than to micromanage them. They are more interested in learning through experience and working independently. They also prefer to develop a portable skill set that they can take with them when the next best opportunity arises.⁴⁴ Knowing the traits of this generation can enhance the working relationship between mentors and their generation X-mentees. For example, because generation X physicians are more autonomous and impacted by technology and skill development, they are suited for learning via surgical simulators. Although autonomy is important to generation X physicians, mentors can also emphasize the importance of experience and collaboration in providing quality medical care.

Methods of Learning Outside of the Operating Room

Most would agree that the key to learning surgical skills is practice, practice, practice. After all, studies have shown that improvement in a surgeon's outcome is correlated with increased volume.⁴⁵⁻⁴⁷ However, mere repetition tends to improve performance up to a plateau that is less than the maximal level.⁴⁸ The key is the time spent in deliberate practice, as opposed to the quantity of time spent in surgery, in order to achieve the maximum level of expertise and outcomes.^{49,50} Deliberate practice is used to improve performance by actively setting new goals and higher performance standards and seeking out training situations to achieve one's goals. This is done to avoid becoming automated where additional experience does not translate into improved performance.⁴⁸ The four conditions of deliberate practice are shown in Table 2. For example, a surgeon may use deliberate practice in order to shorten his/her operating time of a particular procedure to reduce infection rate. He/she could practice using a medical simulator that provides feedback on operating time as well as efficiency.

The best way to practice in a safe environment is using a surgical simulator. Simulation allows residents to "play out a wide variety of scenarios and error-prone situations and to reflect on performance without jeopardizing a patient's safety, while providing a controlled setting in which rigorous skill assessment and feedback occur to help trainees to develop clinical competence."⁵¹ The ACGME states that resources for resident education should include simulation and skills laboratories.¹¹ Patients, also, are more willing to allow medical students to perform certain procedures on them after the student has undergone simulation training.⁵² A meta-analysis comparing simulation-based medical practice combined with deliberate practice found it to be significantly ($p < 0.001$) more effective in clinical skill acquisition compared to traditional clinical education ("see one, do one, teach one") or a pre-intervention baseline measure.⁵³

There are several different types of simulators: standardized patients, virtual reality applications, and high-fidelity mannequin simulators.⁵⁴

Standardized patients are actors who are trained to accurately portray a specific patient role, assess a student's clinical skills, and provide feedback. At the University of Michigan, standardized patients are used throughout the four years of medical school training.⁵⁵ They can be useful in assessing skills such as history-taking, physical examination, and

communication. Standardized patients presenting with melanoma were used in a study of 6 plastic surgery residents to assess the ACGME core competencies. The patients provided valuable feedback and the residents also benefitted from watching the taped interactions.⁵⁶

Virtual reality applications are classified into different levels depending on the degree of interaction between the computer and the user.² Some have mentioned that the skills acquired in a single computer simulation may not be applicable to all patients because of anatomical variations in the human body.^{57–60} However, virtual reality simulation can be used as a pre-operative exercise using 3-dimensional computed tomography scans of the exact patient who will undergo surgery.⁶¹ One advantage is that it provides the opportunity for very detailed feedback and measurement of a trainee's performance.⁶² Advanced simulators for procedural training have been developed for craniofacial reconstructive surgery, breast reconstruction, soft tissue reconstruction, congenital defects⁶³ and cleft lip and palate repair.^{64–66}

High-fidelity mannequin simulators can generally be used to teach procedural skills including cardiac catheterization. They can generate physical findings such as oxygen saturation, respond physiologically to medications, and undergo procedures. However, the mannequin can cost upwards of \$250,000, not including the cost of on-site instructors, maintenance, and the use of operating room equipment.⁶⁷ Also, some have found that it is difficult to overcome the artificiality of using a mannequin.⁶⁸

One disadvantage of surgical simulators is that they are usually not designed for teamwork or for situational decision-making.⁶⁹ There is also no consequence of failure in using a simulator,⁶⁹ whereas it could have dire consequences in an actual operating room. However, surgical simulators give immediate feedback, which is important in the learning process. They also provide objective measurements of technical skill proficiency, which is currently something that is lacking in the certification process.⁷⁰

Conclusion

It was aptly noted by Dr. Rod Rohrich, editor of *Plastic and Reconstructive Surgery*, that in this era of outcome and evidence-based medicine, the enhanced medical learning cycle should be “see many, learn from the outcome, do many with supervision and learn from the outcome, and finally teach many with supervision and learn from the outcome.”³ The traditional method of medical learning with “see one, do one, teach one” is simple, but still applicable. However, it can be built upon and greatly enhanced with various learning principles, committed mentors, and advanced technology, such as medical simulators. Residents must be encouraged and given the opportunities to learn and improve upon their surgical skills by mentors who continue to improve upon their skills as well. This can all be done in an environment that keeps patient safety at the forefront.

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Figure 1. The Learning Pyramid

The learning pyramid shows the least and most optimal methods of retaining information using passive teaching methods (lecture, reading, audiovisual, demonstration) versus participatory teaching methods (discussion, practice, teaching).

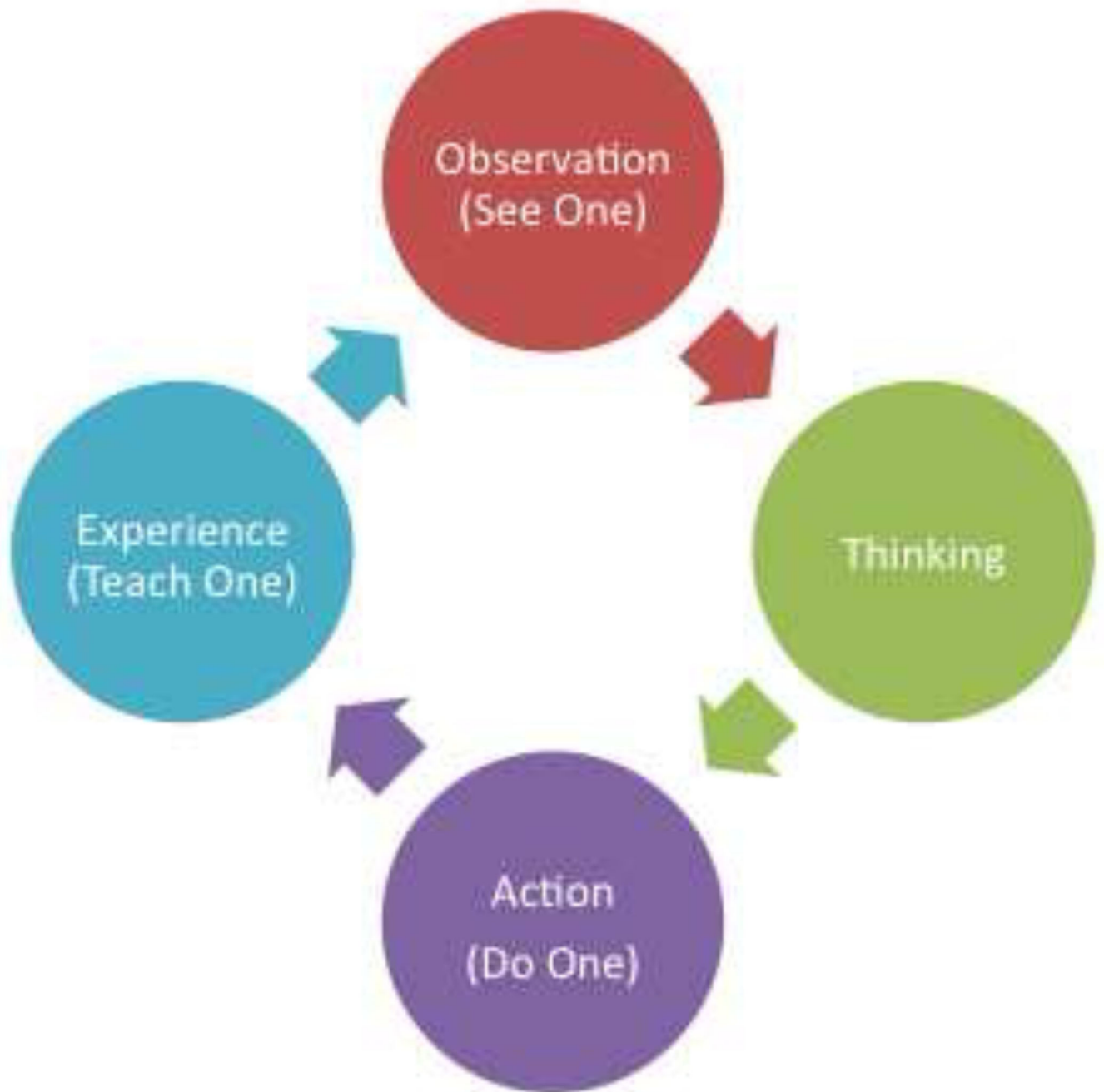


Figure 2. Kolb's Model of Learning by Doing

Diagram illustrates Kolb's continual cycle of learning by doing (experience, observation, thinking, action) and how "see one, do one, teach one" fits into this model.

Table 1

Teaching Tips Using Adult Learning Principles

<p>Pre-operative:</p> <ul style="list-style-type: none"> ➤ Write notes and draw diagrams while studying ➤ Ask questions to determine level of knowledge ➤ Use surgical simulators/cadavers ➤ Prepare for surgery by reading textbooks and journal articles and watching videos ➤ Identify learning objectives for a particular operation
<p>Operating Room:</p> <ul style="list-style-type: none"> ➤ Divide each operation into steps and determine residents' involvement ➤ Discuss previously identified learning objectives
<p>Post-operative:</p> <ul style="list-style-type: none"> ➤ Determine whether the learning objectives were attained ➤ Reflect upon what went well and whether anything could have been improved ➤ Develop rules to guide future procedures ➤ Reinforce what was done right ➤ Address any mistakes and how it can be avoided ➤ Provide feedback and maintain a positive learning environment

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Table 2

Four Steps of Deliberate Practice⁴⁸:

1. Have a task with a well-defined goal
2. Be motivated to improve
3. Be provided with immediate feedback
4. Be provided with ample opportunities for repetition and gradual refinements of performance

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