SPECIAL COMMUNICATION

*Domenick J. Masiello, MA, DO, DHt, C-SPOMM; Martin Torrents, DO, MPH, MBA*

# Osteopathic Manipulation Skills Training: Past, Present, and Future

## Abstract

This article reviews the methods used to teach osteopathic manipulative treatment (OMT) from the inception of the profession in the 19th century through the 21st century. Past and current osteopathic literature contains very few references to psychomotor skills training methods used in the OMM lab. Faced with this paucity of information, suggestions for improving the traditional demonstration/imitation model of instruction are given. These suggestions are derived from the science of learning (SL), Simulation-Based Medical Education (SBME), Evaluation Science (EV), and insights gleaned from sim lab student assessment research. The future of osteopathic pedagogy is discussed in relation to advances in neuroscience, technology, and the need to preserve the uniqueness of the osteopathic profession. Kirkpatrick's method of training evaluation is suggested as a paradigm for assessing curriculum changes and measuring goals set on departmental, college and professional levels.

## The 19th Century

The founding date of osteopathy as a healing concept and method is 1874 but this is not the beginning of osteopathic education. By 1887, Still's practice had grown too large for one physician to manage, so he began to informally teach his sons and a few intimate friends about his discovery. When his sons were able to achieve good results with the new method, it quickly became clear to Still that his method could be learned. The private classes that Still gave at his home continued to grow, and in 1892 Still applied for a state charter to establish a school of osteopathy. At that time, he hired Dr. William Smith of Edinburgh, Scotland to teach anatomy. By October of 1894, Still's American School of Osteopathy (ASO) had moved into a one-story frame building that also housed a tiny infirmary. By 1895, the school and infirmary moved again to larger quarters, this time to a three-story brick building able to accommodate the now 27 students and the increasing number of patients seeking treatment.

The historical landmarks mentioned above and the early history of osteopathy generally, can be found in the school catalogs now archived by the Museum of Osteopathic Medicine. The earliest catalog in the collection is the 1897-1898 edition and it includes a brief history of osteopathic education dating back to 1892.[1] Between 1892 and 1894 changes were made to the curricula which were described as "…Experiments in methods of teaching were now necessary, and these extended over several years with varying success and disappointment

## Corresponding Author

Dominick Masiello, DO

Email: dr.djmasiello@gmail.com

## Disclosures

None reported.

## Keywords

COMLEX-USA-PE, Myron Beal, Louisa Burns, Psychomotor skills, Pre-testing, Reinstatement phenomenon, Simulation-Based Medical Education (SBME), Objective Structured Clinical Examinations (OSCE), Sim Lab, Transcranial magnetic stimulation, Transcranial direct current stimulation, Positron emission tomography, Evaluation science, Osteopathic Manipulative Treatment (OMT), OMT Skills training

until October 1894, when a new charter was granted…" A change in teaching methods during the delivery of an educational program is formative evaluation, a metric well known in the education field of evaluation and measurement.[2] This was most likely achieved by informal faculty polling rather than formal written student surveys. The intimacy of the early osteopathic classroom was conducive to the teacher's understanding of the physical, social, and psychological context of the student's lives and embodies educational concepts espoused by John Dewey (1859-1952), one of the most influential American philosophers, psychologists and educational reformers of the 20th century.[3] Dewey was well known for his views on progressive education and liberalism. He established the University of Chicago Laboratory School where he tested many of his progressive pedagogical ideas.

The first catalog (1897-1898) describes the course of study as extending over two years, divided into four terms of five months each. Subjects included anatomy (descriptive and cadaver demonstration), pathology, physiology, chemistry, toxicology, clinical medicine, surgery, and obstetrics and gynecology. Instruction in the principles of osteopathy started in the second term and clinical demonstrations in osteopathy began in the third term. These early catalogs make clear that the intention was to go beyond the mere passive conveyance of information and to supplement lectures with instructor comments, demonstrations, models, drawings, and blackboard exercises - all of which could engender student discussion. The clinical practice of osteopathic manipulation was reserved for the fourth and final term when students would attend lectures four days a week, observe the faculty diagnosing and treating clinic patients, and practice their manipulation skills with these patients. Each instructor was assigned 2-3 sections consisting of 2-3 students per section. Each section was assigned between 4-8 patients who had been previously examined and diagnosed by the faculty before the class. The students were required to treat those patients assigned to their respective sections. The teaching method of osteopathic manipulation was most likely a demonstration/imitation model, still a mainstay of osteopathic training. With the availability of a large number of clinic patients, there was probably no need for students to pair off in the osteopathic clinic and practice their treatment skills on each other. Students were, of course, required to pass their examinations to graduate but the catalogs do not detail how students' osteopathic manipulation skills were assessed. By 1905 construction began on the ASO hospital and the catalog for that year indicates that the curriculum had expanded to a three-year program with lectures and demonstrations of osteopathic principles beginning in the second year. The practice of osteopathic manipulation was still reserved for senior students who were now permitted to also treat acute cases in the Kirksville area under the supervision of a faculty member. They were required to submit case histories of all such patients - which comprised part of their final grade. At this time other subjects were added to the curriculum, such as pediatrics, neurology, physical diagnosis, and medical jurisprudence. The 1908-1909 catalog is the last archived by the museum and it highlights the new ASO hospital and nursing school. The osteopathic curriculum now included not only philosophy, principles, and diagnosis but also something called, "osteopathic mechanics." These subjects were taught in a lecture format during the first two years. A lab component for these courses is mentioned but it is unclear what was presented during these labs or how the students' work was evaluated. Senior students were now required to give 200 treatments in the clinic plus an additional 200 treatments to patients in the surrounding community.

## The 20th Century

By the late 1890s several other osteopathic schools were established by graduates of the ASO and by 1904 it was estimated that over four thousand DOs were in practice, half of them graduates of these new schools.[4] To trace the osteopathic curricula of all the colleges of osteopathic medicine is beyond the scope of this article. However, using the ASO as a template one can document the evolution of the osteopathic curriculum in the 20th century. Fortunately, Georgia Warner Walter's history of the ASO[5] from 1892 to 1992 provides a view of this evolution. At just over 600 pages, Walter's book is the history of the men and women who transformed the ASO into the A.T. Still University (ATSU). The growth and development of Osteopathy's "mothership" are detailed against the backdrop of 20th-century political, legal, cultural, and educational changes that include the effects of the Flexner Report, an influenza pandemic, an economic depression, two world wars, and changes in the delivery of healthcare in the United States. Changes in the school's infrastructure and staff are well documented; however, there are few details about the teaching methods used by the Osteopathic Principles and Practice (OPP) Department.

There is a photo (circa the 1930s) that shows the demonstration of osteopathic technique before a large class, but it is unclear if the subject is a fellow student or a clinic patient. In 1936, motion picture projectors were being used for instruction, and in 1938 a department of Visual Education was established complete with a studio for the production of movies, prints, and slides. In 1939 comprehensive exams were required for graduation, and as a preparation for the state board exams necessary for licensure, but there are no records of the actual exam material. The teaching of osteopathic principles and techniques was moved into the first-year curriculum around this time, and in 1947 the curriculum was extended to four years. There is a 1962 photo of a faculty member instructing two shirtless students in thoracic HVLA technique, leading us to speculate that the school may have switched from practicing on clinic patients to practicing on classmates in the osteopathic lab. In the 1970s, closed circuit television was being used for teaching osteopathic techniques delivered from the studio to 5 teaching labs, each composed of 25 students.

Scanning archived issues of The Journal of Osteopathy from 1894 to 1914 for references to osteopathic education reveals topics such as entry requirements (preliminary education), education campaigns for the general public, comments about the Flexner Report, curriculum content changes, state requirements for licensure and educational parity with the allopathic profession. Many of these comments were submitted by members of the American Association of Colleges of Osteopathic Medicine (AACOM) which was established in 1898 to represent the interests of osteopathic colleges. What are missing are any references to the teaching methods used to deliver the osteopathic curriculum. Likewise, searching the indices of volumes 1-91 of the Journal of The American Osteopathic Association (JAOA) also shows a lack of articles detailing teaching and evaluation methods used to deliver the manipulative medicine curriculum.

There are articles about osteopathic education written in the 20th and early 21st century such as Ward's article on the history of osteopathic education accreditation; however, pedagogical methods are not discussed.[6] Likewise, Shannon and Teitelbaum discuss the future of osteopathic education but only in terms of the number of colleges and the changes in the now multiple pathways to graduate medical education available to DOs.[7,8] Boulet, Gimpel, et al in their article on the COMLEX-USA-PE do mention the components involved in the administration of this examination.[9] They discuss the training of the standardized patients, the physician raters, the evaluation forms, the scoring, and the post-test data analysis. The authors make clear that the exam is an assessment of the student's ability to know when to utilize osteopathic manipulative treatment (OMT) with the standard patient as not every standard diagnosis presents that opportunity. The article does provide some insight into the administration of the exam but reveals little about how the physician raters are trained nor is there any discussion as to how the developers of the exam might influence the pedagogical methods used by the colleges when teaching osteopathic skills. Snider, Seffinger, et al discuss the lack of a standard trainer-to-student ratio in the osteopathic profession and compare osteopathic skills training ratios to many other types of training such as Alexander technique, clinical dentistry, cardiopulmonary resuscitation, and Osteopathy in the Cranial Field, to name a few.[10] They quote studies indicating the importance of feedback as well as studies indicating the degradation of performance with too much feedback but without ever-defining feedback.

Amidst the paucity of 19th and 20th-century pedagogical references, there is one outstanding exception. The Principles of Palpatory Diagnosis and Manipulative Technique, was published in 1992 by the American Academy of Osteopathy (AAO).[11] Edited by Myron Beal, DO, FAAO, it is an expertly curated collection of articles from the body of 20th-century osteopathic literature. It contains Section III, Psychomotor Skills Training, and may be one of the only such references in pre-21st century osteopathic literature. In his introduction to Section III, Beal states, "A psychomotor skill is one in which voluntary motor action is directly related to mental activity. Palpatory and manipulative technique skills are psychomotor skills. The teaching of these skills in recent years has been referred to as psychomotor skills training." Beal then notes that historically, the standard demonstration/imitation model of osteopathic training paid little attention to the physical skills employed in such training. Section III is mostly composed of articles by Paul Allen, DO, and James Stinson, DO which do call attention to these skills. These Allen and Stinson articles are reprints of their presentations given before the Middle Atlantic States Osteopathic Association in 1940.

Although lacking descriptions of actual pedagogical techniques, the articles are early attempts by the osteopathic profession to begin to define the physical skills needed for expert osteopathic manipulation. Allen and Stinson call

for a common descriptive language of the "felt-sense" involved in manipulation. They mention that without critical thinking, mere demonstration of technique is futile. They advocate for exercises in touch training, awareness of touch, and developing a habitual curiosity to touch, all leading to a well-developed kinesthetic sense which they consider more important than diagnostic skill. They mention the importance of form and liken it to psychomotor skills development in athletes, dancers, and musicians. The development of good form depends on what they call, "dynamic relaxation" which involves leverage, anchorage, muscular activity, follow-through, curvilinear motion, and rhythm. Allen and Stinson define psychomotor skill as, "a physical skill, it involves the use of sense organs and muscles in the execution of a smooth, precise, well-timed performance. The skill is organized to relate to the space around the individual, and the skill is timed so that each muscle's performance comes into play at a certain moment. Examples: writing, drawing, operating machinery or laboratory equipment, swimming, sewing, driving." They also gave a simplified, 3-part model for the teaching of psychomotor skills consisting of an introductory, practice, and perfecting phase.

In Section IV (Palpation), there is a short yet prescient article by Louisa Burns, DO, an early osteopathic research scientist. She advocated training the sense of touch and control of the hands not unlike a musician practicing scales. Drawing anatomical pictures of the tissues the student palpated was another method she advised. She also stressed the importance of establishing an association of the neural pathways of the touch centers in the brain with other cortical areas, especially the speech center, long before these pathways and their relationship to learning and memory had been clarified. She believed that the art of palpation had to be linked to a description of the findings in an accurate language to help establish these neural connections.

Allen and Stinson were not alone in their interest in learning. The concepts they enumerated are part of the science of learning. The science of learning (SL) is an interdisciplinary field drawing from the fields of Neuroscience and Biology, Cognitive Science and Psychology, Computer Science, Engineering, and Education. Each of these fields has its own long and unique history, however, it can be stated that essentially SL, as a separate field of study, began in the 20th century. Dunlosky, et al, in their review article describe 10 learning techniques that have undergone substantial research from the 1960s well into the 21st century.[12] These are *elaborative interrogation*, *self-explanation*, *summarization*, *highlighting and underlining*, *keyword mnemonics*, *imagery for text*, *rereading*, *practice testing*, *distributed practice*, and *interleaved practice*. Weinstein, et al, in their review article on the teaching of SL, mention *spaced practice*, *interleaving*, *retrieval practice*, *elaboration*, *concrete examples*, and *dual coding*.[13] Most of the research in SL has taken place in the mid-20th and early 21st centuries but there are notable exceptions: Ebbinghaus' work on memory dates back to 1885[14] and a master's dissertation by Abbott on the relationship between memory and learning dates back to 1909.[15]

## The 21st Century

AACOM remains a vital organization and routinely surveys each of the colleges of osteopathic medicine (COMs) and issues various statistical reports to the profession regarding curriculum length (all subjects), faculty composition, and COMLEX-USA preparation methods among others. The latest available report on contact hours (all subjects) shows a low of 10 hours for the osteopathic manipulative medicine (OMM) lecture course at one COM and a high of 159 hours at another. Likewise, the OMM lab contact hours were a low of 60 hours at one COM and a high of 328 hours at another.[16] Interestingly, faculty reports generated by AACOM do not routinely track the numbers or credentials of the OMM faculty at the COMs. The AACOM website does contain a link to a PowerPoint presentation delivered at their 2011 annual conference. Psychomotor Skills Training and Table Training Ratios, is a 14-slide presentation that mentions only two educational concepts: the influence of varying levels of feedback on initial skill performance and skill retention and trainer/student ratios from various fields.[17]

The Educational Council of Osteopathic Principles (ECOP) is a constituent council of AACOM. Its mission is to discuss ideas relevant to the teaching of osteopathic principles and practice, recommend improvements to the curriculum, and assist new COMs with curriculum development and implementation. They publish an official glossary of osteopathic terminology, an osteopathic thesaurus, and a technical standards document. Its aims also include developing consensus among AACOM member schools regarding curriculum content and teaching methods. The ECOP webpage does not list any publications which contain information on pedagogical methods.

To this day, it is difficult to know exactly how each of the osteopathic colleges teaches the OMM lecture and lab curriculum. Each school competes with all the others for admissions, board score rankings, and residency match percentages, so understandably there is no formal system of sharing detailed pedagogical methods. However, given the paucity of pedagogical references in osteopathic literature, it might be useful to catalog some concepts from (SL) as a basis for developing best practices in osteopathic education. Most of the COMs may already embody some of the following concepts when it comes to the lecture portion of the OMM curriculum and they may each have learning specialists on staff who can advise entering students on how to best incorporate them. Skills training in osteopathic manipulation, however, is typically not covered by learning specialists in education so an exploration of osteopathic psychomotor skill acquisition may also prove useful.

## Science of Learning Concepts

Osteopathic students are sometimes already credentialed in a related health profession such as physical therapy, nursing, pharmacy, or chiropractic, and normally an educational needs assessment via survey or other means would be performed as a way to measure a knowledge gap and inform curriculum development or evaluation. Typically, this is not part of new student orientation. It is assumed that entering students have no experience in osteopathic principles or practice. However, OMM residency programs accepting MD graduates may need to explore needs assessment as part of their curriculum delivery process.

Osteopathic training occurs during both pre-clinical years, and so continuity, sequencing (via anatomical region), and repetition are built into the lecture and lab curriculum. Integration with anatomy and physiology is part of the osteopathic principles curriculum and some case studies are presented during the 1st and 2nd-year labs. However, there is a need for observational and diagnostic skills to be better integrated with the physical diagnosis (PD) course. They are usually presented as two separate courses. For example, the OMM lab for the cervical spine always includes skills training in observation and palpation but this is typically only from a posterior view. A more inclusive approach would also involve observation and palpation from the anterior view of the neck, and integration with differential diagnoses, for a unilateral or bilateral enlarged or swollen neck typically covered in the PD course.

In our experience as former students and now osteopathic educators, both Pre-Testing and Low or No-Stakes Testing, as learning and memory enhancement tools, are sometimes utilized in the OMM lab curriculum. Pre-testing helps with successful retrieval and re-storage into memory and the formation of new neural connections.[18]

Professor of Biology and adult learning theorist, Robert Leamnson recommends several learning strategies in his book, Thinking About Teaching and Learning, and some of these are readily found in the OMM lab curriculum.[19] *Story-telling*, *paraphrasing*, and *waiting for answers* to anatomical and physiological questions are used in the lab. *Small group peer teaching* during lab is sometimes used as a preparation for upcoming lab practical examinations, although mandatory after-hours study groups are not required. At least one COM offers after-hours voluntary enhancement sessions which provide elements of focus, feedback, and commitment.[20] Staffed by adjunct faculty and second-year student teaching assistants, these sessions provide students an opportunity to ask questions and review techniques while treating their peers. This adjunct-student interaction can be considered a rudimentary form of mentorship. More extensive forms of mentorship are more appropriately implemented by OMM residencies and continuing osteopathic medical education programs offered by component societies such as the American Academy of Osteopathy (AAO).

*Feedback* is essential for the development of psychomotor skills and according to Wiggins it must go beyond praise, blame, or simple adult commentary.[21] It must be timely, continual, and user-friendly. It should allow for the student's deliberate and effective self-adjustment. Clearly, providing faculty feedback days or weeks after a practical exam, as is often the custom, does not meet these criteria. Feedback is information about how the person did relative to what was attempted, the intent versus the effect, and the actual versus the ideal. Facts about the performance are fed back to the student without the faculty's view of the value of the performance. Wiggins defines it as follows: "The best feedback is highly specific, directly revealing or highly descriptive of what actually resulted, clear to the performer, and available or offered in terms of specific targets and standards." These principles apply equally well to the evaluation of OMM faculty by administrative or departmental reviewers.

The development of expertise in osteopathic psychomotor

skills can also be informed by the work of Anders Ericsson, a psychologist who spent over 30 years studying the science of expertise.[22] He studied performers of many kinds - such as chess champions, violin virtuosos, star athletes, and memory experts - and found that the key to their extraordinary skills was deliberate practice. Expertise is best built by working with an experienced coach; deliberate practice must be goal specific, focused, and involve feedback and it must take you out of your comfort zone as you work repeatedly and sometimes differently, all while maintaining motivation. Ericsson's work was the basis for the "10,000- hour rule" of expertise.[23] Ericsson saw the US Navy's Top Gun program as an example of deliberate practice for those already on the job, a kind of practice while getting work done.[24] In 2003 he recommended that radiologists learning to interpret mammograms would benefit from immediate feedback from experienced radiologists, feedback from each patient's physician about the patient's final outcome, and the establishment of a library of digitized mammograms to be used as a form of immediate feedback. Similar programs have been used in laparoscopic surgery with success. Ericsson also mentions something that is currently lacking in such training: learning more about the "mental representations" of the most effective surgeons. This refers to the internal, moment-by-moment mental processes that go on during a procedure, particularly one with unanticipated difficulties. In the osteopathic profession, particularly for those who labor in the cranial field, mental representations would correspond to the thoughts of our "thinking fingers". In 1998, Chila and Gaines called for precisely this, namely, using a phenomenological approach for the development of a formal description of these internal representations corresponding to the lived experience of performing osteopathic manipulation.[25] Lastly, Ericsson makes an important distinction between knowledge versus skill. Too much of medical education is devoted to knowledge via lectures and written exams but much of the practice of medicine involves skill and this is especially true for the OMM labs. Every effort should be made to treat OMM labs as an opportunity for psychomotor skill acquisition and not an opportunity to test concepts best assessed via a written examination. Skill training is not the same as testing for a correct answer on a written exam. In fact, in 1992 Beal and Spraflka recommended prompting the student during a practical exam if he/she seemed to be approaching the technique incorrectly.[26] Practical exams should be designed so that all manipulative techniques on an exam are tested as opposed to requiring students to memorize all the techniques but only test them on one or two - a typically written exam strategy. Holding the practical exams in the lab room with faculty at various stations allows for each student to be tested in multiple techniques and exposes each student to multiple examiners thus "averaging out" any inter-examiner variability.

Psychological research into the *reinstatement* phenomenon improving memory may also prove useful in OMM education.[27] Simply stated, memory improves when the learning location matches the testing location. For example, if OMM psychomotor skills were learned in a large laboratory room, then that would be the best place to test the students. Switching to another location such as an OSCE room may diminish memory. The second aspect of the reinstatement phenomenon is that once a memory or skill is acquired, changing the location will strengthen the memory of that skill. Thus, performing OMT during the clinical years in a different location will enhance memory retention. COMs without a clinic or clinical rotations featuring OMT will put their students at a disadvantage.

## Simulation-Based Medical Education (SBME)

Simulation-Based Medical Education (SBME) is now an integral part of undergraduate medical education in the 21st century. The history of simulation used in medicine dates back to antiquity when models of human patients were built of clay and stone to demonstrate clinical features of diseases and their effects on humans.[28] In 18th century Europe, cloth birthing simulators were used to teach obstetrical techniques to midwives and surgeons. These early uses of simulation were unsystematic and uncommon. In 1911 the first mannequin for the nursing profession was developed. Named after its creator, Martha Jenks Chase, these "chase dolls" as they were known, underwent continued improvements and were used in schools of nursing up to the 1960s.[29] Specialized mannequins with realistic breathing and heartbeats replaced these dolls in the 1970s. Computerized, gender-specific simulators that bleed, blink, cry, and react in real-time have recently proliferated. Simulation-based learning has long been common and institutionalized in high-hazard professions in aviation, nuclear power, and the military. The technological advances in these fields paved the way for the development of medical simulation

labs (sim labs). Mannequins, such as Resusci-Anne have been used to teach cardiopulmonary resuscitation since the 1960s.[30] This was quickly followed by Sim One, a computer-controlled mannequin simulator, and Harvey, a cardiology patient simulator. In the 1980s and 1990s, these software and hardware systems became much more sophisticated and able to mimic physiological responses and provide feedback in real-time. These innovations have now extended to virtual, internet-based worlds such as Second Life which can be used as another simulation tool.[31] Some low-tech methods of simulation have also been introduced. Objective structured clinical examinations (OSCEs) use actor-portrayed, standard patients to assess history taking, physical examination, and communication skills. SBME also provides an opportunity for medical error and risk reduction while providing opportunities for review without assigning liability, blame, or guilt. SBME also eliminates the use of unconscious, heavily sedated, or recently dead patients as subjects for medical training, thus removing ethical dilemmas that plagued older training methods.

Osteopathic medical schools use Sim Labs for teaching hands-on and invasive procedures; however, no such simulation lab mannequins are available for osteopathic manipulation skills training. In this regard, the chiropractic profession is years ahead having already developed mannequins and wired both students and the mannequins for real-time pressure measurements during high velocity/low amplitude manipulation.[32,33,34]

Even though the osteopathic profession currently lacks mannequins for an OMM sim lab, the profession would benefit from recent research findings in sim lab psychomotor skills training derived from the allied health professions and thereby improve our traditional demonstration/imitation model. For instance, Nicholls, et al in their article on teaching psychomotor skills favor a stepwise approach:

1. Task Analysis and Cognitive Load Awareness – the number of skills taught are limited to avoid overloading working memory and complex skills are broken into sub-parts.
2. Identifying Learner Skill Level and Learning Needs – this is essentially a needs assessment.
3. Pre-Skill Conceptualization – using e-learning technologies to provide information before learning the skill.
4. Demonstration/Visualization – silent rehearsal by the educator of several task elements.
5. Demonstration/Verbalization – brief description of the task steps after the previous step.
6. Immediate Error Correction – immediate feedback.
7. Limiting Verbal Guidance and Coaching – comments are limited to the skill teaching steps.
8. Verbalization/Execution – here the roles are switched and the student describes the tasks and the educator performs them.
9. Verbalization/Performance – the student describes the skill steps before performing them.
10. Skill Practice – ample opportunities for practice to encrypt the task into the motor cortex.
11. Post Skill Execution Feedback – provided at the end of the performance which may come from the teacher or intrinsically from the student.[35]

Taking the lead from the Nicholls article, OMM departments should consider experimenting with the following:

1. Use interactive/clicker sessions to aid pre-skill conceptualization.
2. Limit power point and video presentations in the lab to skills acquisition and not to material best assessed via written exams.
3. Control cognitive load at each lab by limiting the number of techniques taught at each lab. This can be achieved by spreading out the total number of techniques over the total number of lab sessions for each semester rather than basing it only on the anatomical areas covered in a semester.
4. During the video and live demonstration phase of the lab, remove sources of input typically used for written material acquisition such as paper notebooks, smartphones, tablets, and laptop computers.
5. Deliver at least some of the demonstrations or videos in silence at first, forcing the students to rely on observation before a verbal explanation of the technique is given.
6. Improve adjunct-student ratios so that feedback can be immediate.
7. Require verbalization/performance and verbalization/execution as noted above.

Change and experimentation can be challenging, so it should proceed incrementally with departmental and administrative buy-in. Changes in OMM lab teaching methods can be tested on a semester or marking period basis, and organizations like the AAO can use some of their CME offerings as a testing ground for such changes and afterward share their findings with the profession. Part of the difficulty with curriculum change is the concept of the "tyranny of content."[36] It is the fear that

moving towards evidence-based student-centered methods of education will fail to cover all of the course content resulting in decreased student performance and eventually, lower course, faculty, and institutional rankings. However, COMS are already moving forward in this regard. Rocky Vista University College of Osteopathic Medicine (RVUCOM) has been experimenting with adult learning concepts such as self-directed learning as part of its OMM curriculum.[37] The RVUCOM program embraces concepts espoused by adult education expert, Stephen Brookfield. Adult students are trusted to identify their own needs, generate their own goals, identify resources, rate their progress, and evaluate themselves. The Lake Erie College of Osteopathic Medicine (LECOM) offers a three-year curriculum for students interested in family medicine as well as other curriculum choices such as the Lecture-Discussion Pathway, the Problem Based Learning Pathway, and the Directed Study Pathway, a kind of hybrid remote learning option. However, these new curriculum pathways did not change the standard format of the OMM lecture or lab at LECOM.[38] The newly opened Kansas College of Osteopathic Medicine plans to implement curriculum innovations developed by Medical Intelligence10, an artificial intelligence company, but it is unclear how these implementations will change their OMM curriculum.[39]

## Context

Almost 100 years ago, preeminent educational scholar and philosopher John Dewey explored the importance of experience in education.[40] He noted that experience involved an interplay between the student's internal milieu and their external educational environment and that it was the responsibility of the educator to know, in concrete terms, those environmental conditions which would lead to an educative experience. This would include knowing the social, economic, and psychological aspects of their student's lives. Back in the early days of the ASO, this was achieved, in part, by faculty-moderated social, educational, and athletic clubs and the sense of an educational enclave fostered by the positive student-town relationship in Kirksville. Many of the early ASO students barely had a high school education and their attendance at the school was their only college-like experience. These days some of that sense can be achieved by ongoing, scheduled, social interactions with faculty and by expanding new student orientation. Rather than limit student orientation to simply a listing of the requirements for each course over a 1-2 day period, COMs should consider expanding orientation to a week or more and include more intramural and extramural social events with full-time and adjunct faculty and a formal introduction to the osteopathic profession from the perspective of faculty, students, residents, and patients. This is an approach used by Harvard Medical School (HMS) which has introduced student-patient interaction during student orientation and the first-year curriculum.[41] Part of the student's inner life at an osteopathic school is the fact that, for most students, an osteopathic medical education is not their first choice; rather it is a means to an end. Most students can experience the added work of learning osteopathic principles and practice as a burden, something their allopathic counterparts do not have to endure and DO students must endure it dressed in gym attire as they practice on their classmates in the OMM lab. This is part of the lived experience of an osteopathic student and it should be openly addressed during orientation. It should also be reframed as an introduction to skill development in observation, palpation, diagnosis, and treatment during their pre-clinical years, something many MD students don't receive.

Often OMM departments will get reports from their students or residents during their clinical years about the stunning results that osteopathic manipulative treatment (OMT) can often achieve in a clinical setting. These interviews are easy to document with a cell phone and the student testimonials should be uploaded to a central, digital library to which all COMS would have access. Each COM can link its websites to the digital library. These student testimonials would help with *diffusion*, a process by which an idea or innovation is communicated to a social system, with these students/residents acting as change agents.[42] Selections from the video library can be played for students during orientation and a similar video library with patient testimonials should be created by the American Osteopathic Association (AOA). Organized by diagnosis, this public video library would help inform both the general public and prospective osteopathic students about the benefits of OMT from the patient perspective, and can help antidote some of the negative comments about the osteopathic profession so easily found in online student blogs these days.

## The Future

The technology for the future development of osteopathic sim lab mannequins already exists, and given the potential benefits to student learning and expertise development, osteopathic research dollars should be dedicated to the adaptation of this technology from other fields to the profession's unique OMM simulation needs. This would include a mannequin skull with sophisticated servo motors and pressure sensors to mimic the motion of both physiological and pathological cranial patterns, check finger placement, and assess student attempts at treatment. Despite a larger, wealthier, and more integrated osteopathic profession, the pedagogical challenges set by Beal, Allen, Stinson, and Burns remain largely unanswered.

So far, the 21st century has seen a fair number of studies dedicated to sim lab skills acquisition in the health professions. These include reports on core clinical skills, invasive procedures, management of complex clinical conditions, communication skills, and professionalism. *Simulation-based mastery learning* is a form of competency learning in which the results are uniform for each student, but the time required for mastery achievement varies based on the individual.[43] Skill acquisition and knowledge are rigorously measured in relation to high standards. Like most psychomotor skills acquisition paradigms, it is theory-based. Theories are a set of assumptions and ideas that help explicate and predict phenomena, and as such are an integral part of the scientific method. For psychomotor skills training, various learning theories come into play such as the behavioral, constructivist, and social-cognitive.

The elaboration of learning theories as they relate to psychomotor skill acquisition will no doubt continue in the future. However, on a parallel course, the neurophysiological basis for learning, memory, and skills acquisition will also continue to evolve. For instance, Spampinato and Celnik reviewed studies utilizing transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS) to explore the neurophysiological basis for error-based learning, reinforcement learning, use-dependent learning, and cognitive strategies.[44] They point out that skill acquisition likely involves different forms of learning which interact with each other. They identified various brain sub-systems involved in learning, such as the pre-frontal cortex, the primary motor cortex (M1), the basal ganglia, and the cerebellum. This information, integrated with various learning strategies, can provide the basis for not only helping patients with neurological diseases but may help with the development of best practices for osteopathic manipulation skill acquisition. Likewise, Steven Brown, et al studied the neural basis of human dance.[45,46] They used a positron emission tomography (PET) scan to study amateur dancers performing small-scale, bipedal dance steps on an inclined surface and compared the results to auditory, motor, and rhythmic controls. They sought to localize brain areas involved in leg movements synchronized to rhythm and auditory stimuli and to identify brain areas involved in voluntary control of metric movements. They found that motor planning occurs in the frontal lobe where the premotor cortex and the supplemental motor area evaluate signals from other areas of the brain indicating position in space and remembered past actions. These areas communicate with the primary motor cortex which determines which muscles need to contract, with the instructions being sent to the muscle via the spinal cord. Fine-tuning occurs as muscles return signals via the cord to the cerebellum, which helps maintain balance and refine movements. In addition, the basal ganglia collect sensory input from various cortical regions and convey it through the thalamus to motor areas of the cortex.

Osteopathic research should go beyond studying the efficacy of OMT as a therapeutic modality for various conditions, and expand into the science of learning (SL) as it pertains to osteopathic pedagogy. Future neurophysiological findings could then be integrated into osteopathic psychomotor skill acquisition. The goal would be to improve not replace our traditional demonstration/imitation model by using SL insights gleaned from sim lab student evaluation research while also exploring the use of osteopathic sim lab mannequins and virtual reality treatment training.

## Teaching Doctors to Teach

Some MD institutions such as Harvard (HMS) offer a master's degree in medical education as an optional pathway to their MD degree and ATSU offers an online master's degree in education in the health professions.[47] These and other programs reflect the tacit understanding that being an expert physician is not always equivalent to being an expert teacher of physicians. At the University of Connecticut School of Medicine, the internal medicine residency offers an optional Clinician-Educator Track whereby residents have formal experiences that prepare

them for careers in academic medicine.[48] Pre-doctoral Osteopathic Manual Medicine Fellowships (pOMMFs), offered at various COMs, should consider doing the same. One of the unintended consequences of expanding the number of osteopathic medical schools is not only the increased competition for residency positions but also the dwindling number of OMM faculty available to staff the increased number of OMM departments. As a profession, we may be rapidly approaching the point when OMM departments will only be staffed by recent residency graduates with little or no post-graduate, real-world experience. Requiring some health professions education courses during residency training may help to mitigate this potential shortfall.

## Evaluation

The evolution of osteopathic education in the 21st century requires a structure for setting and measuring goals on departmental, school, and professional levels. As the DO and MD worlds continue to grow closer together, we should adopt some of the research-based evaluation methods long used by the medical and allied health professions and by the educational field generally. Sometimes called evaluation science or evaluation and measurement, educational evaluation is a set of techniques used to judge the effectiveness or quality of a training or education program. One such training evaluation paradigm was developed by Don Kirkpatrick; it enumerates four levels of training:

1. Level 1 (Reaction) – The degree to which participants find the training favorable, engaging, and relevant to their jobs.
2. Level 2 (Learning) – The degree to which participants acquire the intended knowledge, skills, attitude, confidence, and commitment based on their participation in the training.
3. Level 3 (Behavior) – The degree to which participants apply what they have learned during training when they are back on the job.
4. Level 4 (Results) – The degree to which targeted outcomes occur as a result of the training and the support and accountability package.[49]

Developed in the 1950s for use in corporate training programs and updated for the 21st century, the Kirkpatrick model has also been applied to the military and government agencies. It can be used by the medical profession in the areas of continuing medical education and undergraduate medical education. Levels 1 and 2 correspond to coursework that medical students are required to take with evaluation via written exams, quizzes, and practical exams, as well as formative course evaluation surveys distributed at the end of each course.[50] Summative evaluations are not used for required courses, especially OMM courses, which are required for school accreditation.[51] Level 3 corresponds more to the clinical years. Attending physicians and other staff members have a list of professional behaviors expected of students and students are graded on how well they model these critical behaviors. Level 4 corresponds to the level of the individual institution or the profession as a whole and the degree to which a targeted outcome is achieved will depend on how the goals are defined.

Many COMs have mission statements that mention the goals of educating osteopathic physicians and providing more doctors to underserved areas of the United States. In terms of the number of new osteopathic graduates, recent efforts by the profession have been a stunning success. According to the AOA, there are almost 34,000 osteopathic medical students, and approximately 134,000 DOs in practice, with about 57% of them providing primary care services.[52] Within the next few years the number of osteopathic teaching campuses will rise to 60 yet despite this increase in the number of schools, a report by the American Academy of Family Physicians in 2015 showed a downward trend in the percentage of DOs practicing primary care.[53] While it is hoped that the growing number of osteopathic physicians may lead to more primary care DOs in rural and underserved areas, recent statistical reports on this issue are hard to find. A 2021 survey by US News found that of the top 50 medical schools with graduates practicing in underserved areas, only 10 were osteopathic.[54]

Level 4 outcome success should also be considered in terms of the definition of an osteopathic physician. Looking beyond the numbers, if our distinctive, holistic or whole-person approach is a consequence of osteopathic principles and practice, it is fair to ask how many DOs practice OMT. The AOA routinely issues a triannual report on professional practices and preferences and the results of the 2018 survey are not good.[55] A sample of 10,000 DOs was randomly surveyed about their use of OMT. Only 1,308 reported using OMT. About 57% used no OMT at all and the percentage of DOs using OMT with 50% or more of their patients was less than 5%. Several barriers to OMT use were identified such as lack of time, lack of reimbursement, lack of institutional

support, and lack of confidence and proficiency. If the goal of the profession is to train physicians who are distinctly different, then these results indicate that changes to Levels 1, 2, and 3 should be made. Increasing the number of DOs who embody not just the knowledge of osteopathy but also the expert skill of OMT should become a new Level 4 goal.

In summary, improving Level 3 and 4 outcomes requires a multi-year, profession-wide vision and incremental systemic changes at various organizational levels. These should include better tracking of OMM faculty numbers and credentials, setting of minimum instructional hours for OMM lab and lecture, expansion of health professions educational opportunities within the profession, and the establishment of a nationwide patient video library to raise public awareness of our uniqueness. Political action to insure reimbursement for OMM is also needed. Improved outcomes at Levels 1 and 2 will require further implementation of the science of learning concepts into the OMM curriculum, rededication of OMM labs as a place exclusively for psychomotor skills training, development of OMM-specific sim lab mannequins, the establishment of a student/resident testimonial digital library and expansion of student orientation to include more interaction with faculty and patients. Organizations such as the AAO can expand the mentorship program on a regional basis connected via remote video feeds when needed. The AAO can use some of its CME offerings as a testing lab for the evaluation of new OMM skill training ideas. Implementation of these concepts will help protect and preserve our osteopathic uniqueness for the remainder of the 21st century.

## Acknowledgments

The authors would like to thank the following individuals for their assistance in the preparation of this article:

1. Thomas J. Van Hoof, MD, EdD, FACMQ
Associate Professor, Schools of Nursing and Medicine
University of Connecticut

2. The staff of the Museum of Osteopathic Medicine at the A.T. Still University.

## References

1. Catalogue of the American School of Osteopathy. Museum of Osteopathic Medicine. https://www.atsu.edu/museum-of-osteopathic-medicine/wp-content/uploads/2019/04/1897-1897ASO.pdf

2. Kirkpatrick D, Kirkpatrick WD. Four levels of Training Evaluation. Alexandria, VA: ATD Press; 2016. (p.39-40)

3. Dewey J. Experience and Education. New York, NY: Frees Press; 1938.

4. Gevitz N. The DO's: Osteopathic Medicine in America. Baltimore, Maryland, The Johns Hopkins University Press; 1982. (p.43).

5. Walter GW. The First School of Osteopathic Medicine. Kirksville, Missouri, Kirksville College of Osteopathic Medicine, 1992.

6. Ward D, RetzK. History of Osteopathic Medical Education Accreditation, *JAOA*, Vol. 97, No. 11, November 1997.

7. Shannon S, Teitelbaum H. The Status and Future of Osteopathic Medical Education in the United States, Academic Medicine, June 2009:84(6).

8. These pathways now include: A. Directly matching into an ACGME transitional year or residency program. B. Matching into an AOA internship and residency track. C. Performing an initial AOA internship followed by matching into an ACGME residency.

9. Boulet J, Gimpel J, Dowling D, et al. Assessing the Ability of Medical Students to Perform Osteopathic Manipulative Treatment Techniques, *JAOA*, May 2004:104(5).

10. Snider K, Seffinger M, Ferrill H, et al. Trainer-to-Student ratios for Teaching Psychomotor Skills in Health Care Fields, as Applied to Osteopathic Manipulative Medicine, *JAOA*, April 2012:112(4).

11. Beal M (ed.). The Principles of Palpatory Diagnosis and Manipulative Technique. American Academy of Osteopathy, Newark, OH:1992.

12. Dunlosky J, Rawson KA, Marsh EJ, et al. Improving Students' Learning with Effective Learning Techniques: Promising directions from cognitive and educational psychology. *Psychol Science Public Int.* 2013;14:4-58.

13. Ebbinghaus, H. Memory: A contribution to experimental psychology (H. A. Ruger & C. E. Bussenius, Trans.). New York, NY: Dover. 1964.

14. Weinstein, Y, Madan CR, Sumeracki MA. Teaching the Science of Learning. *Cogn Res Princ Implic.* 2018;3(1):2. doi:10.1186/s41235-017-0087-y

15. Abbott EE. On the analysis of the factors of recall in the learning process. *The Psychol Rev: Monograph Supplements.* 1909; 11:159-177. DOI 10.1037/h0093018

16. 2018-19 Osteopathic Medical College Contact Hours of Required Clinical Science Instruction. American Association of Colleges of Osteopathic Medicine. https://www.aacom.org/searches/reports/report/2018-19-ContactHrs-of-ReqClinicSciInstr-by-COM

17. Snider KT, Seffinger MA, Ferrill HP, Gish EE. Trainer-to-Student Ratios for Teaching Psychomotor Skills in Health Care Fields, as Applied to Osteopathic Manipulative Medicine. *JAOA.* 2012;4. https://www.aacom.org/docs/default-source/2011-annual-conference/snider_psychomotor-skills-training.pdf

18. Carey B. How We Learn. New York, NY. Random House, 2014: 94-103.

19. Leamnson R. Thinking About Teaching and Learning. Stylus Publishing, Sterling, VA. 1999: 81,57-59,116.

20. Volokitin M, Ganapathiraju P. Osteopathic Philosophy and Manipulation Enhancement Program: Influence on Osteopathic Medical Students' Interest in Osteopathic Manipulative Medicine. *JAOA*, January 2017:117(1).

21. Wiggins G. Ensuring Authentic Performance, Chapter 2. In *Educative Assessment: Designing Assessments to Inform and Improve Student Performance*. Jossey-Bass, San Francisco, CA. 1998:21-42.

22. Ericsson A, Pool R. Peak: Secrets from the New Science of Expertise. Mariner Books, New York, NY. 2017.

23. Author Malcolm Gladwell used the term in his book, Outliers, incorrectly based partly on Ericsson's research and it later became a mainstream expression for achieving expertise in one's field of endeavor.

24. The US Navy Strike Fighter Tactics Instructor Program was established in 1968 to improve US fighter pilot performance during the Vietnam War. Mock dogfights are staged against expert instructors and results are examined by after-action reports, film review, and radar data review.

25. Chila A, Gaines E. Communication for Osteopathic Manipulative Treatment: The Language of Lived experience in OMT Pedagogy. *JAOA.* March 1998:98(3).

26. Beal M (ed.). The Principles of Palpatory Diagnosis and Manipulative Technique. The American Academy of Osteopathy, Newark, OH. 1992:39.

27. Carey B. How We Learn. Random House, New York, NY. 2015:48,51,62.

28. Smith CR, Peng YG. The Evolution and Role of Simulation in Medical Education. *APSF*. https://www.apsf.org/article/the-evolution-and-role-of-simulation-in-medical-education/. Accessed 3/9/2022.

29. Singleton M. Flashback Friday - Practice Makes Perfect: The History of Simulation. UVA School of Nursing. https://www.nursing.virginia.edu/news/flashback-history-of-simulation/

30. Resusci Anne QCP. Laerdal. https://laerdal.com/us/products/simulation-training/resuscitation-training/resusci-anne-qcpr/

31. Medical Training in Second Life. Wall Street Journal. https://www.wsj.com/video/medical-training-in-second-life/9F96D4FB-AFF3-4D08-8F3F-E437AF63B974.html Accessed 3/9/2022.

32. Fleximan Manikin. Tim Young Chiro. https://fleximan.com.au/index.php/fleximan-manikin Accessed 2/26/2022.

33. Life University Center for Chiropractic Research Adjusting Mannequin. YouTube. https://www.youtube.com/watch?v=kVKUmeGyz7c Accessed 2/26/2022.

34. Life University Introduces its Latest Innovation in Chiropractic Technology – PAT. YouTube. https://www.youtube.com/watch?v=-StFUmdFMA0 Accessed 2/26/2022.

35. Nicholls D, Sweet L, Muller A, et al. Teaching Psychomotor Skills in the Twenty-First Century: Revisiting and Reviewing Instructional Approaches Through The Lens of Contemporary Literature. *Med Teacher*, 2016:38:(10).

36. Peterson C, Baepler P, Beitz A, et al. The Tyranny of Content: "Content Coverage" as a Barrier to Evidence-Based Teaching Approaches and Ways to Overcome It. *CBE-Life Sci Edu*. Summer, 2020:19(ar17).

37. Jons-Cox LD. The Self Directed Osteopathic Medical Student: Brining Adult Learning into the Osteopathic Manipulative Technique Lab. *IJOM*. 2014:17. 61-65.

38. Personal communication with LECOM's OMM Department.

39. Putting Innovation Front and Center, Leadership Profile: David J. Ninan, DO, FAOCA, CPE. KHSC. https://www.kansashsc.org/blog/leadership-profile-david-j-ninan-do-faoca-cpe/. Accessed 3/2/2022

40. Dewey J. Experience and Education. Frees Press, New York, NY. 1938.

41. The Harvard Medical School MD Program. Harvard. https://harvard.hosted.panopto.com/Panopto/Pages/Viewer.aspx?id=45ae2151-5b41-4ebe-bd3e-acf701890719. Accessed 2/28/2022.

42. Rogers EM, Elements of Diffusion Chapter 1. In *Diffusion of Innovations, 5th edition.* Free Press, New York, NY. 2003:1-38.

43. McGaghie WC, Harris IB. Learning Theory Foundations of Simulation-Based Mastery Learning, *Soc Sim Healthc.* June 2018:13 (3S).

44. Spampinato D, Celnick P. Multiple Motor Learning Processes in Humans: Defining Their Neurophysiological Basis. *Neuroscientist*, 2021. Jun27(3):246-267.

45. Brown S, Martinez J, Parsons L. The Neural Basis of Dance. *Cerebral Cortex*. August 2006:16(8): 1157-67.

46. Brown S, Parsons L. The Neuroscience of Dance, *Scientif Am,* July 2008:78-83.

47. Master of Education in Health Professions. ATSU College of Graduate Health Studies. https://www.atsu.edu/college-of-graduate-health-studies/academics/master-of-education-in-health-professions Accessed 3/2/2022.

48. Clinician-Educator Track. UConn Health. https://health.uconn.edu/graduate-medical-education/internal-medicine-residency-program/clinician-educator-track/ Accessed 3/2/2022.

49. Kirkpatrick JD, Kirkpatrick WK. Four Levels of Training Evaluation, ATD Press, Alexandria, VA. 2016.

50. Formative evaluations are assessments conducted at any time during a course that is meant to improve the course.

51. Summative evaluations are high-stakes, make-or-break assessments used to determine whether a course should continue or be canceled.

52. OMP Report. American Osteopathic Assocation. https://osteopathic.org/about/aoa-statistics/ Accessed 3/12/2022.

53. Barnes K, Petterson S, Bazemore A. Osteopathic Schools Are Producing More Graduates, But Fewer Are Practicing in Primary Care. *Am Fam Physician*. 2015;91(11):756 https://www.aafp.org/afp/2015/0601/afp20150601p756.pdf Accessed 3/12/2022.

54. Medical Schools with Graduates Practicing in Underserved Areas. US News. https://www.usnews.com/best-graduate-schools/top-medical-schools/graduates-practicing-underserved-rankings Accessed 3/14/2022.

55. Healy CJ, Brockway MD, Wilde BB. Osteopathic Manipulative Treatment (OMT) Use Among Osteopathic Physicians in the United States, *JOM.* 2021;121(1):57-61.