

# Standardizing the Educational Experience of Medical Students Rotating With the Orthopedic Department Regardless of Subspecialty Assignment

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## ABSTRACT

**Introduction:** Musculoskeletal (MSK) conditions are frequently encountered by physicians in emergency and primary care settings. An orthopedic surgery elective provides an opportunity for medical students to develop knowledge and skills in evaluating and managing these conditions; however, increasing subspecialization and limited curricular time may restrict exposure to the breadth of MSK pathology.

**Methods:** A standardized video lecture series covering common orthopedic conditions was developed for use during 2-week orthopedic surgery elective for third-year medical students at a single academic institution. Students completing the elective during May 2023 to April 2024 completed a 50-question pre-rotation knowledge assessment and were instructed to complete the video curriculum during the rotation. The same 50 question assessment was administered at the end of the rotation. Students also completed a 4-item qualitative survey evaluating the perceived educational value of the lecture series.

**Results:** All 24 students (100%) completed the pre- and post-rotation assessments. Post-rotation scores were 4.96 points higher (9.9%) than pre-rotation scores ( $P = .0052$ ). Nineteen students (79%) completed the post-rotation survey; 89.5% agreed or strongly agreed that the lectures improved their general knowledge of orthopedic topics, and 52.6% agreed or strongly agreed that the lectures adequately prepared them for the post-rotation assessment.

**Conclusions:** Students demonstrated significant improvement in MSK knowledge after completing a 2-week orthopedic surgery rotation that incorporated a standardized video curriculum. Survey findings suggest the curriculum enhanced students' confidence in understanding MSK pathology and may help address educational gaps resulting from subspecialty based clinical assignments.

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## INTRODUCTION

Musculoskeletal (MSK) conditions are a common reason for patients to seek medical care, with studies in the United States (US) and Canada estimating that approximately 27% of ambulatory physician visits, 9% to 20% of all emergency department visits, and 21% of urgent care visits involve MSK concerns.<sup>1,2</sup> Despite this high prevalence, many graduating medical students lack the basic competencies necessary to diagnose and treat MSK conditions.<sup>3-7</sup> In a survey at one US medical school, only 24.7% of fourth-year students achieved a passing score on a validated MSK competency assessment.<sup>8</sup> At another allopathic US medical school, just 26.8% of second-, third-, and fourth-year medical students reported that their MSK curriculum was adequate.<sup>9</sup>

An elective rotation in orthopedic surgery provides a critical opportunity to develop MSK diagnostic skills, particularly for students not pursuing residency in orthopedic surgery, who receive limited MSK-focused training. In previous studies,

completion of a MSK elective or orthopedic rotation resulted in a 12% to 24% increase in competency scores related to MSK conditions.<sup>1,3-6</sup> At our institution, only 28% of the 120 students who completed a third-year orthopedic surgery rotation in the past 6 years pursued an orthopedic surgery residency, indicating that most students enter other specialties and must gain baseline MSK knowledge during a brief rotation. Given these findings—along with the high prevalence of MSK complaints and the relatively small number of orthopedic specialists—there is a clear need for

an orthopedic rotation curriculum that provides broadly applicable MSK training across clinical settings.

Prior to clinical rotations, medical students at our institution are exposed to orthopedic topics for a total of a few weeks within a several-month, lecture-based block that covers neurologic and musculoskeletal anatomy and pathophysiology. During the third-year rotation, students are assigned to one orthopedic subspecialty for the duration of their 2-week experience. Subspecialty options for students completing this rotation are arthroplasty, foot and ankle, hand, oncology, pediatrics, spine, sports, and trauma. Because of logistical constraints in coordinating multiple students across services, most institutions, including ours, limit students to a single subspecialty. Although subspecialty assignment should not hinder learning basic orthopedic principles—such as focused history-taking and MSK examination—it does limit exposure to the range of conditions typically tested on standardized medical exams. Consequently, students may not encounter either common or less frequent MSK conditions during their rotation.

The primary aim of this study was to develop a standardized curriculum focused on a variety of commonly tested MSK topics in the United States Medical Licensing Examination (USMLE) content outline and to evaluate the curriculum's effect on student knowledge through pre- and post-rotational assessments. A secondary aim was to assess students' self-perceived confidence in their orthopedic knowledge after completing the standardized curriculum.

## METHODS

### Curricular Context

At the University of Wisconsin School of Medicine and Public Health, all third-year medical students complete a 12-week surgical and procedural care block, which can include a rotation in orthopedic surgery. Of the 174 third-year medical students each year, approximately 20 complete the 2-week orthopedic elective. This elective is assigned as part of a rank list and lottery system. Those participating in the rotation are asked to rank their preference for the seven orthopedic surgical subspecialties (listed above). Students are assigned to one service for the entire rotation, with most rotating on the sports (n=11) and arthroplasty (n=4) services. The curriculum—including the video content and the pre- and post-rotation assessments—was integrated into required online learning modules.

**Table 1.** Utilization of Kern's 6-step Framework for Curriculum Development to Create Video Curriculum

Kern's 6-Step Framework	Online Video Curriculum
1. Problem identification and general needs assessment	<ul style="list-style-type: none"> <li>Multiple studies have shown the inadequacy of musculoskeletal education within medical education</li> <li>This is despite MSK conditions comprising a large percentage of outpatient visits across multiple specialties</li> </ul>
2. Targeted needs assessment	<ul style="list-style-type: none"> <li>There is limited pre-clinical musculoskeletal experience in medical school</li> <li>For students who do rotate, there are minimal MSK didactics including lectures, clinical skills, and anatomic dissection</li> <li>Students' rotations are limited to 1 subspecialty within the field of orthopedics, decreasing exposure to a variety of common MSK conditions</li> </ul>
3. Goals and objectives	<ul style="list-style-type: none"> <li>Increase medical student knowledge within USMLE MSK system content outline (Table 3)</li> </ul>
4. Educational strategies	<ul style="list-style-type: none"> <li>Online video curriculum to be utilized in adjunct to the formal clinical rotation</li> </ul>
5. Implementation	<ul style="list-style-type: none"> <li>Precurriculum assessment to assess baseline MSK knowledge</li> <li>Students will review the 2-part video curriculum at their own pace during their 2-week rotation</li> </ul>
6. Evaluating the effectiveness of the curriculum	<ul style="list-style-type: none"> <li>Evaluation of the immediate effect on MSK knowledge will occur with a postcurriculum knowledge assessment</li> <li>Evaluation of student's perception of the curriculum will occur with a postcurriculum feedback survey</li> </ul>

Abbreviations: MSK, musculoskeletal; USMLE, United States Medical Licensing Exam.

### Box. Clinical Learning Objectives for the Two-Week Orthopedic Surgery Rotation

- Gain exposure to a focused area of orthopedics surgical practice, yet understanding the wide scope of practice of the field
- Participate in obtaining an orthopedic-focused history and communicating verbally and in writing the findings from that focused history
- Demonstrate the ability to perform basic and independent musculoskeletal XR/CT/MRI review
- Participate in the care of patients requiring emergent orthopedic care
- Perform musculoskeletal physical exam skills for the upper and lower extremity
- Participate in an informed consent discussion with an orthopedic surgical patient
- Demonstrate proper technique for skin closure of surgical wounds
- Understand when common orthopedic problems can be managed by primary care physicians and when referral to orthopedic surgery is indicated
- Understand the role of members of the interdisciplinary team, particularly regarding rehabilitation and therapy for orthopedic surgery patients

### Development of Standardized Didactic Curriculum

Curriculum development was informed by Kern's 6-step framework (Table 1). Existing orthopedic rotation learning objectives at this institution were clinically focused without specific knowledge-based objectives (Box). The USMLE MSK topic outline<sup>10</sup> was evaluated to ensure alignment with commonly encountered MSK pathology across orthopedics and other specialties, such as primary care, internal medicine, and rheumatology. Using these learning objectives, 2 approximately 30-minute video presentations were created. The decision to incorporate video presentations into the curriculum was informed by the recent shift toward online learning and mounting evidence supporting the effectiveness of educational videos.<sup>11-13</sup> Additionally, the multimodal education model has proven effective, as evidenced by Noetel et al's

**Table 2.** The United States Medical Licensing Exam (USMLE) Musculoskeletal Content Outline and Curriculum Content

USMLE Content	Curriculum Content
<b>Infectious disorders</b> Gangrene, dry and wet, clostridial myonecrosis ( <i>Clostridium perfringens</i> ); discitis; myositis, infective; necrotizing fasciitis; osteomyelitis; septic arthritis; spondylitis, tuberculous	5 minutes of video discussion on gangrene, necrotizing fasciitis, osteomyelitis, and septic arthritis
<b>Immunologic disorders</b> Ankylosing spondylitis; dermatomyositis/polymyositis; juvenile idiopathic arthritis; rheumatoid arthritis, Felty syndrome; psoriatic arthropathy	5 minutes of video discussion on ankylosing spondylitis, dermatomyositis/polymyositis, juvenile idiopathic arthritis, rheumatoid arthritis
<b>Inflammatory disorders</b> Adhesive capsulitis of shoulder (frozen shoulder syndrome); ankylosis/spondylopathy (inflammatory); bursitis; fasciitis; osteochondritis, osteochondritis dissecans; tendinitis, supraspinatus syndrome, enthesopathy of spine, elbow, ankle; temporomandibular joint disorders; fibrositis, myofascial pain syndrome; synovitis; tenosynovitis; myositis	7 minutes of video discussion on bursitis, tendonitis, synovitis, tenosynovitis, myositis, adhesive capsulitis, rotator cuff arthropathy, epicondylitis
<b>Neoplasms</b> Benign neoplasms (eg, ganglion cyst); malignant neoplasms of bone (eg, osteosarcoma, sarcoma, leiomyosarcoma, rhabdosarcoma); metastases to bone, secondary malignant neoplasm of bone	5 minutes of video discussion on giant cell tumor, osteochondroma, enchondroma, chondrosarcoma, Ewing sarcoma, osteosarcoma
<b>Degenerative and metabolic disorders</b> <ul style="list-style-type: none"> <li>Degenerative/metabolic disorders of bone, tendon, and cartilage: chondromalacia; disc degeneration, herniated disc; Legg-Calvé-Perthes disease; Osgood Schlatter disease; osteodystrophy; osteomalacia; osteonecrosis (avascular), bone infarct; osteoporosis; osteopenia; osteitis deformans (Paget disease of bone); pathologic fracture; radiculopathies; spondylolisthesis/spondylosis (degenerative)</li> <li>Degenerative/metabolic disorders of joints: gout, gouty arthritis, pseudogout; joint effusion; osteoarthritis</li> <li>Degenerative/metabolic disorders of muscles, ligaments, fascia: Dupuytren contracture; muscle calcification and ossification; muscle wasting and diffuse atrophy; rhabdomyolysis</li> </ul>	17 minutes of video discussion on osteoporosis, Paget disease, Legg-Calvé Perthes disease, osteodystrophy, osteomalacia, carpal tunnel syndrome, ganglion cysts, avascular necrosis, spondylolisthesis, radiculopathy/cauda equina syndrome, femoroacetabular impingement, Achilles tendinopathy/rupture, plantar fasciitis, Morton's neuroma, gout, osteoarthritis, rhabdomyolysis
<b>Traumatic and mechanical disorders</b> Amputation and care of amputees; backache, including low back pain; blast injuries; compartment syndrome; hospital-acquired contractures; contusions; dislocations; fractures; sprains, strains; kyphoscoliosis, scoliosis; rotator cuff syndrome; slipped capital femoral epiphysis; dislocation of hip	8 minutes of video discussion on compartment syndrome, shoulder dislocations, hip dislocations, knee dislocations/ligamentous injuries, acromioclavicular injury, common upper extremity fractures (supracondylar humerus, distal radius, scaphoid), slipped capital femoral epiphysis, lower extremity fractures (Lisfranc, Jones, stress fractures)
<b>Congenital disorders</b> Achondroplasia/dwarfism; disorders of limb development ( <i>HOX</i> gene mutation, phocomelia); developmental dysplasia of the hip; dislocation of hip in infantile spinal muscular atrophy; genu valgum or varum; foot deformities (flat foot, valgus/varus deformities); osteogenesis imperfecta; McArdle disease; mitochondrial myopathies	5 minutes of video discussion on developmental dysplasia of hip, genu valgum or varum, foot deformities, achondroplasia, osteogenesis imperfecta
<b>N/A</b>	5 minutes of video discussion on clinically significant upper and lower extremity anatomy (osteology, neurovasculature)

systematic review of 105 studies, which showed that incorporating video modules into existing teaching methods resulted in strong learning benefits.<sup>14</sup>

The videos were designed according to principles of the cognitive theory of multimedia learning, emphasizing segmentation, highlighting of key points, and utilization of both auditory and visual channels to deliver complementary content.<sup>15-17</sup> Video content was compiled by the primary and senior authors, with the creation of the videos completed by the primary author. Videos consisted of slide sets with both written and visual information. Audio lecture associated with the slide sets was then recorded by the primary author. The USMLE topic outline and video content are shown in Table 2. After production, the videos were reviewed by three authors—a faculty orthopedic surgeon, a nonoperative

orthopedic fellow physician, and a medical student—and revised for content organization and clarity based on reviewer feedback.

### Curriculum Implementation and Knowledge Assessments

Students completing the 2-week orthopedic rotation during May 2023–April 2024 were asked to complete a 50-question pre-rotation knowledge assessment and confidence survey prior to their rotation. Assessment questions were written by content experts consisting of faculty from all orthopedic subspecialties at our institution and aligned with the curriculum's learning objectives. Students did not receive scores or the answers to the questions after the pre-assessment.

During the rotation, students were required to complete the video curriculum at their own pace. At the end of the rotation, they completed an identical 50-question post-rotation assessment

to allow direct comparison of pre- and post-rotation performance. These assessments were designed to evaluate levels 1 and 2 of Kirkpatrick's model of training evaluation.<sup>18</sup>

### Post-Rotation Attitude Assessment

A 4-item qualitative questionnaire was created and administered at the end of the rotation to assess students' perceptions of the curriculum and their confidence in understanding common MSK pathology. Items were designed to elicit feedback on the standardized curriculum video series and included:

1. The provided lectures improved my overall knowledge of general orthopedic topics.
2. The lectures provided a foundation of orthopedic knowledge that was useful for my clinical rotation.
3. The provided lectures prepared me well for the post-rotation assessment.
4. The lectures provided a foundation of orthopedic knowledge that will be useful when preparing for my required standardized exams.

Responses used a 5-point Likert scale (strongly agree, agree, neutral, disagree, and strongly disagree).

### Statistical Analysis

A 2-tailed paired *t* test was performed to compare mean scores on the pre- and post-rotation assessments within groups. Statistical significance was defined as  $P < .05$ , and the statistical analyses were conducted in R (R Foundation for Statistical Computing).

## RESULTS

### Pre- and Post-Rotation Knowledge Assessment Scores

All 24 rotating medical students completed both the pre- and post-rotation assessments (100%). The mean score on the pre-rotation score was 31.75 out of 50 (63.5%; SD, 8.35). The post-rotation score increased to 36.7 (73.4%; SD, 5.86). The mean change in correctly answered questions was + 4.96 ( $P = .0052$ ), with a 95% CI of 1.63–8.28. Individual scores and changes are shown in Table 3. Overall, 18 students (75%) demonstrated improved scores.

### Post-Rotation Attitude Assessment

Nineteen students completed the post-rotation survey (79%). Seventeen (89.5%) agreed or strongly agreed that the lectures improved their overall orthopedic knowledge, and 14 (73.7%) agreed or strongly agreed that the lectures provided a useful knowledge foundation for the clinical rotation. A graphical summary is presented in the Figure. Fifteen students (78.9%) agreed or strongly agreed that the lectures were useful for standardized exams, and 10 (52.6%) agreed or strongly agreed that the lectures prepared them well for the post-rotation assessment.

## DISCUSSION

In this study, third-year medical students demonstrated a 10-percentage-point improvement on USMLE content-based MSK

**Table 3.** Pre- and Post-rotation Knowledge Assessment Scores for Each Student (n = 24)

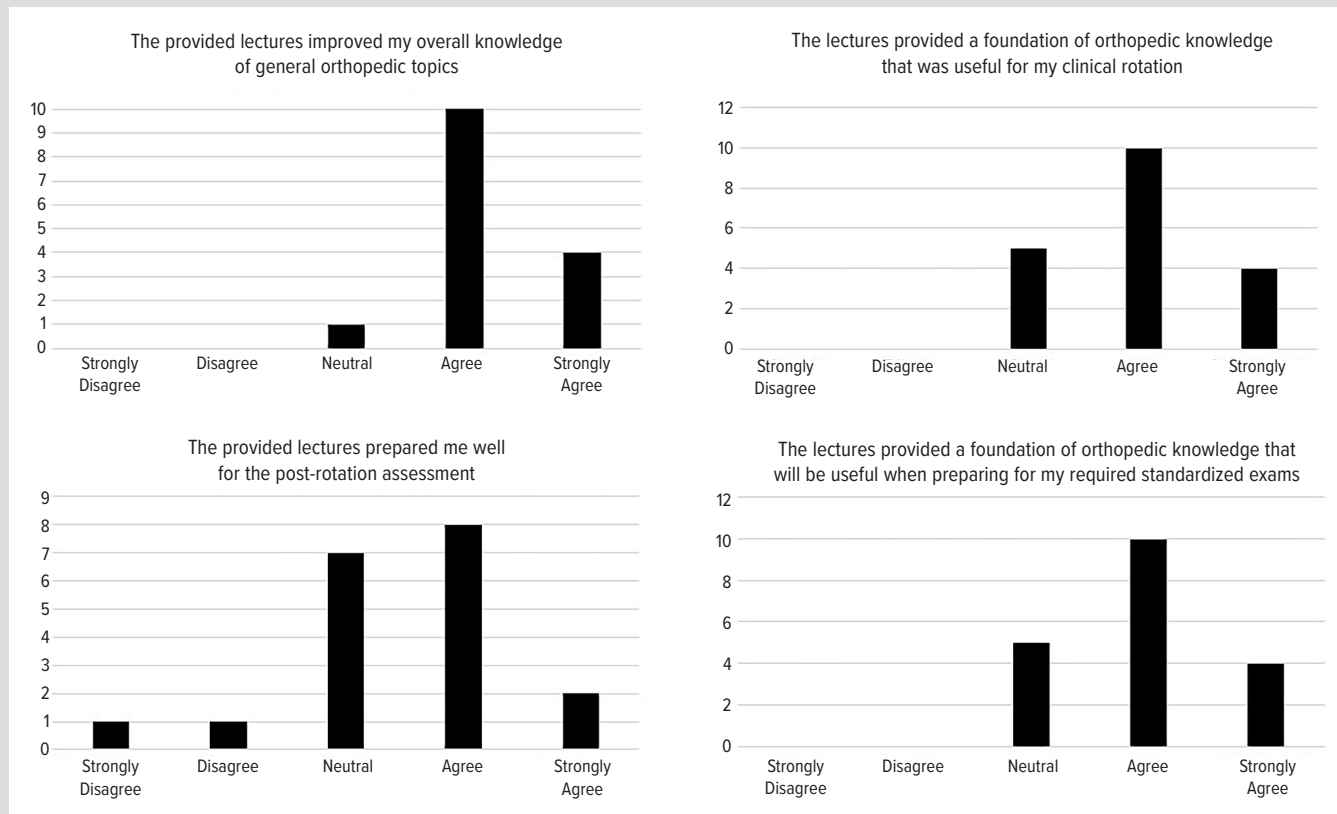
	Pre-rotation	Post-rotation
Student 1	39	45
Student 2	37	40
Student 3	37	31
Student 4	35	32
Student 5	27	40
Student 6	8	37
Student 7	26	32
Student 8	26	30
Student 9	39	38
Student 10	31	32
Student 11	32	36
Student 12	32	39
Student 13	40	42
Student 14	17	31
Student 15	42	38
Student 16	37	41
Student 17	34	38
Student 18	32	43
Student 19	25	19
Student 20	31	34
Student 21	31	38
Student 22	43	46
Student 23	21	39
Student 24	40	40

assessments after completing a standardized online video curriculum in addition to a 2-week orthopedic rotation. These findings are encouraging given the long-standing gaps in MSK education in medical schools,<sup>3-7,8,9</sup> which have prompted efforts to enhance MSK training nationwide.<sup>19</sup>

This curriculum was developed after identifying that short elective rotations, coupled with assignment to a single orthopedic subspecialty, limited students' exposure to common MSK conditions. Broader exposure through a general orthopedics rotation is difficult in academic centers where subspecialization dominates; rotating through all subspecialties would allow only brief experiences and compromise continuity and assessment. Standardized web-based learning offers a practical strategy to ensure consistent exposure to core MSK topics. Prior studies support online modules as effective tools for orthopedic education.<sup>20-22</sup> For example, Back et al found that medical students showed significantly greater knowledge gains and higher satisfaction when learning through narrated PowerPoint podcasts compared to textbook reading.<sup>23</sup> Our findings similarly support online, pre-recorded lectures as beneficial supplements to MSK education during clinical rotations.

A secondary finding was that most students—nearly 90% of survey respondents—indicated that the video lectures improved their overall orthopedic knowledge, and approximately 75%

**Figure.** Bar Graphs Representing the Distribution of Responses to the Four Items Included in the Post-rotation Survey



found them useful for both clinical practice and exam preparation. This suggests the curriculum provided meaningful educational value. Fewer students (52.6%) indicated that the video lectures adequately prepared them for the post-rotation assessment, yet scores still improved, indicating that the curriculum enhanced knowledge without simply teaching to the test. Future curriculum revisions should explore why some students felt underprepared despite scoring better overall.

A standardized curriculum may also benefit other medical specialties with extensive subspecialization, providing a mechanism to deliver core, broadly relevant content despite variable clinical experiences. Future work could evaluate such curricula across additional specialties.

### Limitations

This study has several limitations. Generalizability is limited due to the single-institution design; MSK exposure and clinical structure differ widely among medical schools. A nationally available web-based orthopedic curriculum could help evaluate broader applicability. Another limitation is the sample size. The study population was relatively small, limited by both student interest and elective capacity. Additionally, knowledge was assessed only immediately following the rotation. Because identical pre- and post-rotation assessment were used, score improvements may partially reflect short-term recall of test material ver-

sus an increase in overall knowledge. Longer-term assessments would help determine durability of knowledge gains; Kelly et al showed sustained MSK knowledge retention 1 year after a 1-week instructional course consisting of brief didactic talks and case-based small group.<sup>24</sup>

Finally, it is not possible to isolate the effect of the video curriculum from clinical learning, as all students completed both experiences. However, given the narrow scope of individual subspecialty assignments, clinical experience alone is unlikely to provide comprehensive MSK education. Future studies could include a control group completing the 2-week clinical rotation without supplemental videos or could explore additional dissemination approaches. Selection bias is also possible, as students choosing an orthopedic elective may be more motivated or have greater baseline MSK knowledge, potentially influencing learning outcomes.

### CONCLUSIONS

Medical students' post-rotation knowledge assessment scores significantly improved following a 2-week orthopedic surgery elective that included the standardized video curriculum. Given the increasing subspecialization within orthopedic surgery, implementing a standardized curriculum may be a beneficial addition to medical student rotations, providing exposure to a broader range

of common MSK conditions. While this study has limitations, it highlights an important opportunity to enhance MSK education and demonstrates a feasible approach to supplement learning for students completing an orthopedic surgery elective.

**Financial disclosures:** None declared.

**Funding/support:** None declared.

**Acknowledgements:** The authors thank Heidi Ableidinger for her assistance with data collection and organization and Sam Mosiman for his assistance with figure design and statistical analysis.

## REFERENCES

1. MacKay C, Canizares M, Davis AM, Badley EM. Health care utilization for musculoskeletal disorders. *Arthritis Care Res (Hoboken)*. 2010;62(2):161-169. doi:10.1002/acr.20064
2. Weinick RM, Burns RM, Mehrotra A. Many emergency department visits could be managed at urgent care centers and retail clinics. *Health Aff (Millwood)*. 2010;29(9):1630-1636. doi:10.1377/hlthaff.2009.0748
3. Freedman KB, Bernstein J. The adequacy of medical school education in musculoskeletal medicine. *J Bone Joint Surg Am*. 1998;80(10):1421-1427. doi:10.2106/00004623-199810000-00003
4. Matzkin E, Smith EL, Freccero D, Richardson AB. Adequacy of education in musculoskeletal medicine. *J Bone Joint Surg Am*. 2005;87(2):310-314. doi:10.2106/JBJS.D.01779
5. Day CS, Yeh AC, Franko O, Ramirez M, Krupat E. Musculoskeletal medicine: an assessment of the attitudes and knowledge of medical students at Harvard Medical School. *Acad Med*. 2007;82(5):452-457. doi:10.1097/ACM.0b013e31803ea860
6. Schmale GA. More evidence of educational inadequacies in musculoskeletal medicine. *Clin Orthop Relat Res*. 2005;(437):251-259. doi:10.1097/01.blo.0000164497.51069.d9
7. Harkins P, Burke E, Conway R. Musculoskeletal education in undergraduate medical curricula—a systematic review. *Int J Rheum Dis*. 2023;26(2):210-224. doi:10.1111/1756-185X.14508
8. Skelley NW, Tanaka MJ, Skelley LM, LaPorte DM. Medical student musculoskeletal education: an institutional survey. *J Bone Joint Surg Am*. 2012;94(19):e146(1-7). doi:10.2106/JBJS.K.01286
9. Sabesan VJ, Schrottenboer A, Habeck J, et al. Musculoskeletal education in medical schools: a survey of allopathic and osteopathic medical students. *J Am Acad Orthop Surg Glob Res Rev*. 2018;2(6):e019. doi:10.5435/JAAOSGlobal-D-18-00019
10. *USMLE Content Outline: A Joint Program of the Federation of State Medical Boards of the United States and NBME*. Federation of State Medical Boards of the United States, Inc. and National Board of Medical Examiners. Updated 2025. Accessed May 11, 2024. [https://www.usmle.org/sites/default/files/2022-01/USMLE\\_Content\\_Outline\\_0.pdf](https://www.usmle.org/sites/default/files/2022-01/USMLE_Content_Outline_0.pdf)
11. Green JL, Suresh V, Bittar P, Ledbetter L, Mithani SK, Allori A. The utilization of video technology in surgical education: a systematic review. *J Surg Res*. 2019;235:171-180. doi:10.1016/j.jss.2018.09.015
12. Crawshaw BP, Steele SR, Lee EC, et al. Failing to prepare is preparing to fail: a single-blinded, randomized controlled trial to determine the impact of a preoperative instructional video on the ability of residents to perform laparoscopic right colectomy. *Dis Colon Rectum*. 2016;59(1):28-34. doi:10.1097/DCR.0000000000000503
13. Cheng YT, Liu DR, Wang VJ. Teaching splinting techniques using a just-in-time training instructional video. *Pediatr Emerg Care*. 2017;33(3):166-170. doi:10.1097/PEC.0000000000000390
14. Noetel M, Griffith S, Delaney O, et al. Video improves learning in higher education: a systematic review. *Rev Educ Res*. 2021;91(2):204-236. doi:10.3102/0034654321990713
15. Brame CJ. Effective educational videos: principles and guidelines for maximizing student learning from video content. *CBE Life Sci Educ*. 2016;15(4):es6. doi:10.1187/cbe.16-03-0125
16. Iorio-Morin C, Brisebois S, Becotte A, Mior F. Improving the pedagogical effectiveness of medical videos. *J Vis Commun Med*. 2017;40(3):96-100. doi:10.1080/17453054.2017.1366826
17. Krumm IR, Miles MC, Clay A, Carlos WG II, Adamson R. Making effective educational videos for clinical teaching. *Chest*. 2022;161(3):764-772. doi:10.1016/j.chest.2021.09.015
18. The Kirkpatrick Model. Kirkpatrick Partners. Updated 2024. Accessed June 18, 2024. <https://www.kirkpatrickpartners.com/the-kirkpatrick-model/>
19. Day CS, Ho P. Progress of medical school musculoskeletal education in the 21st century. *J Am Acad Orthop Surg*. 2016;24(11):762-768. doi:10.5435/JAAOS-D-15-00577
20. Mookerji N, El-Haddad J, Vo TX, et al. Evaluating the efficacy of self-study videos for the surgery clerkship rotation: an innovative project in undergraduate surgical education. *Can J Surg*. 2021;64(4):E428-E434. doi:10.1503/cjs.019019
21. Back DA, von Malotky J, Sostmann K, Peters H, Hube R, Hoff E. Experiences with using e-learning tools in orthopedics in an uncontrolled field study application. *Orthop Traumatol Surg Res*. 2019;105(2):389-393. doi:10.1016/j.otsr.2019.01.002
22. Schöbel T, Zajonz D, Melcher P, et al. Podcasts as a teaching tool in orthopaedic surgery: Is it beneficial or more an exemption card from attending lectures? *Orthopade*. 2021;50(6):455-463. doi:10.1007/s00132-020-03956-y
23. Back DA, von Malotky J, Sostmann K, Hube R, Peters H, Hoff E. Superior gain in knowledge by podcasts versus text-based learning in teaching orthopedics: a randomized controlled trial. *J Surg Educ*. 2017;74(1):154-160. doi:10.1016/j.jsurg.2016.07.008
24. Kelly M, Bennett D, Bruce-Brand R, O'Flynn S, Fleming P. One week with the experts: a short course improves musculoskeletal undergraduate medical education. *J Bone Joint Surg Am*. 2014;96(5):e39. doi:10.2106/JBJS.M.00325

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