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## Innovations in Learning and Teaching: How AO “Pivoted” in Response to COVID-19

*Guest Editors:*

*Brett D. Crist, MD, Kodi E. Kojima, MD, PhD, and Chitra Subramaniam, PhD*

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**AO** North America

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# Innovations in Learning and Teaching: How AO “Pivoted” in Response to COVID-19

*Reimagine, Rethink, and Innovate* was the approach core to AO’s success in engaging and delivering quality content at a pace that matched the needs of the learners during the height of the COVID-19 pandemic that prevented face-to-face events and hands-on skills training. Between April 2020 and May 2022, AO education designed and organized educational content that moved beyond the typical “webinar” to deliver online examples of innovation, teamwork, collaboration, and commitment that AO faculty exemplify. To recognize all the arduous work, support, and passion for education that all faculty exhibited, and the successes achieved, the guest editors and AO Trauma North America dedicate this resource to sharing all the events delivered during COVID-19, the lessons learned, discoveries made, and research conducted. True to its mission, the AO volunteers and staff worked tirelessly through the COVID-19 pandemic to reach thousands of learners across the globe from more than 80 different countries. “*Innovations in Learning and Teaching: How AO “pivoted” in response to COVID-19*” gives a glimpse of the different digital offerings and describes the experiences gathered from the faculty, learners, and staff.

The topics highlight innovative educational formats that created and delivered engaging interactive sessions. In addition, technology platforms and tools augmented the learning experiences. Blended learning opportunities became an integral part of what was offered. “Firesides” which are interactive case discussions, and an AO tradition, were redesigned for online delivery. In addition, AO Trauma faculty experimented with new formats such as online journal club, use of digital platform for surgical planning, and an online talk show that included discussions highlighting important concepts.

Learning resources associated with the online sessions were available to the participants in diverse ways including precourse materials, recorded lectures, procedural videos, skills manuals, and references. In addition, blended learning opportunities offered discussion forums and a community network online which made collaboration and peer learning possible. The AO North America YouTube channels, and the podcasts now available through various platforms offer ways to reinforce concepts learned and helped translate knowledge gained to real-world surgical procedures and cases.

All that was accomplished during the COVID-19 years could not have been possible without the dedication of AO staff and faculty. We thank everyone for their efforts and commitment to the organization and to education. Lessons learned, skills acquired, and feedback gathered from learners during this process have further strengthened our abilities to adapt to changes in the landscape and have provided insights into what works and does not work in online learning.

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# COVID-19: A New “Virtual” Era for Resident Education

Harin B. Parikh, MD, Abrianna S. Robles, BS, and Carol A. Lin, MD, FAAOS

**Introduction:** The advent of COVID-19 has significantly affected in-person interactions and, as a result, orthopaedic residency training. In this study, we investigate whether the coronavirus pandemic led to changes in (1) hours spent in didactic education, (2) changes in education modalities, and (3) hands-on skills laboratory utilization by orthopaedic surgery residents.

**Methods:** After institutional review board approval, an anonymous survey was administered to program directors of ACGME-accredited orthopaedic surgery programs who were part of the Collaborative of Orthopaedic Educational Research Group (COERG) through e-mail. All survey responses were stored in a REDCap database. Statistics were performed using paired *t* tests ( $P < 0.05$ ) and chi-square analysis.

**Results:** A 90% response rate was achieved. Residents spent more time on core curriculum during the pandemic (5 vs. 6.3 of working hours,  $P = 0.002$ ). 74.1% of respondents reported making changes to their respective residency rotation schedule. In addition, the percentage of live streams, webinars, and video meetings used increased during the pandemic. The use of hands-on laboratories decreased (94% use rate before COVID-19 vs. 7.4% during COVID-19,  $P < 0.001$ ).

**Discussion:** The coronavirus pandemic significantly altered the delivery of resident education. Although orthopaedic surgery residents spent a larger percentage of time in didactics during the pandemic, we noted a steep decline in hands-on learning in favor of virtual modalities (ie, surgical educational videos and question banks). Additional research is needed as to how permanent these changes have been and how they have affected resident training overall.

**Key Words:** coronavirus, pandemic, resident education, virtual

(*J Orthop Trauma* 2023;S1–S5)

## INTRODUCTION

Residency is a critical time in the development of young physicians. Across all specialties, residents make some of the greatest strides of their careers through immersion in clinical work, didactic education, and independent research endeavors. The coronavirus/COVID-19 pandemic

significantly altered the residency experience. During the peak of the pandemic, residents' valuable clinical experience was decreased to comply with the Centers for Disease Control and Prevention (CDC) recommendations of maintaining 6 feet of “social distancing” and “stay-at-home” orders.<sup>1</sup>

These measures, albeit necessary for promoting resident and patient safety, raised significant concerns regarding the ability to continue high-quality resident education. Training programs were tasked with the responsibility to adapt to these constraints and rethink resident education during this unique time.<sup>2</sup> Many changes were required to maximize resident education while minimizing spread of illness.<sup>3</sup> A large number of residency training programs and medical schools transitioned to a “virtual curriculum” comprising web-based lectures, teaching conferences, case conferences, and question-and-answer sessions.<sup>2,4–8</sup>

The purpose of this study was to quantify the changes that programs implemented in response to the limitations imposed by the pandemic. Our primary aim was to quantify changes in hours spent in resident didactics. Additional aims included investigating changes in modalities used for education and utilization of “hands-on” skills for learning. We hypothesized that all US residency training programs would demonstrate increased use of remote learning tools because of the COVID-19 pandemic and less able to partake in “hands-on” learning.

## METHODS

### Participant Selection and Data Collection

After obtaining institutional review board approval, an anonymous survey was administered to program directors and assistant program directors of American College of Graduate Medical Education (ACGME)-accredited orthopaedic surgery programs within the United States. These individuals were identified through the Collaborative of Orthopaedic Educational Research Group (COERG). Potential study subjects were contacted for participation through e-mail. The survey was conducted between May 2020 to September 2020—during the initial wave of the coronavirus pandemic. Respondents to the survey were considered to consent for participation in this study. Those who did not reply to initial outreach or declined participation were excluded.

### Survey Development and Characteristics

The survey (see **Appendix 1, Supplemental Digital Content 1**, <http://links.lww.com/JOT/B890>) was developed at a sixth grade reading level. The survey was validated for readability and mitigation of bias by an independent reviewer.

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The authors report no conflict of interest.

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The anonymous questionnaire included demographic information such as program location, training setting, and number of residents. Respondents were additionally asked to provide the number of hours spent in core curriculum and rotation-specific didactics before and after COVID-19. Respondents were also asked to comment on the nature of in-person attendance, use of video/live streams, webinars, teleconferences both before and during the COVID-19 pandemic. Finally, respondents were asked which educational materials were implemented before and during the COVID-19 pandemic by residents (ie, hands-on laboratories, textbook/article reading, online modules and videos, question banks, and/or society-based webinars).

## Outcome Variables

The primary outcome investigated was the hours spent in core curriculum didactics and rotation-specific didactics before and during the COVID-19 pandemic. Secondary outcomes studied included the proportion of rotation-specific lectures, residency-wide lectures, journal clubs, morbidity and mortality conferences, and grand rounds spent in-person versus virtually before and during the COVID-19 pandemic. Additional variables included the proportion of in-person versus virtual educational tools and proportion of tele/video conferencing systems used before and during the COVID-19 pandemic. Demographic information including the geographical classification (ie, rural vs. urban), location (regions defined by the United States Census designation), and total number of residents was also collected.

## Data Storage

Survey data were collected and managed using the REDCap (Research Electronic Data Capture) database. Survey responses were only available to study personnel. Respondent identifiers were removed by an independent party before data analysis.

## Statistical Analysis

Descriptive statistics were used to analyze demographic data. Paired *t* tests were used to investigate differences in hours spent in core and rotation-specific didactics before and after the COVID-19 pandemic. All other secondary outcomes were classified as categorical variables and evaluated using the McNemar  $\chi^2$  test for equal proportions with an alpha level of 0.05.

# RESULTS

## Response Rate and Demographic Information

Fifty-four program directors and assistant program directors consented to study participation, leading to a response rate of 90%. Program characteristics are summarized in Table 1. The mean number of residents in each program was 25. 72.2% of programs were located in an urban environment, while 24.1% of programs were located in suburban settings. 35.2%, 27.8%, 27.8%, and 9.3% of respondents were located in the Northeast, Midwest, South, and West geographic regions in the United States, respectively.

**TABLE 1.** Program Characteristics

Number of Residents	N	%/Mean	SD	Min	Median	Max
In each class (PGY-1s)	54	4.91	2.04	2	5	13
Total	54	24.74	10.38	10	25	63
Geographical classification						
Rural	1	1.9				
Suburban	13	24.1				
Urban	39	72.2				
Others	1	1.9				
Geographical region						
Northeast	19	35.2				
Midwest	15	27.8				
South	15	27.8				
West	5	9.3				

PGY, post graduate year.

## Primary Outcome

According to data summarized in Table 2, there was a significant increase in the hours spent in core curriculum didactics during the COVID-19 pandemic (5 hours on average before COVID-19 vs. 6.3 hours during COVID-19,  $P = 0.01$ ). There was no statistical difference between the hours spent in rotation-specific didactics (2.3 hours on average before COVID-19 vs. 1.93 hours during COVID-19,  $P = 0.2$ ).

## Secondary Outcomes

74.1% of respondents reported having to make changes to their respective residency rotation schedule because of the COVID-19 pandemic. Rotation-specific lectures, residency-wide lectures, journal clubs, morbidity and mortality conferences, and grand rounds shifted from being in-person to virtual modalities (Table 3). Of educational tools used, there was a statistically significant decrease in the use of hands-on laboratories with the onset of the COVID-19 pandemic (94% use rate before COVID-19 vs. 7.4% during COVID-19,  $P < 0.001$ ). In addition, independent article reading, online video use, and society-based webinar attendances all had greater use during the COVID-19 pandemic, reaching statistical significance for each (Table 4).

Overall, 70.4% of respondents reported that their respective program did not use any teleconferencing or videoconferencing platform before the COVID-19 pandemic. After the COVID-19 pandemic, all respondents used some form of teleconferencing or videoconferencing. The most widely used platform during the COVID-19 pandemic was Zoom,<sup>9</sup> reported to be used by 79.6% of respondents.

## DISCUSSION

The COVID-19 pandemic significantly affected both patients and the young physicians caring for them. “Stay-at-home” mandates and “social distancing” measures were implemented in many cities and states in hopes of protecting both patients and the medical providers who care for them.



**TABLE 2.** Pre–COVID-19 and Post–COVID-19 Hours Spent in Core Curriculum and Rotation-specific Didactics

Before COVID-19	N	Mean	SD	Min	Median	Max
Hours spent in core curriculum didactics	54	5	1.45	2	5	10
Hours spent in rotation-specific didactics	54	2.3	1.63	0	2	10
During COVID-19						
Hours spent in core curriculum didactics	54	6.3	3.74	2	5	15
Hours spent in rotation-specific didactics	54	1.93	1.7	0	2	8
Paired <i>t</i> test	N	Diff <sup>Δ</sup>	95% CI	<i>P</i>		
Hours spent in core curriculum didactics	54	1.3	0.32,2.31	0.01		

One of the many challenges faced included providing resident education in both a safe and effective manner. In this study, our aim was to better depict this change. Our primary aim was to quantify changes in hours spent in resident didactics. Additional aims included evaluating changes in educational conferences and educational tools used by resident physicians.

Most program directors and assistant program directors (75%) reported making changes to their curriculum during the pandemic. One aspect of this was seen with an increase in hours spent in core curriculum. This may be a result of decreased elective case volumes during the pandemic, thus reduced opportunities for residents to participate in the operating room. Although most of these activities seemed to

**TABLE 3.** Educational Tools Delivery Summary

Pre–COVID-19			Post–COVID-19		
Rotation-specific Lectures	N	%/Mean	Rotation-specific Lectures	N	%/Mean
In-person + virtual	5	9.3	In-person only	1	1.9
In-person only	46	85.2	Live stream only	6	11.1
All virtual (no in-person)	3	5.6	Multiple = all virtual	13	24.1
			Multiple = including in-person	4	7.4
			Teleconference only	1	1.9
			Video meeting only	24	44.4
			Webinar only	5	9.3
Residency-wide lectures			Residency-wide lectures		
In-person + virtual	2	3.7	Live stream only	5	9.3
In-person only	0	0	Multiple = all virtual	13	24.1
All virtual (no in-person)	52	96.3	Multiple = including in-person	2	3.7
			Video meeting only	29	53.7
			Webinar only	5	9.3
Journal clubs			Journal clubs		
In-person + virtual	1	1.9	Live stream only	6	11.1
In-person only	49	90.7	Multiple = all virtual	6	11.1
All virtual (no in-person)	4	7.4	Multiple = including in-person	2	3.7
			Video meeting only	35	64.8
			Webinar only	5	9.3
Morbidity and mortality			Morbidity and mortality		
In-person + virtual	5	9.3	Live stream only	1	1.9
In-person only	45	83.3	Multiple = all virtual	6	11.1
All virtual (no in-person)	4	7.4	Multiple = including in-person	9	16.7
			Video meeting only	33	61.1
			Webinar only	5	9.3
Grand rounds			Grand rounds		
In-person + virtual	9	16.7	Live stream only	9	16.7
In-person only	41	75.9	Multiple = all virtual	9	16.7
All virtual (no in-person)	4	7.4	Multiple = including in-person	1	1.9
			Video meeting only	30	55.6
			Webinar only	5	9.3

**TABLE 4.** McNemar  $\chi^2$  test for Pre-COVID-19 and Post-COVID-19 Educational and Video Conferencing Tools

Additional Required Educational Tools <sup>^</sup>	Chi-sq	df	P
Hands-on laboratories	45	1	<0.001
Independent textbook reading	0.1	1	0.70
Independent article reading	4	1	0.04
Online modules	2	1	0.10
Online videos	5	1	0.03
Online question banks	2	1	0.20
AAOS/society-based webinars	4	1	0.04
Others	NC	—	—
None of the above	0.2	1	0.70
Tele/Video conferencing systems Used <sup>^</sup>			
Cisco Webex	1	1	0.3
Zoom	32	1	<0.001
Microsoft Teams	NC	—	—
Google Meet	NC	—	—
Apple FaceTime	NC	—	—
Others	0.2	1	0.6
None of the above	NC	—	—

continue during the pandemic, the way in which they were delivered also changed. We found that most of the educational conferences shifted from being in-person to virtual means.<sup>9</sup> The educational tools used also significantly changed. Pre-pandemic, 94% of residents reported spending time in hands-on laboratories, which decreased to only 7% after the onset of COVID-19; instead, residents spent time reading articles, watching online videos, or participating in online webinars.

This virtual education was possible due to various technological advances over the past few decades. Reports of web-based conferencing and synchronous distance learning date back to the early 2000s, subsequently deemed efficacious for resident learning.<sup>10–12</sup> In 2000, surgical residency programs began using interactive multimedia programs to encourage the development of technical skills in a safe and low-pressure manner.<sup>13</sup> In the COVID-19 era, even more platforms were created or expanded (ie, Skype, Zoom, and Webex) to facilitate virtual education and collaboration. The quality of surgical simulations has improved and are actively being used by programs to mitigate the consequences of decreased operative caseloads. Some examples of this include creating separate “active” and “remote” factions of residents to accommodate for those who may necessitate periods of quarantine.<sup>4,5</sup> Virtual or VR adaptations of national meetings, industry-related meetings, and surgical training courses have also been implemented.<sup>4,5,8</sup>

Similar trends were reported in the literature across other medical specialties including radiology, pathology, urology, neurosurgery, and ophthalmology.<sup>14–18</sup> General surgery programs implemented a “virtual-based” education including teleconferencing, online videos, and surgical simulations to practice technical skills (ie, silicone tissue for suturing or laparoscopic surgery box trainers).<sup>19</sup> Of note, to the best of our knowledge, no verifiable outcomes measuring the efficacy of these methods have been reported in the literature. Interestingly, residents in European countries were primarily

redeployed to other areas including intensive care units or emergency departments, leading to a decreased amount of time spent in didactic education or skills training.<sup>20</sup> Many residents throughout the world delayed board examinations in need of additional preparation because of time missed from the COVID-19 pandemic.<sup>20</sup>

Many institutions viewed these constraints as an opportunity for innovation and rethinking traditional methods of resident education. One program began the implementation of “smart glasses” for resident and medical student education.<sup>20</sup> This allowed medical students to gain a more first-hand view of fast-paced traumas. From the resident perspective, residents had an opportunity to identify potential areas for improvement in the future. In orthopaedic surgery, institutions began virtual surgical planning courses and virtual reality training programs.<sup>21</sup> Not only does this establish an additional dimension of resident education, it also potentially reduces cost and travel times for similar traditionally conducted in-person programs.

As government and health care restrictions necessitated by COVID-19 are lifted, the question remains as to which of the aforementioned adaptations will persist. A limitation of our study is an absence of long-term data to see whether any or all of the above changes in orthopaedic surgery resident education are maintained. As with many surveys, another limitation is that survey participants may have been subject to recall bias. We hoped to mitigate this concern by administering the survey as close to the onset of the COVID-19 as possible. In follow-up surveys, we hope to quantify whether these virtual modalities have a permanent role in educational activities longitudinally. In addition, we also hope to evaluate preparedness of orthopaedic surgery residents graduating after the COVID-19 pandemic for fellowship and independent practice. Given that the level of “hands-on” educational activities decreased during the pandemic, there may be concern that residents are not receiving the technical skills training needed for safe patient care.

The rise of the COVID-19 pandemic placed tremendous pressure on residency programs to adapt to “social distancing” measures and resident absenteeism due to illness or quarantine protocols. Residency programs across the country responded by relying heavily on a new “virtual” era of resident education. In this study, we found a dramatic shift in time spent from in-person conferences and more hands-on learning to virtual conferences and educational tools. Moreover, many institutions viewed these challenges as an opportunity to incorporate novel technologies in teaching strategies. Moving forward, the question remains as to which of these adaptations persist as mask mandates are now being lifted and prior precautions relaxed.

## CONCLUSIONS

Residency programs have been tasked with adapting to the challenges of the COVID-19 pandemic. In this study, we surveyed 54 US ACGME-accredited orthopaedic surgery program directors and assistant program directors identified through the COERG initiative. We found that due to COVID-19, programs are spending more time in core didactic education rather than clinical activities. There were also

reduced “hands-on” learning opportunities, which became increasingly dependent on more virtual modalities. As the coronavirus pandemic subsides, we will be able to better assess whether virtual resident education will persist.

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# Evolution of AO Trauma North America “Basic Principles of Fracture Management” Education During the COVID-19 Pandemic

Jason Lowe, MD<sup>a</sup> and Carla Smith, MD, PhD<sup>b</sup> on behalf of the AO Trauma North America Education Committee

**Summary:** The Arbeitsgemeinschaft für Osteosynthesefragen (AO) Foundation is a 501(c)(3) nonprofit organization committed to fracture management education. From basic principles to advanced concepts, AO has developed and refined its educational events using adult education theory. The 2020 COVID pandemic required AO Trauma North America to rapidly transition its course format to continue its education mission while responsibly adapting to pandemic-associated travel and social distancing restrictions. The authors present how AO Trauma North America adapted its “Principles of Fracture Management” course during the COVID-19 pandemic, lessons learned from this transition, and the future state of AO Trauma North America Principles of Fracture Management courses.

**Key Words:** virtual education, resident education, COVID

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## INTRODUCTION

The Arbeitsgemeinschaft für Osteosynthesefragen (AO) principles of fracture management have been taught to generations of orthopaedic surgeons by dedicated AO faculty. Currently, the AO Foundation provides education to over 98,000 participants worldwide through over 775 educational events. The pre-COVID-19 AO Trauma North America Basic Principles of Fracture Management course was the product of 50 years commitment to education in fracture care. Since the first North American AO course in 1969, committed surgeon faculty and staff refined and improved the educational experience. Before the pandemic in 2020, this course was an in-person event administered over 4 days, which we will refer to as the traditional course. In the traditional course, participants engaged in an outcomes-based curriculum through lectures, audiovisual resources, demonstration, small group discussion, and practical skills exercises. Given the prolific rise and availability

of digital educational material and the notable shift in the learning styles of younger trainees and surgeons, the AO Trauma North America Education Committee dedicated resources to change the traditional course format to a more modern format, including online content delivery. The COVID-19 pandemic dramatically pushed the “evolution” of the Basic Principles of Fracture Management course to where it is today.

In March 2020, AO Trauma North America faculty began what most believed would be another productive course. Faculty and residents arrived from across North America. Course chairpersons, course evaluator, and faculty discussed forthcoming course curricula improvements. Regrettably, this course coincided with the rapid spread of COVID-19 and the imperative nature of social distancing followed. As such, future, in-person education events were cancelled, but course updates and refinements remained a primary objective. A rapid transition to a virtual education platform was conducted, reviewed, and refined. The purpose of this article was to describe the educational tenets behind AO Trauma North America’s basic principles course curriculum, our transition to an all-virtual format, and the lessons learned during an iterative course improvement process constrained by an evolving global pandemic.

## Traditional Course Format

Before the COVID-19 pandemic, AO Trauma North America “Basic Principles of Fracture Management” courses were offered throughout each region of the United States and Canada with courses geographically located to optimize participant access and minimize travel. To support 120 participants, each course required approximately 32 faculty (21 teaching faculty, 2 chairpersons, 5 new mentored faculty, 3 couches, and 1 evaluator) and 22 support staff and was designed around standardized learning outcomes that used teaching techniques to maximize participant knowledge retention. Enhanced knowledge retention was achieved by combining Dale Learning Pyramid,<sup>1</sup> Kolb Learning Style Theory,<sup>2</sup> and the concept of chunking, which breaks informational sessions into digestible aliquots of information. Courses used these techniques using lectures, small group discussions, demonstration, and practical skills exercises.

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This traditional course curriculum paradigm is based on Dale Cone of Experience<sup>1</sup> (more commonly referred to as the Pyramid of Learning) and Learning Style Theory.<sup>3</sup> Dale first presented his Cone of Experience theory in 1945 where he offered a visual analog to describe and order types of instructional formats-based “concreteness” of each format. As the “Cone” yielded to the “Pyramid,” learner’s capacity for retention was valued according to the teaching format. In the Pyramid, lectures are associated with the least capacity for learner retention and practical exercises with the highest retention. A full discussion of the Learning Pyramid is beyond the scope of this article; however, it is important to recognize that although the Pyramid of Learning is frequently applied to medical education curricula, its validity is still a topic of debate.<sup>4</sup>

Learning Style Theory is the second feature of AO Trauma North America course formats. Learning Style Theory holds that how different adults optimally receive and retain information varies. Many “learning style” systems exist, and again, they are beyond the scope of this article. AO Trauma North America’s curricula are rooted in Kolb Learning Style Theory.<sup>2,5</sup> Conveying course content through audio, visual, written, and hands-on practical skill laboratory sessions; AO Trauma North America courses provide experiential processes that meet the needs of concrete, abstract, observational, and reflective learners, and tie into Dale Learning Pyramid.

The Learning Pyramid and Learning Style Theory structure an experience which facilitates retention and targets optimal learning modalities of individual participants. Maximizing learner retention is challenging as the sheer volume of knowledge within a traditional AO Trauma North America course is substantial. For this reason, course curricula use the educational principle of “chunking.” Chunking is an active process of breaking large complex topics into small, relatable aliquots of information that may be retained and linked to other chunks. This process, not dissimilar to stringing letters to form words, and words to form sentences to create a manuscript or novel, facilitates comprehension and retention of principles of fracture management. For example, absolute stability is 1 of 9 learning modules. Principles of absolute stability is delivered in discrete chunks using 5 ten-minute lectures and supported by 2 skills laboratory sessions, 6 practical laboratory sessions, and 1 discussion group. The volume of content in this 1 module is too great to expect meaningful retention when delivered all at once. When, however, each learning point is taught as a discrete topic and strung together using various teaching media, the theory takes form as a principle of fracture management.

As society masked, socially distanced, and eventually isolated as a result of personal preference, employer’s policy or municipal/state/federal mandates, in-person courses were no longer feasible for the foreseeable future. Committed to continued education, AO Trauma North America’s Education Committee and AO Trauma North America staff began a rapid transition to a virtual course format and curriculum that used the same adult learning principles that made in-person courses successful.

## Virtual Principles of Fracture Management Course Version 1.0, “Basic Principles of Fracture Management Essentials”

AO Trauma North America turned to a virtual course format by leveraging the educational software platform Totara Learning Inc (Wellington, New Zealand) and Zoom Video Communications Inc (San Jose, CA) meeting platforms. The course curriculum remained based on the same learning outcomes and followed the logical progression through topic modules as existed in the traditional in-person course. The course continued to take advantage of chunking. How to provide teaching techniques that could reach various learning styles on a virtual platform was a larger challenge.

To convey base knowledge, required for all advanced small group discussions and practical exercises, lectures were required. Lectures were previously conveyed in a 10-minute lecture and totaled 8 hours of lecture spaced over 4 days in the traditional course. Moving to an online platform, participant completion of 8 and a half hours of videos however could not be realistically anticipated as part of a single, live virtual session over a weekend nor combined in 1 sitting with virtual discussion sessions. This challenge was approached by chunking content into 8-week long modules on Totara platform. Individual learning styles were accommodated through asynchronous educational opportunities provided through prerecorded lectures, module-based blogs, live AO faculty discussion forums (office hours), and a required weekly module review (fireside chat). Fireside chats were weekly 1-hour live virtual sessions in which faculty would summarize each module’s learning outcomes using standard presentations, faculty debates, or participant game theory formats (question/answer).

Live virtual fireside chats and 3 small group discussions held on weeks 1, 3, and 5 constituted the synchronous portion of the course, providing direct interaction between faculty and participants. In this modernized format, participants had the concrete module structure mixed with the flexibility to watch prerecorded video lectures, respond to learning platform blog posts, and attend one of several virtual “office hours” at their convenience.<sup>6</sup> Participation was motivated by requiring video lecture completion to attend the live fireside chats and completion of the fireside chat to progress to the next module. Participation in blog posts and offices was encouraged, but optional. Eighty percent module completion was required to be able to participate in the practical skills session. The eventual plan was for participants who successfully completed the virtual component to attend a face-to-face practical skills session over 2 days to successfully complete the course.

With the addition of blog posts, office hours, and fireside chats, the AO Trauma North America faculty sought to create opportunities that would meet the needs of a new generation of learners, consistent with Kolb Learning Theory, and help facilitate content retention. During fireside chats, module leaders were encouraged to experiment with various teaching methods including gaming, audience response questions, and point counterpoint debates.<sup>7</sup> At the conclusion of each module and at the end of the course, a faculty debrief was performed and participant evaluations solicited.

From August 2020 to October 2021, 792 residents completed the 8-week virtual basic principles course. Faculty, staff, and participant feedback was solicited during each course. Initial responses showed that recorded lectures, which could be viewed at the participant’s convenience, were well received. Achieving protected time from programs was reported as a significant challenge by residents and all faculties. Many participants reported that their learning time was not protected. Several learners were required to simultaneously perform call responsibilities and surgical cases during live virtual sessions. Faculty also had difficulty balancing the demands of precourse meetings, premodule discussion groups, fireside chats, and debriefs over 8 weeks with their professional and personal lives. In addition, faculty and AO Trauma North America staff observed challenges connecting with and engaging participants. Faculty noted the current course format, which required significantly more faculty for each course owing to competing life/professional obligations, resulted in inconsistent faculty–participant pairing for sequential discussion groups on weeks 1, 3, and 5. Inconsistent faculty–participant pairing was believed to be an obstacle to developing interpersonal relationships and trust between the faculty and participants necessary for productive small group discussions. Objectively, 99% participated in the module blogs, and less than 10% participated in office hours. After consistent feedback was available, iterative course improvement planning began and focused on (1) course time obligations for both participants and faculty and (2) participants’ engagement in virtual interactive exercises.

### Virtual Principles of Fracture Management Course Version 2.0

The second iteration of the basic principles virtual course format is shown in Fig. 1. To address course time commitment for faculty and participants alike, the course’s synchronous virtual sessions (fireside chats and small group discussions) were condensed into a 2-day weekend event. This step reduced the precourse meetings from 9 to 2 and allowed participants and faculty to request a finite aliquot of protected time intended to respect professional and personal life obligations. With this change, the weekly module tempo was discarded, but the chunked curriculum remained. Virtual lectures became available 6 weeks before the synchronous virtual session. These videos could be completed at any time, but 100% of the video lecture was still required completion to participate in the live event, and participants were required to attending 80% of the 2-day live virtual weekend modules. This paradigm preserved participant choice and autonomy of learning schedule. To accommodate more concrete learners, a recommended schedule was provided (Fig. 2). Corresponding with the recommended lecture schedule, course faculty held weekly case discussions through Totara course blog and held weekly “office hours” to discuss module learning outcomes and answer questions.

The “live” two-day virtual session itself was held on a weekend. It required a 5.5-hour commitment each day from participants. Faculty could attend the entire session, but faculty schedules were limited to a 5-hour obligation over 2 days

for any 1 faculty member. The new format sought to maintain active resident engagement throughout the live virtual session, by using teaching methods found to be successful in the virtual course’s first iteration. Specifically, fireside chat formats that required participant active engagement (online voting, virtual question and answer, faculty debates, and gaming formats) were encouraged. These changes resulted in a newly formatted daily schedule that required active participant interaction in each module (Fig. 1). The 2-day condensed format also allowed residents to be matched in consistent discussion groups. As discussed previously, this step was designed to foster trust and more productive case discussions.

After the initial 2-day virtual course, which was held in November 2021, course faculty provided feedback. Course time conflict with personal and professional responsibilities was much improved. Connecting with participants during small group discussions was easier, but consistently described as “not as good as in-person.” Objectively, resident participation in asynchronous office hours was less than 5%, and 100% completed the video lectures. We did observe 97% participation in all fireside and small group discussion sessions, which was an improvement from the first iteration. The 2-day blended course format remained in use until the fall of 2022.

By the time the pandemic was into its second year, just over 1000 residents had completed the virtual course but had not yet participated in the practical skills exercise component. A clear end to travel bans or social distancing was not in sight, which represented a gap in the educational process. In the spring of 2021, AO Trauma North America’s Education Committee piloted a locally driven practical laboratory course. Operating within their local institutional guidelines

AONA Basic Course 2 Day Virtual-Live Session Agenda					
Weekend day 1			Weekend day 2		
Time	Activity	Links in Totara	Time	Activity	Links in Totara
6:00-6:20	Introduction, goal review	Zoom Link #1	6:00-6:20	Introduction, Goal review	Zoom Link #1
6:20-7:05	Fireside Chat 1 (Soft tissues and bone healing)		6:20-7:05	Fireside Chat 1 (Articular fractures)	
7:05-7:15	Break	Zoom Link #2	7:05-7:15	Break	Zoom Link #2
7:15-8:30	SGD 1 (Soft tissue and Bone Healing)		7:15-8:00	Fireside Chat 2 (Poly-Trauma and Pelvis)	
8:30-9:30	Fireside Chat 2 (Absolute/Relative Stability)		8:00-9:15	SGD 3 (Articular Fractures)	
9:30-9:40	Break	Zoom Link #3	9:15-9:25	Break	Zoom Link #3
9:40-10:25	Fireside Chat 3 (Diaphyseal Fractures)		9:25-10:05	Fireside Chat 3 (Special Fracture Problems)	
10:25-11:40	SGD 2 (Diaphyseal Fractures). SG leaders to do wrap up		10:05-11:00	Post-Test and wrap up	

FIGURE 1. Two-day virtual blended course schedule.



Basic Principles of Fracture Management Essentials Pre-Course					Module's Self Directed Study	
	Week 1	Week 2	Week 3	Week 4	week 5	Virtual Live Session
Date	October 18-24	October 25-31	November 1-7	November 8-14	November 14-19	November 20 & 21
Modules	Soft tissues and Bone Healing	Absolute Stability Relative Stability	Diaphyseal Fractures	Upper Extremity Articular Fractures Lower Extremity Articular Fractures	Polytrauma and Pelvis Special fracture Problems	course
LECTURE VIDEO TIME	1HR 7MIN	2 HR	1 HR	1 HR 38 MIN	2 hr	

**FIGURE 2.** Example of self-directed study schedule a resident can follow to budget time and chunk learning topics.

AO Trauma North America faculty from 8 residency programs administered practical skills sessions within their own institutions. These laboratory sessions were supported by AOTNA who shipped laboratory instruments, implants, and synthetic bone models to each site. Laboratory demonstration videos were supported by AO Trauma North America staff using Zoom. Using this practical laboratory course design, AO Trauma North America was able to maintain small cohorts faculty and participants who both knew each other and could minimize potential spread of the COVID-19 virus. Nine centers participated in regional practical courses, and while successful, this iteration was not long lasting.

As COVID-19 vaccinations expanded and novel treatments improved survival, institutional travel bans subsided. The principles course was now poised for another transition, which capitalized on lessons learned from the virtual course and brought a return of the best aspects of the traditional, pre-pandemic course practical laboratory sessions, skills laboratory sessions, and direct faculty-participant interaction and mentoring.

### Blended Principles of Fracture Management Course

In September 2021, AO Trauma North America began the Blended Principles of Fracture Management Course format for both basic and advanced courses. This course paradigm consisted of the prerecorded video lectures, a 2-day live virtual session consistent with version 2.0 and included discussion groups and fireside chats as well as a live, in-person, 1-and-a-half-day practical skills session. Based on recurring feedback from participants and faculty, “office hours” and blog posts were removed. In addition to de novo participants, there were 1300 participants who had completed the virtual course components during the prior 18 months but had not completed the in-person practical session. To accommodate this need, practical courses were again scheduled regionally for ease of travel and 1–2 laboratory sessions were scheduled at each location. AO Trauma North America maintained mandatory masking and social distancing to comply with CDC and local facility rules. Feedback was again solicited from participants and faculty.

The in-person practical skills course curriculum and tempo left little time for participant reflection. This differed from the classic 4-day where course participants had time between lectures, laboratory, and discussion sessions to

reflect and engage with faculty about any lingering questions. In addition, the new format was more demanding of faculty. The absence of lectures meant faculty was engaged in direct and continuous participant interaction over a day and a half to 3 days. Additional feedback revealed a lapse in basic knowledge retention provided by lectures viewed months in advance of a practical exercise. These observations revealed a need to balance the in-person course in a way that revisited critical concepts and provided time for reflection of faculty and participants. As a result, beginning in September 2022, AO Trauma North America launched the newest version of the Blended Principles of Fracture Management course. Unencumbered by the strict restrictions necessary during the height of the pandemic and drawing on successes and challenges of previous iterations, the new courses will include (1) participant self-study including required completion of video lectures and (2) a 2-and-a-half day in-person course complete with select live lectures focusing on key principles, small group case discussions, and practical skills exercises. Future practical laboratory sessions will feature a new format that will require participants to apply knowledge delivered in self-study to clinical vignettes before selecting and applying fixation schema. This blended format captures the benefits of asynchronous learning in advance of the in-person course, while maintaining the benefits of direct in-person interactions between participants and faculty.

### SUMMARY

The COVID-19 pandemic forced AO Trauma North America to rapidly transition into a virtual course format. Members of the Education Committee created a new course format while adhering to adult educational principles of Dale and Kolb. Committed to ongoing improvement, the Education Committee sought and acted on near-continuous feedback from participants and faculty. Adopting a flexible and agile mindset allowed dedicated AO Trauma North America staff, the AO Trauma North America Education Committee members, and AO Trauma North America faculty to facilitate iterative course improvements and simultaneously address the changing challenges presented by the COVID-19 pandemic. Using lessons learned, the AO Trauma North America Principles of Fracture Management course is now a blended course taking the very best aspects of the virtual course experience and combining them with the traditional in-person AO Trauma North America course.

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# Innovations in Learning and Teaching: How AO Adapted in Response to COVID-19 AO Journal Club

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**Summary:** Journal clubs have been an integral part of medical education since their conception by Sir William Osler in 1875 at McGill University. They now serve as a cornerstone of nearly all orthopaedic residencies' core curriculum. Journal clubs educate the participants on the current literature and how to critically appraise the literature to make sound evidence-based medical decisions. The Arbeitsgemeinschaft für Osteosynthesefragen (AO) foundation has been at the forefront of orthopaedic trauma education and is known for its didactic courses, webinars, discussions, and practical exercises. To advance its educational offerings, a virtual monthly webinar entitled "AO Trauma North America Journal Club" was created. The objective of this webinar was to showcase landmark historic and contemporary orthopaedic trauma articles in a unique interactive format. The authors are recorded answering specific questions about their articles; these recordings are then grouped based on subject and presented in a live webinar that includes a question and discussion panel with all of the authors. As of February 2022, 20 sessions have been completed encompassing various topics in upper and lower extremity trauma. Registration and viewership for the events have been consistently high (average 475, 183 persons, respectively) with growing numbers of viewers engaging by the podcast download. There is an average of 1020 views (509–2532) of the recordings per club on the AO Trauma North America YouTube channel. The global reach continues to expand as the podcast has downloads from over 70 countries. The AO Trauma North America Journal Club provides a unique opportunity to educate the global orthopaedic trauma community and promote evidence-based decision-making.

**Key Words:** journal club, AO, trauma, virtual education, didactics  
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## INTRODUCTION

The Arbeitsgemeinschaft für Osteosynthesefragen (AO) foundation is a nonprofit medical organization that is dedicated to advancement in the surgical treatment of bone pathology through educational resources and research innovation. Founded in 1958, the AO's main objective is to educate providers on how to improve patient outcomes in the treatment of musculoskeletal trauma and other bone disorders. Through their didactic courses, discussions, and practical exercises, the organization has become the leading education provider to orthopaedic surgeons and other health care professionals around the world. The AO offers around 775 educational events annually that are attended by over 98,000 participants worldwide.<sup>1</sup> According to the AO website, "to date, more than 460,000 health care professionals from 1600 countries have participated in AO courses."<sup>1</sup>

Journal clubs allow for orthopaedic surgery residents, fellows, attendings, and other support staff to stay up to date on published articles and current literature. Sir William Osler started the first journal club in 1877 at McGill University, initially as a way to distribute unaffordable periodicals. Slowly through the years, it evolved to a forum that allows for the analysis of various research studies, promotion of staying current on literature, and encouraging the practice of evidence-based medicine.<sup>2</sup> Journal clubs have proven to be more impactful on medical trainee education in comparison with the traditional classroom teaching seminars. A randomized controlled trial was conducted in 1988 to investigate the utility of journal clubs in medical education. Forty-four medical interns were randomized to attend a journal club or a control classroom seminar. According to the study, by self-report, 86% of the medical interns in the journal club group improved their reading habits in comparison with 0% in the control group. Those in the journal club group also reported improvement in epidemiology and statistics, as well as the use of the information in the journals in their medical practice.<sup>3</sup> The journal club format allows for increased interest in research, ultimately leading to the translation of current literature into evidence-based practice. Despite being developed over 100 years ago, journal clubs have remained essential in the education of orthopaedic surgeons and other medical trainees. As the world became faced with the devastating COVID-19 pandemic, institutions were forced to amend the way they hosted their in-person learning sessions. An

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increased demand for frontline clinicians, lockdown restrictions, and limitations on in-person gatherings led to a need for virtual educational opportunities. The use of alternative education tools such as virtual journal clubs, online procedure simulations, prerecorded didactic lectures, and telemedicine became the standard.<sup>4</sup> These alternatives aided in the continuation of education in compliance with COVID-19 social distancing protocols. By creating virtual educational opportunities, some sense of normalcy in graduate medical education was able to be maintained during an unprecedented time in medical training. This article aims to discuss how the AO Trauma North America journal club affected orthopaedic education in the face of the COVID-19 pandemic.

### FORMAT OF THE AONA JOURNAL CLUB

The AO Trauma North America (NA) journal club was developed to address the need for virtual educational opportunities in the face of the COVID-19 pandemic. The series occurs monthly for 1-hour sessions and consist of interviews with authors of influential orthopaedic trauma articles. The purpose of the series is to provide a live forum to discuss the purpose, design, and impact of the study, as well as how to implement the key takeaways into practice.<sup>5</sup> The AO Trauma North America Journal Club Advisory committee selects a variety of topics for discussion that encompass many of the common themes seen in orthopaedic trauma practice. Moderators then select landmark articles related to the month’s specific topic and interview the primary authors. AO faculty members are notified of that month’s topic and are allowed to sign up as lead moderator or comoderator. The moderators are asked to have participated in previous journal club sessions to better understand the format and flow, facilitating seamless discussion. Participants can submit their questions to the moderators during the session, to which the authors will be able to provide answers and additional

comments. Participants that view the recorded sessions may submit their questions in the comment section of the videos, allowing for quality discourse. Each session is recorded to provide access and increase reach to those that may not be available for the live webinar. Topics are based on anatomic location/injuries and have previously included pediatrics, infections, scapula, acetabulum fractures, and nonunion. The sessions are open to the global community of orthopaedic surgeons, fellows, residents, and anyone with an interest in orthopaedic trauma free of cost to all attendees. The monthly series allows for critical analyses of orthopaedic trauma research among orthopaedic trauma community members, leading to improved evidence-based orthopaedic trauma practice.

### VIEWERSHIP AND PARTICIPATION

As of February, 2022, there have been a total of 15 different journal club sessions, with the first session occurring on September 22, 2020. The inaugural session had 59 downloads. In 2021, there was a steady increase in both the number registered and the number who actually attended the session (Fig. 1). In its entirety, 2021 saw 5387 people register for the virtual journal club, with 2419 people who actually attended. The global reach continues to expand as the podcast has downloads from over 70 countries. 40.4% of downloads are from the United States. Saudi Arabia had 14.9% of downloads, and the United Kingdom had 7.1%. 46.1% of those that downloaded the podcast used Spotify to tune in, whereas 44% used Apple podcasts to tune in. 92.2% of podcast listeners used a mobile app, whereas 2.8% used a smart home device (Fig. 2). The episode recordings are uploaded to YouTube (Google LLC, San Bruno, CA) and podcast listening formats by the next day, allowing accessibility to those who are unable to attend the live session. The online format of the AO Trauma North America journal club, in addition to the

Date	Topic	Registered	Actual	Podcast Downloads
<b>2021</b>				
January 19	Humeral Shaft	426	183	
February 23	Pelvis (2)	661	248	3
March 30	Calcaneus Fractures	736	278	13
April 13	Clavicle Fractures	689	281	24
May 18	Distal Femur Fractures	696	266	15
June 15	Distal Humerus Fractures	622	228	15
August 17	Young Femoral Neck Fractures	494	217	18
September 21	Talus Podcast		370 YouTube Views	15
October 26	Femoral Shaft Fracture	519	154 in attendance Podcast/YouTube uploaded	35
November 30	Lisfranc	414	139	23
December 14	DCO vs ETC	130	55	38
<b>TOTAL</b>		<b>5,387</b>	<b>2,419</b>	

FIGURE 1. Journal club attendance.

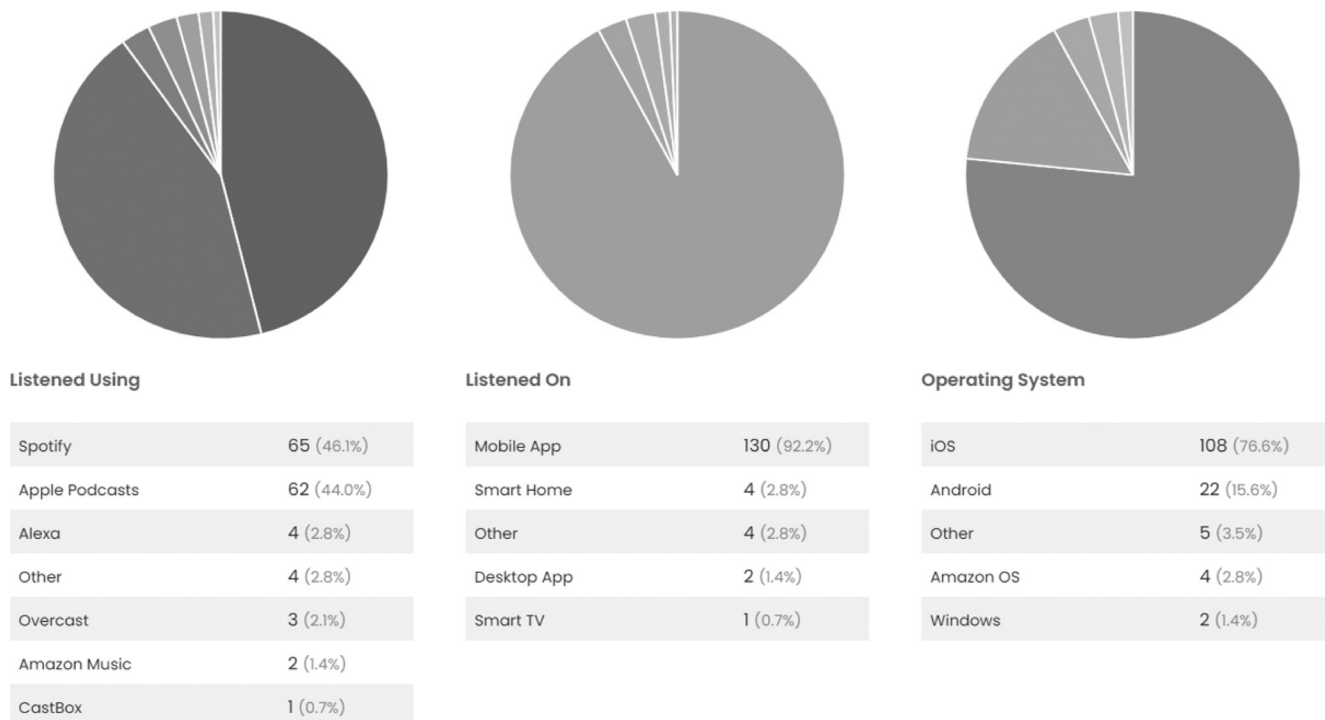


FIGURE 2. How AONA journal club participants listen.

recorded podcasts and YouTube videos, gives those that are interested an opportunity to access the session at a time that works best with their schedule.

### BENEFITS AND LIMITATIONS OF THE VIRTUAL JOURNAL CLUB

Having a means of virtual education became of utmost importance during the COVID-19 pandemic. As we start to move toward in-person learning opportunities, it is important to evaluate the utility of the journal club moving forward. For one, the virtual format allows for an international reach. Attendees can tune into the live sessions or obtain the information through YouTube or podcast. Through the question and answer periods in the live sessions, attendees are able to connect, network, and collaborate with as well as learn alongside orthopaedic surgeons from all over the world, an opportunity that would not be possible in a fully in-person format. Because the sessions are recorded, people are afforded the ability to attend the session on their own time and can listen independently. This allows for continued education despite the hectic schedule of orthopaedic surgery training and practice. When mentioning the benefits of this virtual format, it is important to also analyze the challenges and weaknesses. With more and more telemedicine, virtual meetings, classes, and other learning opportunities, it is possible that by adding another virtual experience the attendee may become overburdened by virtual formats. Research conducted by psychologists at the University of Basel in Switzerland demonstrated that repeated exposure to computer, tablet, and/or smartphone screen is linked to various stress-related symptoms, ultimately contributing to exhaustion and burnout.<sup>6,7</sup> Although it is a

benefit that the sessions are recorded, those that miss the live session miss out on a chance to participate in a live discussion. Any questions, comments, or concerns the attendee has may go unrecognized solely because of the nature of the virtual format. As the numbers show, the number of people both registering and attending the sessions is slowly declining. This is likely due to increased virtual education options, as well as a return to in-person didactic sessions. Currently, the Journal Club is being advertised through mass emails to AO members. To increase viewership, it will be necessary to improve advertising of the sessions and recordings to both AO and non-AO members.

### CONCLUSION

The AO Trauma North America Journal Club has a large footprint on the global orthopaedic trauma community. With over 100s of viewers per webinar and 2000 downloads among 70 plus nations, the AO Trauma North America Journal Club continues to be an effective virtual modality to educate orthopaedic surgeons on evidence-based surgical care in the face of the COVID-19 pandemic.

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# Engaging Learners Through AO North America Fireside Series

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**Summary:** As the COVID-19 pandemic began, the AO North American community needed to pivot to having a virtual presence. In a very short period of time, our leaders and educational partners designed an intense online asset to engage residents, fellows, and North American practicing surgeons through case and literature-based discussion. The idea was to provide a pragmatic approach to working through complex fractures relevant to the learners. One moderator and 2 faculty members lead the charge. Each session included a recent or impactful journal article related to the topic; at times, the faculty member was the author. It was important for us not to mimic the AO Trauma North America Webinars, but instead instructing our faculty to have it as interactive as possible. This included polling questions and Q&A during the talks. Twelve sessions occurred from April through July 2021. The series was titled: *AO Fireside: Working through Problem Fractures Together*.

**Key Words:** AO Fireside, fracture, limb reconstruction, case-based, online

(*J Orthop Trauma* 2023;S15–S18)

## INTRODUCTION

*Arbeitsgemeinschaft für Osteosynthesfragen (AO) North America* takes its mandate seriously: “to further the goals of the AO Foundation by promoting excellence in patient care and outcomes in trauma and musculoskeletal disorders. AO North America’s purpose is to be a validated, credible resource for the continuous professional development of surgeons. We achieve this by creating a community that learns from and with each other.”

AO Trauma North America sits beneath AONA in the organizational chart and is focused primarily on the subject of fractures and posttraumatic reconstruction related to orthopaedic trauma. Leveraging the existing roster of faculty, educational consultants, and administrative personnel, we were able to design an effective online forum for engaging with our North American surgeons. As the COVID-19 pandemic began, the AO North American

community needed to pivot to having a virtual presence. In a very short period of time, our leaders and educational partners designed an intense online asset to engage residents, fellows, and North American practicing surgeons through case and literature-based discussion. The idea was to provide a pragmatic approach to working through complex fractures that were relevant to the intended learners. Initially planned to be a 3-session webinar, we used strategies to maintain high-level enrollment and participation, and subsequently, it was renamed to a *series*. Namely, having it occur in the late evenings for Eastern time zone, while ensuring that surgeons from the west coast were likely to be performed with their work day. In addition, having a consistent day of the week that would not interfere with other AO, Orthopaedic Trauma Association offerings, and having it repeat on a weekly basis to create reliability and rhythm. Our design and execution was successfully received through the 12 sessions, and it will be described herein. Of note, a 2022 8-session iteration of the AO Fireside Series has been just completed given the large success of the first year (2021).

## METHODS

### Development Sequence

The 2 course chairpersons engaged in brainstorming discussions over email and through online meeting platforms to discuss the lack of in-person events because of the ongoing COVID-19 pandemic during calendar year 2021 (Fig. 1). The learning need was apparent, and we had an opportunity to connect with practicing orthopaedic surgeons, build on the AONA brand, and simultaneously include our current AO Trauma North America faculty roster who loved to teach with limited opportunities. A subsequent online meeting occurred with multiple key AONA team members including chief learning officer, director continuing medical education, project development coordinator, media resources, and online/digital program coordinator. To optimize meeting efficiency, we circulated an agenda with focused tasks. We sought to define our purpose and ensure we had AONA administrative support needed to generate resolutions and move to next steps quickly. A proposal was sent to the AO Trauma North America Educational Committee for approval.

### Topics

Our initial aim was to target practicing surgeons (formerly known as community surgeons). Based on feedback

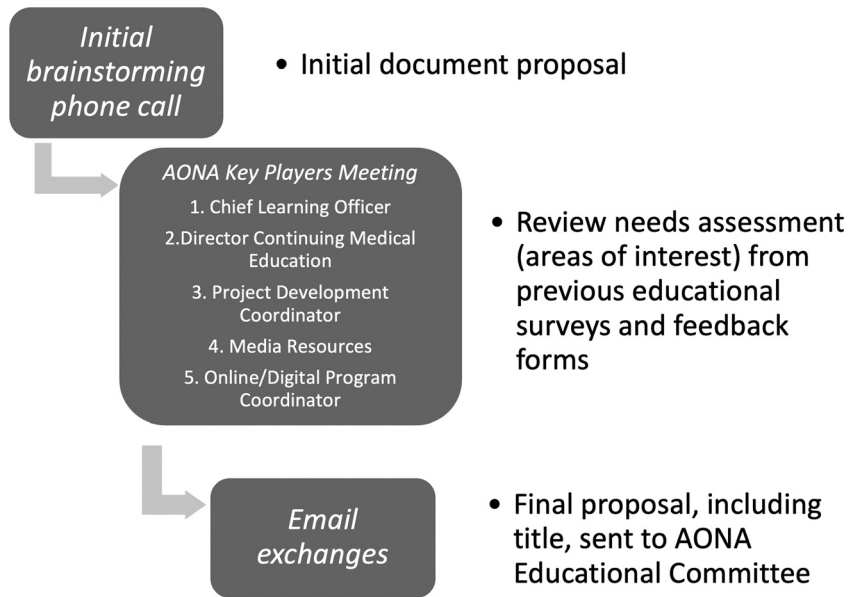
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B. D. Crist: AO Trauma Education Committee Member. The remaining author reports no conflict of interest.

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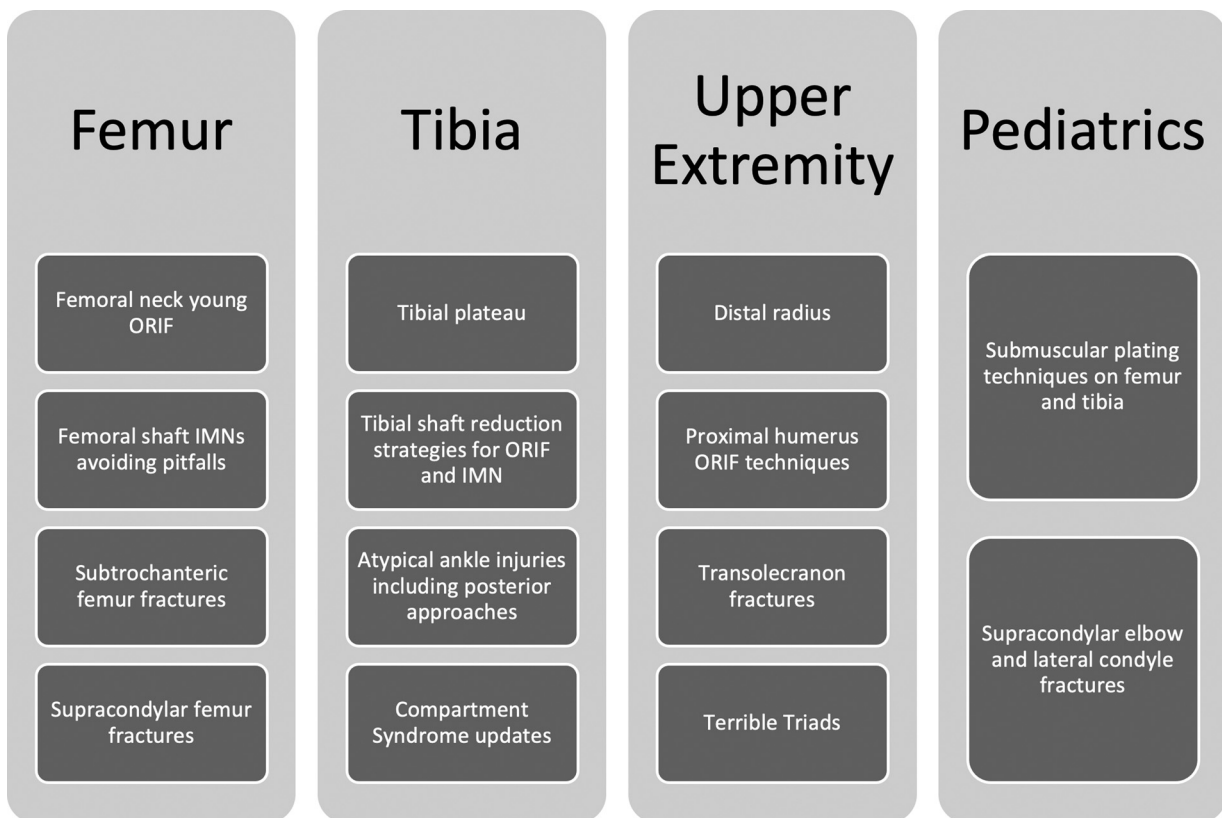


**FIGURE 1.** Course development sequence. Flow diagram showing the development process for the virtual series.

from the Community Surgeons Taskforce, 4 modules with associated topics were generated (Fig. 2). A subsequent meeting with several of the members from the Community Surgeons Taskforce helped us validate the content and ensure it met their needs.

**Initial Grouping of Topics for Fireside Series Format**

Each session included a recent or impactful journal article related to the topic; at times, the faculty member was



**FIGURE 2.** Initial grouping of Topics for Fireside Series. Listing of specific topics based on anatomy.

the author. It was important for us not to mimic the AO Trauma North America Webinars, but instead instructing our faculty to have it as interactive as possible. This included polling questions and Q&A during the talks. We had 12 sessions from April through July 2021. The series was titled: *AO Fireside: Working through Problem Fractures Together*.

Consistent with all AO Foundation educational events, adult learning principles were followed for development of the virtual series.<sup>1</sup> The 7 principles that have been adopted by the AO are listed herein: motivating, meaningful, actively involving, outcome driven, based on capacity to learn, incorporating reflection, and with feedback. *Learning Outcomes* were imperative for each session to be specific, relevant, and follow a general flow from series to series. As an example, the learning outcomes from our Supracondylar Femur Fracture Fireside are described below.

**Learning Outcomes:**

1. Understand how to use a plate to restore alignment.
2. How to avoid common malreductions from plate application.
3. Describe how to modulate strain at the fracture site.
4. Appreciate the indications for 2 implant constructs.

Fig. 3 shows a sample agenda for one of the weekly sessions over Supracondylar Femur Fractures. Immediately after the 90-minute session, the recorded session would be edited by our AONA staff, and it would be uploaded to the AO Trauma North America Fireside Series YouTube channel site ([https://www.youtube.com/playlist?list=PLK\\_-TIY7xyD5NqRN3wjW1ZGhW\\_D47I2OE](https://www.youtube.com/playlist?list=PLK_-TIY7xyD5NqRN3wjW1ZGhW_D47I2OE)).

**RESULTS**

Instead of only targeting North American learners, we advertised among our global AO community. We had on average 229 participants per session, from multiple countries around the world. Consequently, with this volume of participants, we noted that interaction with the audience members, which was initially planned including bringing cases, was not possible. Instead we focused and pivoted to ensuring high-level engagement among the faculty. Our AO

Trauma North America faculties are experienced in engaging learners, planning ahead, and making it relevant. They are also excellent at promoting feedback exposing knowledge gaps and inspiring those to improve patient care around musculoskeletal trauma. Furthermore, time was allotted to answer filtered participant questions that they submitted through the chat function of the online platform. Faculty members also answered participant questions that were not brought before the faculty during the live question and answer session. Faculty tried to limit the live questions to those that seemed relevant to most learners. This educational series' format proved successful in having participants continuing to come back each week and staying engaged.

We have had unsolicited feedback from multiple attendees who have implemented the discussions into their clinical practice. We have had others who have discussed how they have appreciated what they did not know and have been inspired to learn more around those fractures that were discussed. It is evident from this series that it was extremely relevant to learners it also created a digital asset that continues to be available on the AO Trauma North America YouTube channel which has several thousand views already.

**Best Practices and Avoiding Pitfalls**

One of the things that contributed to the series' success was the faculty. The course chairpersons specifically chose experienced AO Trauma North America faculty to function as moderators of each session. AO Trauma North America faculties have all taken courses designed to enhance their teaching skills. This includes coaching, feedback, giving a lecture, and leading small group discussions. This was evident in our series both in the presentations and discussion components. Interactivity was difficult as we had during most sessions >150 participants. Entertaining live discussions with participants was not practical. The Q&A function was encouraged, and our faculty screened questions and made judgments on the relevance (using real-time assessment of the content and cases being presented). However, the preparedness of our faculty and content design was critical for engagement and driving relevant questions. Our faculty met with the senior

Topic	Duration (minutes)
Introduction	5
Cases	15
Discussion/Questions	15
Cases	15
Discussion/Questions	15
Journal Article-Biomechanics	10
Discussion	10
Wrap up	5
<b>TOTAL</b>	<b>90</b>

**FIGURE 3.** Sample agenda from Supracondylar Femur Fracture AO Trauma North America Fireside.

authors to discuss the content and learning outcomes for each session. For example, our first Fireside Session was on *Young Femoral Neck Fractures*. A method that we thought would increase interactivity in an online venue was to have it focused on open approach techniques with a high-definition 4K surgical video. Learning objectives were harmonized with the cases being presented and the journal club article (1) describe indications for open reduction of femoral neck fractures, (2) describe preoperative logistics needed for surgical execution, and (3) describe the key steps in an anterior approach to the hip joint for ORIF of a femoral neck fracture). In addition, the faculty in that session was also the author of the journal article.

Similarly, the AO Trauma North America experience with online education both webinars before the COVID-19 pandemic and pivoting to provide virtual courses during the COVID-19 pandemic during 2020 helped maintain the high educational standards that is associated with AO Education. Precourse virtual meetings before each week's events with the chairperson(s) and faculty feedback sessions immediately after the event provided the improvements that occurred during the series and maintained the consistency of the product throughout the series because the faculties were usually different each week.

An advantage and potential pitfall with free online educational offerings is the lack of control of who signs up. The inability to target the webinar to a specific learner level can distract the experienced learner if the content is too basic or lacks relevance for the inexperienced learner if the discussion is too advanced. For example, an inexperienced moderator may lead the discussion away from what is more relevant for the more experienced participants. Because we

specifically had experienced moderators, we tried to minimize this risk.

Reliability of internet access may be a pitfall with online offerings. We were excited that we had a global audience; however, limited high-speed internet access was evident as some participants noted inability to see or hear the webinar properly. Although it is less interactive, the fact that the content remains available on the AO Trauma North America YouTube channel provides the opportunity for these participants to potentially get the content at their leisure.

Finally, reaching a global audience may cause a different challenge. Regional standards for treating certain fractures outside those in North America can also lead to inconsistencies and lack relevance for the learners. For example, the implants used may not be available, or surgical techniques that require significant fluoroscopic dependence may not be feasible because of lack of imaging capabilities.

## CONCLUSIONS

COVID-19 provides not only educational challenge but also opportunity. AO Trauma North America's "*AO Fireside: Working through Problem Fractures Together*" was a vehicle used to increase audience engagement through relevant topics for practicing surgeons, relevant literature discussion, and faculty interaction that was able to maintain an audience of over 200 participants for 12 weeks. The continued engagement reiterates the demand for high-quality virtual educational opportunities moving forward.

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# Surgical Planning Education Using a Digital Platform

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**Introduction:** Formal preoperative planning increases surgical efficiency, helps communication with operating room personnel, and improves patient outcomes. The Bonesetter App (Bonesetter Solutions, Ann Arbor, MI) is a free online educational planning tool for digital images. The purpose of this study is to evaluate learner and educator efficiency with this tool in Association for the Study of Internal fixation AO courses.

**Methods:** The Bonesetter App was used for digital planning in 8 AO Trauma Advanced Principles courses (>500 participants), 1 AO Trauma Basic Principles course (120 participants), 1 AO Trauma North America Deformity and Nonunion course (178 participants), 2 AO Recon courses (32 participants, 16 participants), and 1 AO Trauma North America Lower Extremity Deformity and Nonunion course (32 participants). Data included saved plans, participant evaluations, and faculty feedback.

**Results:** In the AO Trauma North America Deformity and Nonunion, 655 entries with 3275 tasks were evaluated with 74% of the exercises performed correctly. Difficulties included understanding retorsion/antertorsion of the femur and total deformity calculation. The AO Trauma North America Advanced Principles had difficulty with equipment, faculty discomfort with the application which led to improvements in the equipment, software, and teaching material. Participants of the AO Recon, Deformity and Nonunion courses provided overwhelming positive feedback, but only a 40% completion rate of exercises.

**Conclusions:** Remote learning platforms and digital planning are new tools for the AO courses. Hurdles develop when implementing new technology, including training faculty, making tools user friendly, and affordable. These tools can show whether participants are performing skills correctly and where educational difficulties are encountered, so teaching strategies can change.

**Key Words:** remote learning platforms, digital planning, preoperative planning, educator efficiency

(*J Orthop Trauma* 2023;S19–S25)

## INTRODUCTION

Operative management begins with preoperative planning. Although often viewed as a time-consuming process with little actual benefit, surgeons who neglect the formulation of a surgical tactic often prove true the maxim, “failing to plan is planning to fail.”<sup>1,2</sup>

The steps of preoperative planning first described by Lambotte<sup>3</sup> have been popularized throughout Arbeitsgemeinschaft für Osteosynthesefragen (AO) fracture courses and are part of nearly every orthopaedic resident’s training. The materials required include radiographs of the fractured bone, a radiograph of the contralateral uninjured extremity, templates of implants, tracing paper, and colored pens. The overlay technique<sup>1</sup> begins with making a tracing of the injured and uninjured sides. The intact tracing is placed over the fracture tracing, and the fracture pieces are traced onto the uninjured side creating a template for the position of the fracture pieces once they have been completely reduced. Various aspects of the plan are then considered such as the surgical approach, methods of preliminary fixation, and optimal handling of the soft tissues. Once these factors have been considered, implants are selected, and the order of placement is described and this is termed the “surgical tactic.” Logistics represents the management of resources for an operation, for example, the type of operating room table, patient positioning, use of intraoperative imaging, and required implants. Together, these form a comprehensive surgical preoperative plan.<sup>1,2,4</sup> However, despite considering preoperative planning to be important, surprisingly few surgeons routinely create a preoperative plan.<sup>5</sup>

There may be several reasons for this disconnect. With the move to digital imaging at most modern centers, it has become cumbersome to obtain a key component required for the creation of the traditional preoperative plan—the printed radiographs of the injured and uninjured extremities. Commercial solutions have been developed in an attempt to compensate for the lack of physical radiographic films. Their cost may be prohibitive, and they may not provide the functionality or implant selection desired by the surgeon.

It was with this preamble that we found ourselves at our US county hospital, with a lack of resources to purchase digital planning software, which also did not address many of our needs. We felt that video games cost about 50 US dollars and

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were much more complex than digital planning software developed by companies that wanted thousands of dollars for very little return. The problems that had to be overcome were a library of implant templates, sizing of radiographs, measuring tools and the ability to cut and paste fracture fragments, osteotomies, or bones for joint replacement. An application (App) was created at our institution with programmers to solve this dilemma. The AO provided a unique environment to develop this tool, test it, and rework it so that the App could be used in multiple educational situations and environments. Regarding this, we have partnered with many AO surgeons, staff, and participated in courses. This has led to a point where the Bonesetter App (Bonesetter Solutions, Ann Arbor, MI), a free online program, has the ability to aid surgeons and orthopaedic residents in their quest to plan their operations. The purpose of this descriptive paper is to detail the capabilities and review the educational experience with the App thus far.

## METHODS

### Development: The Hardware/Access

The App was designed to be web-based so that it can be used on any personal computer, smartphone, or tablet device with internet access. The website is <https://detroitbonesetter.com>. We found that residency programs wanted to plan as groups, so group logins were developed so that radiographs and computed tomography scans could be placed in a folder and multiple users could use them for planning and altering each other's surgical tactics at the same time. The program had to be Health Insurance Portability and Accountability Act compliant so there is a function to remove any words and numbers before entering an image into the program. Sizing is very important and so there are 4 ways to size the images correctly: (1) with radio-opaque markers that are recognized by the program, (2) with a ruler on the radiographs, (3) sizing to images that have been already imported from the same patient, and (4) sizing to a standard template of body parts that are in the program that have been sized to an average from the bones of 100 individuals from our practice.<sup>6</sup>

### Internet Access

We discovered that internet access is an issue for many courses because organizers of events are charged per user at hotel venues. Thus, we developed a downloadable version called Learn. [detroitbonesetter.com](https://detroitbonesetter.com), which can be used to make any teaching module. The teaching module can be downloaded directly to the device you want to use without the need of internet access. For the AO Trauma North America Advanced Fracture Principles course, this was an iPad (Apple Inc, Cupertino, CA).<sup>7</sup> For the basic course, it was downloaded to a personal computer or Mac computer or used online.

### Tools

We added tools for measurement including distance, angle, area, tracing, cut out inverting, grouping, opposite side templates, and a tool to show progression of your case. Specialty tools for deformity planning (right deformity and left deformity) can measure coronal deformity and move with the bones after osteotomy. For arthroplasty, Ranawat angles

and an acetabular anteversion tools were developed. For fracture implants, a plate bending tool and the ability to overlay radiographs were developed, and a tool to enter or make your own templates and store them in your account. A text box was added for the logistical component of the plan.

## COVID-19

The pandemic made it necessary for courses to be virtual. The challenge for any course was to evaluate practical skills exercises. When exercises were performed, there had to be a way to check them and give feedback. The use of online video conferencing and web meeting platforms were embraced for virtual meetings and were used for AO Trauma North America courses such as the Basic Principles and Advanced Fracture, Lower Extremity Deformity, and Nonunion courses.<sup>8</sup> The ability to demonstrate on an online meeting platform, and then put forth exercises on the Bonesetter Learn App provided an opportunity for teaching surgical planning and deformity measurement, assessment, and feedback.

## Deployment

The Bonesetter App was used for digital planning on 8 live AO Trauma North America Advanced Fracture Principles courses (>500 participants), 1 AO Trauma Middle East Basic Fracture Principles course (120 participants: Middle East, Assiut, Egypt), a virtual AO Trauma North America Lower Extremity Deformity and Nonunion course (178 participants), 2 AO Recon courses (32 participants, 16 participants), and a blended AO Trauma North America Lower Extremity Deformity and Nonunion course (32 participants). Data included saved preoperative plans from the blended and virtual AO Trauma North America Advanced courses, Lower Extremity Deformity, and Nonunion courses, participant evaluations at the online AO Foundation Recon and deformity courses, and from faculty of the other events.

## RESULTS

### AONA Advanced Fracture Principles Course Proximal Femoral Osteotomy Module Live Events (2016-Current, [https://www.youtube.com/watch?v=\\_3ocbyjb7S4](https://www.youtube.com/watch?v=_3ocbyjb7S4))

In 8 live AO Trauma North America Advanced courses with approximately 500 participants, the proximal femoral osteotomy module was used for a femoral neck fracture nonunion (2017–2021). Challenges occurred with this lab and the App. Problems included difficulty with Wi-Fi early on leading to the development of the App that was downloaded on iPads. Other hardware improvements included switching from the 100 US dollar iPad pen to 3 US dollar generic styluses that performed better and did not require charging. The faculty had a much harder time learning the App than participants who were more comfortable with modern digital media. Teaching planning on the App was streamlined by teaching the tools online before the course<sup>7</sup> and then chunking the workflow into 7 parts via a prerecorded video session to minimize challenges with live

demonstrations. These 7 parts included: (1) measurement of the resultant deformity including leg length discrepancy, neck shaft angle, and Pauwels angle; (2) tracing the fractured proximal femur; (3) using the contralateral proximal femur as a template; (4) creating an opening wedge osteotomy; (5) medializing the proximal fragment to get the correct height; (6) placing the 120 degree angled blade plate (Depuy Synthes, Paoli, PA); and (7) applying Kirschner wire markers for reverse planning of the osteotomy on the operative side. In the latest version of the App, this module worked seamlessly (Fig. 1).

### AO Middle East Basic Fracture Principles Course, Assiut, Egypt (March 2018)

There were 120 participants. The Bonesetter App was introduced as an alternative to planning for the forearm fracture bone model on paper. The internet connection was unreliable so a USB drive with the program was distributed to all the participants. Participants attempted to complete both tasks. The problem for the course was that many participants only had a cell phone available as their device (about 30% of participants had PCs and could use the App well). Others with android phones and pencil type styluses were also able to complete the task. Those without styluses or those with iPhones were not able to complete the task at all because using one's finger was not an accurate method of the manipulating the tools. For courses where the internet connection may not be reliable, the downloadable version of the exercise is mandatory.

### AO Trauma North America Lower Extremity Deformity and Nonunion Course (Virtual, [https://www.youtube.com/playlist?list=PLK\\_-TIY7xyD45C4upDXXY5xK28\\_3P4k6t](https://www.youtube.com/playlist?list=PLK_-TIY7xyD45C4upDXXY5xK28_3P4k6t))

During the virtual AO Trauma North America Lower Extremity Deformity and Nonunion course, 178 participants learned how to measure coronal, sagittal, and axial alignment through lectures and tutorials. There were 8 modules (4 on coronal alignment and 4 on axial alignment). There were 655 participant entries with 3275 tasks that were saved and evaluated.<sup>8</sup>

In 238 entries encompassing 1190 measurements for 4 cases measuring axial alignment, the success rate for completing the task correctly 5/5 points was 158/238 (66%). It improved from 56.25% for case 1 to ~80% for the last 2 cases. We discovered that the SD of these angular measurements for all measurements was  $\pm 4.29$  degrees. It was found that participants easily found a measurement for the posterior condylar axis of the femur (SD  $\pm 1.6$  degrees), but the landmarks of the femoral neck (SD  $\pm 4.5$  degrees) and bimalleolar axes (SD  $\pm 4.2$  degrees) were more difficult for them to reproduce ( $P < 0.001$ ). Participants had trouble with adding and subtracting numbers when retrotorsion of the femur was an issue that led to 8% calculating errors versus 2% when there was normal anteversion. Direct measurements of the angles versus measuring to horizontal lines and then adding or subtracting lead to less variation and errors (participants who used the horizontal line method were

more likely to measure outside of 1 SD than the direct method,  $P < 0.025$ ) (Fig. 2).

The number of measurements from each method outside 1 SD was totaled for right and left tibial torsion in all 4 cases and ranked from low to high in a Mann–Whitney  $U$  test. The direct method (R = 169.5) produced less measurements outside of 1 SD than compared with the horizontal line method (R = 358.5); the test statistic for the directional measurement was used,  $U_{0.01,16,16} = 169.5$ ,  $p < 0.025$ . Participants who used the horizontal line method were more likely to measure outside of 1 SD, then the direct method ( $P < 0.025$ ).

Case 1: <https://www.youtube.com/watch?v=HL8wq8mUL7o>.

Case 2: [https://www.youtube.com/watch?v=4y\\_OYq7RZIQ](https://www.youtube.com/watch?v=4y_OYq7RZIQ).

Case 3: <https://www.youtube.com/watch?v=5RJNvpJ5R00>.

In 417 entries, we evaluated the completion of 2085 tasks for coronal alignment. Each exercise had 5 components: the leg length or leg length discrepancy, total deformity, femoral deformity, joint line deformity, and tibial deformity. To complete the task correctly, all 5 tasks had to be correct for each exercise. There was a 76% success rate for the 4 tasks. Thirty four percent of the participants attempted the exercise more than once (best completed exercise was chosen). The most errors during the trials were made when measuring the total deformity (12%) and joint deformity (9%). Instructors should repeat how to do these measurements during the tutorial several times because once you have failed at the total deformity measurement, the rest of the tasks follow along (Fig. 3). The average SD of length measurements across the exercises was  $\pm 0.29$  cm (417 measurements) and for angular measurements it was  $+0.71$  degrees (1668 measurements) between participants. This was calculated from participants who correctly completed the tasks. It shows the accuracy of multiple individuals being able to get the same answer with this digital planning tool. The measurement of coronal deformity using the hip center tool and easily identifiable lines such as the distal femur and tibial plateau was much better than that of axial measurements ( $P < 0.001$ ).

In addition to the course, the recorded teaching sessions and exercises are available on the AONA YouTube (San Bruno, CA) channel: [https://www.youtube.com/results?search\\_query=aona+north+america+youtube+channel](https://www.youtube.com/results?search_query=aona+north+america+youtube+channel).

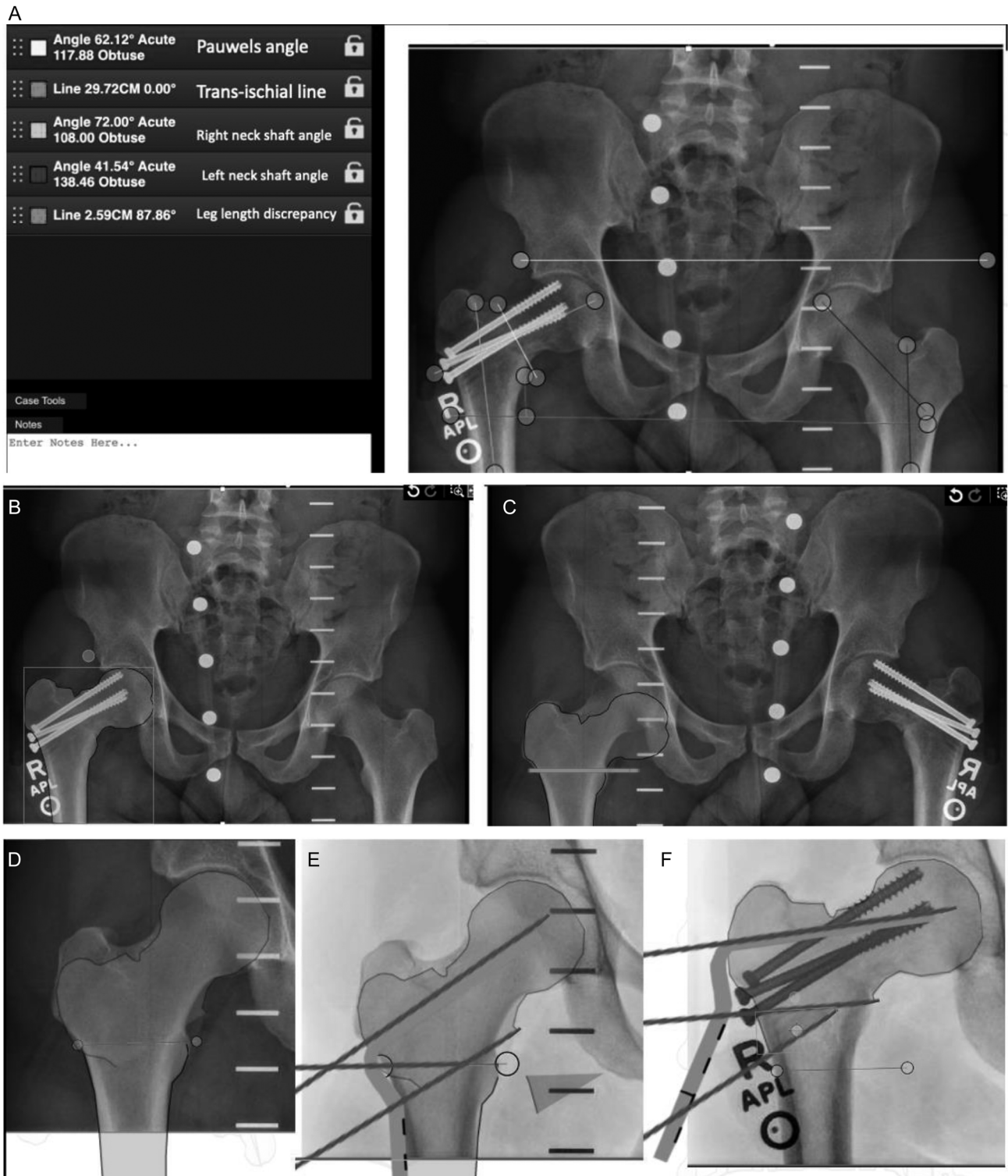
To date, 127 more participants have completed the coronal exercises on their own and 52 more have completed the axial exercises.

Case 2: [https://www.youtube.com/watch?v=t7c7GBUeu7o&list=PLK\\_-TIY7xyD45C4upDXXY5xK28\\_3P4k6t&index=55](https://www.youtube.com/watch?v=t7c7GBUeu7o&list=PLK_-TIY7xyD45C4upDXXY5xK28_3P4k6t&index=55).

Case 3: [https://www.youtube.com/watch?v=1n-XH3\\_oFaI&list=PLK\\_-TIY7xyD45C4upDXXY5xK28\\_3P4k6t&index=51](https://www.youtube.com/watch?v=1n-XH3_oFaI&list=PLK_-TIY7xyD45C4upDXXY5xK28_3P4k6t&index=51).

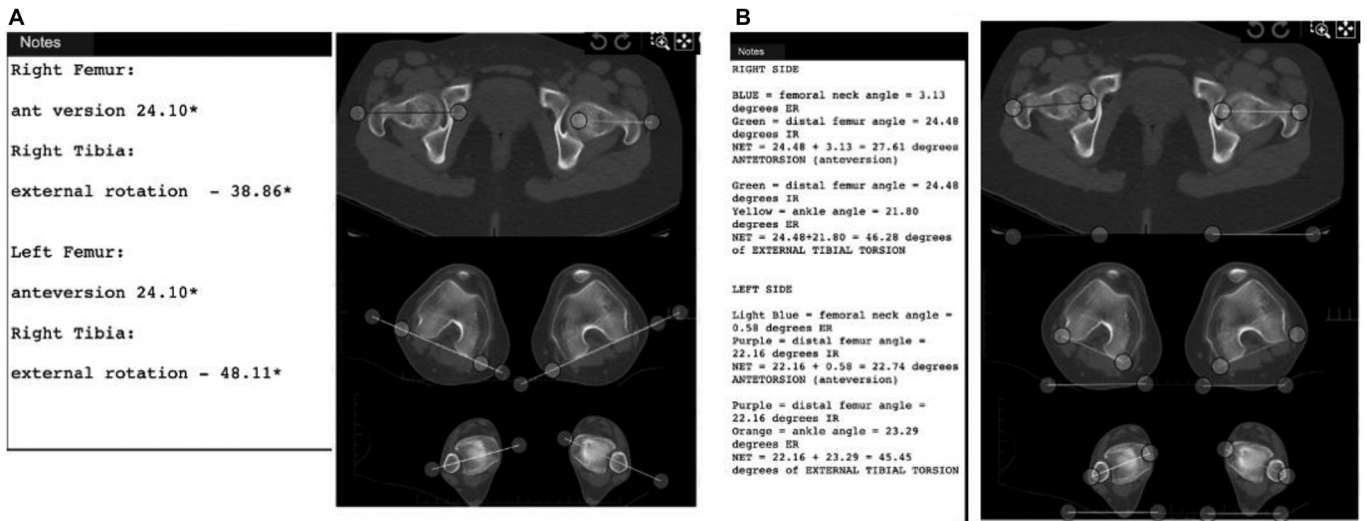
### AO Recon Principles and Complex Hip/ Blended AO Trauma North America Lower Extremity Deformity and Nonunion Courses

The Bonesetter App was used for an AO Recon pilot course (32 participants), AO Recon Complex Hip course



**FIGURE 1.** Nonunion of a femoral neck fracture with varus collapse for osteotomy. A, The first step is to measure the neck shaft angle on both sides, leg length discrepancy, and Pauwels angle. B, The trace tool is used to draw the fractured proximal femur. C, The pelvis radiograph is flipped over and used as a template for the osteotomy of the right hip, which is made just at the level of the lesser trochanter. D, A 30-degree valgus osteotomy is made with the proximal femur moved to mimic the length of the opposite side. E, The 120-degree blade plate is applied and k-wires are used to mark its location and the osteotomy. F, The image is then templated again on the fractured side to mark the k-wires for blade plate insertion and the osteotomy cuts.

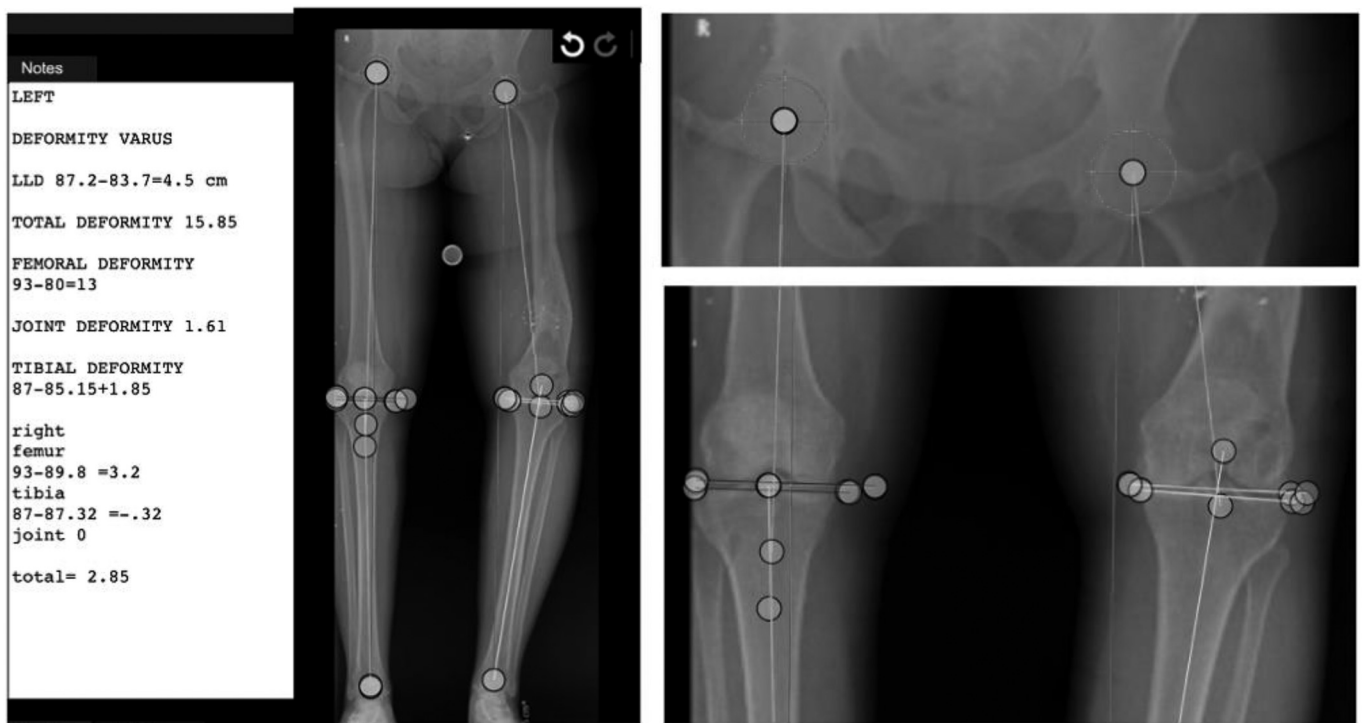




**FIGURE 2.** Measuring axial alignment—AONA osteotomy course. A, Measuring axial alignment using single angles between the proximal femur and distal femur and the distal femur and the ankle axis. B, Using horizontal lines to measure each location the proximal femur, distal femur, and ankle axis. The distal femoral axis was easiest to reproduce with the proximal femur and distal ankle axis measurements had more variability because there are poorer landmarks.

online (16 participants), and a blended AO Trauma North America Lower Extremity Deformity and Nonunion course (32 participants). There were 2 modules in the AO Recon Principles pilot course, 5 modules in the AO Recon Complex, and 5 in the AO Trauma North America Lower Extremity Deformity and Nonunion pilot course. Participants had a

positive opinion of the exercises and 46% of the participants completed the cases (Fig. 4). In these courses, we did not evaluate the data except to see whether the plans were performed reasonably and in 72% of cases, a reasonable rendition of a plan was completed and in 28%, a plan was started but not completed.



**FIGURE 3.** Measuring coronal alignment—AONA osteotomy course. Measuring the total deformity, femoral deformity, tibial deformity, and joint deformity to then assess which location the deformity is in.

### DISCUSSION

The AO has been a champion of preoperative planning in its courses, publications, and online resources. A preoperative plan enables the surgeon and the operating room personnel to ensure the required instruments and implants are prepared in the operating room before beginning the case. Radiology can be prepared with intraoperative fluoroscopic equipment setup and ready to go in the desired position, and the anesthesia team can follow the anticipated flow of the case to ensure smooth and timely emergence from anesthesia. A well-formulated preoperative plan leads to smoother cases with less stress, and operating room personnel are more likely to have a positive view of the surgeon as competent and dependable. Better outcomes and increased safety typically result from solid preparation and are a direct benefit to the patient.<sup>1,2,4</sup> In addition, a detailed preoperative plan can be discussed with the patient and included in the medical record, providing and documenting a thorough discussion of the risks and benefits of surgery.

The Bonesetter App was developed as a digital planning tool for the tactics and logistics that are required for an effective preoperative plan. The move to digital imaging was an opportunity to develop digital planning tools that are portable, accurate, and sharable for collective planning and education. Through courses, interaction with AO faculty and users, the online planning tool has morphed into a tool that can be used for various orthopaedic surgical specialties: trauma, total joints and deformity, and for educational courses.

The App was used for preoperative planning an osteotomy of the proximal femur in the AONA Advanced Principles course. It replaced a paper and pencil exercise, which is rarely possible because of digital imaging. Through several courses, glitches in the software, hardware, and education format lead to a lab that could be accomplished by all participants, and used to plan real proximal femoral osteotomies. For the Basic course, the AO felt that at least 1 paper and pencil exercise should be completed by residents in their career and for now the digital exercise is on the back burner. During the online AONA osteotomy course, we were able to assess each individual’s ability to learn and preform the skills of deformity measurement, give real-time feedback, and discover where difficulties exist in teaching these skills. At the course, instructors need to explain retrotorsion and antetorsion and internal and external rotation with greater care, because this was a common mistake within the data. Thus, the next time this course is taught, focus can be on reinforcing the total deformity measurement in the coronal exercises and understanding anteversion and torsion and retroversion and torsion of the femur to develop better methods of measuring the femoral neck and distal tibial measurements.

The Covid-19 pandemic was an opportunity to shift to online and remote learning. Despite engaging participants online for virtual AO Foundation courses, there is still a disconnect that occurs. In several courses, less than half of the participants actually completed or even attempted the exercises unlike in the live events where there is approximately 100% engagement and effort to complete the tasks. This is likely true for other assignments besides just digital planning. At live

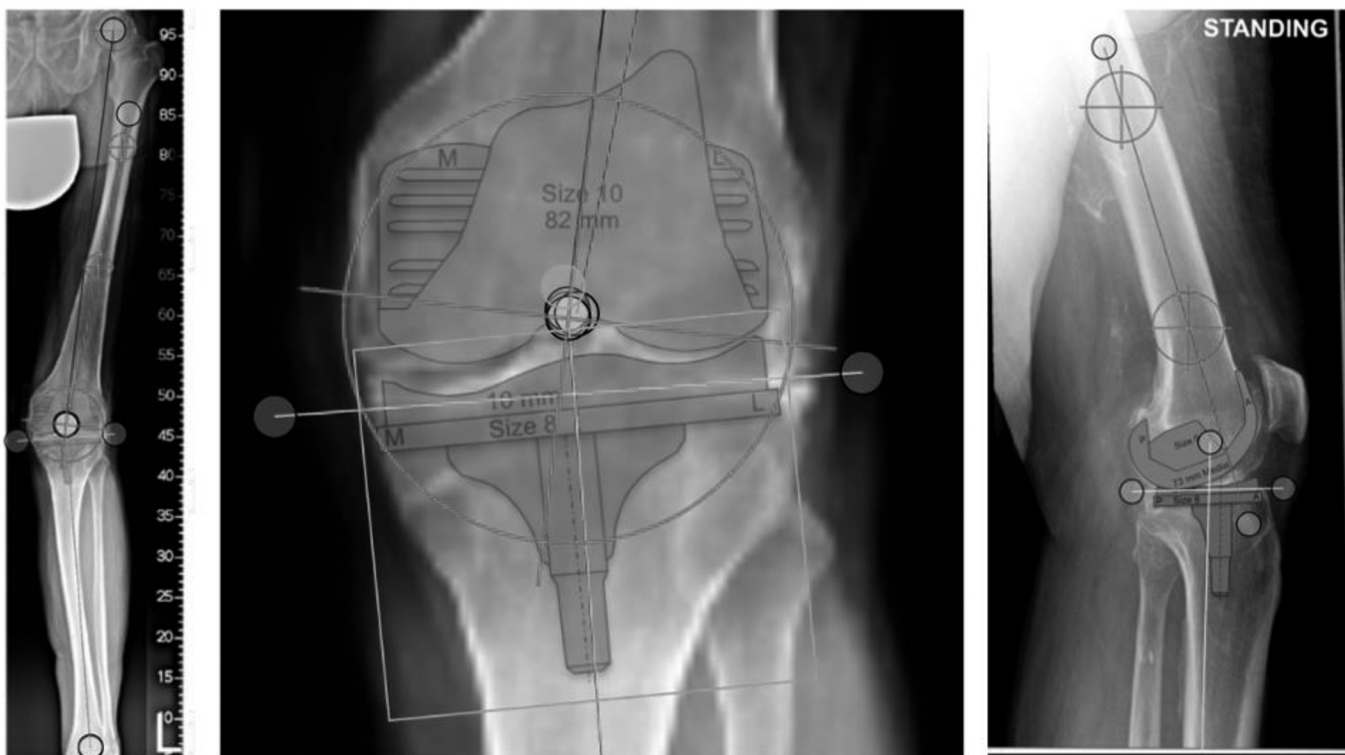


FIGURE 4. The AO Recon knee course. Measuring alignment and then placing the implants in the correct location.

events, participants are engaged and separated from other work and life issues, and can focus on learning. This is a real challenge with online learning. With online courses, lecture videos, exercises, and skills modules can be left online without expiration. Participants can access the information indefinitely.

The main shortcomings of the Bonesetter App were its reliance on the internet and difficulty with use on a smartphone. However, the reliance on the internet was resolved with downloadable modules. The difficulty of using the App with a phone device still exists. This may not be solvable because of the resolution, size of the screen, and manipulation controls available.

Other challenges with the process included faculty engagement and use during courses, and established surgeon participant incorporation into their practice. Having faculty who are unfamiliar with the app and its functionality make it challenging for faculty to teach using the App. Up until now, there has been a paucity of AO faculty who are comfortable teaching the App, but there are approximately 10,000 participant users worldwide who use the App routinely. To meet the needs of the learners, perhaps better videos or a course on digital planning would be appropriate. Alternatively, exclusively using faculty who are comfortable with digital planning to teach the planning component of the courses could prove successful.

Currently, several digital planning platforms are available. The barriers that exist for a lot of surgeons worldwide including platform cost and the need to work with individual picture archiving communication systems. Most of this software validation was performed for arthroplasty sizing and not fracture or deformity, where preoperative planning may be more critical. Many digital platforms also lack the same capability to manipulate radiographs or use in an educational environment.<sup>9–13</sup> However, with the Bonesetter App, access is free, radiographs may be uploaded via screenshot, exported from picture archiving communication systems, or simply a photo. Validation of the software has been performed with arthroplasty, deformity, and fracture cases.

## CONCLUSION

Through virtual and blended educational events, participants were introduced to digital templating; they were

taught the tenets of the surgical tactic, logistics, and how to formulate a preoperative plan. Many participants were able to correctly measure deformity and plan surgery, which could be evaluated directly by the faculty. Errors could be observed and corrected by faculty. Online material was developed that learners and faculty could practice repeatedly using YouTube videos with answers to reinforce knowledge and exercises that are freely available. Remote learning platforms and digital planning are new tools for the AO in courses and for participants. There are many hurdles to implementing new technology, including training faculty and making tools user-friendly, helpful, and affordable.

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# Use of Digital Platforms in Supporting the Intended Learning Outcomes of the Educational Intervention(s)

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**Summary:** During the COVID-19 pandemic, medical education witnessed some remarkable changes including a digital transformation and the use of social media to maximize the learning experiences. In 2021, AO launched the AO Trauma Study Club—Middle East and North Africa where a group of local surgeons (local faculty and orthopaedic trainees) and international AO Trauma faculty would meet monthly online to discuss clinical cases and exchange experiences. In addition, this learning initiative allowed participants to access online material and interact through several additional communication channels. In this article, we describe the intervention, the learning principles followed, and the technical aspects and functionalities used to support the learning activity.

**Key Words:** online learning, learning principles, social media and learning

(*J Orthop Trauma* 2023;S26–S30)

## INTRODUCTION

Since the beginning of the COVID-19 pandemic, medical education witnessed some remarkable changes. The tight restrictions on travel and close physical interactions accelerated a digital transformation, increased the offering of online learning, and encouraged the use of technology and social media to maximize the learning experience. In 2021, the Arbeitsgemeinschaft für Osteosynthesefragen (AO) Foundation offered a total of 771 educational events; of which 322 were on orthopaedic trauma topics: 96 were fully online, 53 blended, 3 hybrids, and 170 in person. The design of these educational activities followed defined learning principles, a competency-based approach through backward planning<sup>1</sup> and Kern 6-step model for curriculum development.<sup>2</sup> The AO process for developing a competency-based curriculum following Kern model has been reported for several subspecialties,<sup>3–7</sup> therefore, will not be discussed here, and we will focus on learning principles.

The design of learning activities can be guided by a variety of learning theories that provide insights into how

learning occurs and what makes the application of new knowledge more likely.<sup>8–10</sup> These theories provide a rational basis for the selection of specific teaching methods, framing learning objectives, and designing evaluation strategies. Several learning principles are common to the various theories, and the choice of which one to use is based on the target learners and the subject, for example, basic science is different from clinical skills, so distinct theories can guide the design of the respective learning activities. The target audience of AO courses are orthopaedic surgeons at various practice levels; therefore, the AO has chosen to develop educational activities around the following 7 principles of adult education<sup>9</sup>: based on needs, motivates to learn, relevant, interactive, provides feedback, promotes reflection, and leads to verifiable outcomes (Fig. 1). In this article, we describe how these learning principles were applied in the design and delivery of a new learning format, and the technical aspects and functionalities used to support it.

## AO Trauma Study Club—MENA

In 2021, AO Trauma launched the AO Trauma Study Club—Middle East and North Africa (MENA), a 6-month online learning initiative combining synchronous and asynchronous learning. It covered one topic each month: violation of the principles, preoperative optimization of the elderly patient, articular fractures, diaphyseal fractures, fracture-related infection, and non-union.

Surveys, focus groups of experts, and literature searches were used to determine the educational needs in the planning phase. This is a standard step in planning AO events.<sup>11,12</sup> To conduct a needs analysis with the actual participant group, the standard AO evaluation and assessment questionnaire was provided shortly before the event.<sup>13</sup> An additional option at the start of a new topic, one or more cases were posted for discussion either on the discussion forum of Totara Learn (<https://www.totaralearning.com/en/products/learning-management-system>) or in the myAO app (a social network of trauma and orthopaedic surgeons [https://welcome.myao.app/welcome/?utm\\_source=AOF&utm\\_medium=website\\_myao\\_lp&utm\\_campaign=myAO\\_hard\\_launch\\_2021](https://welcome.myao.app/welcome/?utm_source=AOF&utm_medium=website_myao_lp&utm_campaign=myAO_hard_launch_2021)). The discussions gave an indication to the faculty of the real needs of the participants and their level of experience, made the activity more interactive, made participants reflect on their practice while reading the different answers, provided feedback, and possibly motivated participants who had chosen less optimal treatment option to learn more.

The Study Club was open to AO Trauma members located in the MENA region and to the 20 young trauma

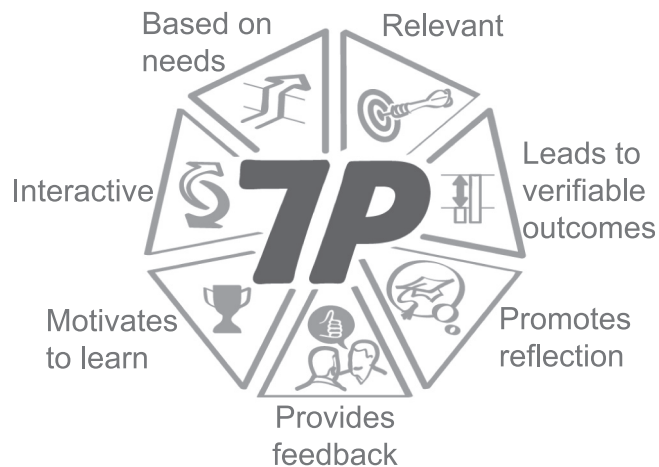
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**FIGURE 1.** 7 principles of adult learning used at AO.

surgeons enrolled in the AO College initiative. The AO College is a 6-month cross-divisional program launched in 2021 to support motivated young trauma, spine, or cranio-maxillofacial surgeons based in low-income and middle-income countries in the MENA region. Surgeons were informed about the events through the AO website, email advertising, AO Trauma Facebook page in addition to other orthopaedic educational groups on Facebook, and different WhatsApp and Telegram groups. Registration was free of charge.

### Live Sessions

The Study Club's 126 participants were offered a monthly live session of 60 minutes run on the Zoom platform (Zoom Video Communications, San Jose, CA), which allows live presentation, live text chat, a virtual classroom, instant messaging, live audio or video chat, and live quizzes.<sup>10</sup> The session included a welcome note and faculty introduction, housekeeping remarks explaining how participants should interact during the session, the learning objectives, 3 plenary case discussions with 3 speakers presenting 1 case each, a moderator posing questions to 3 senior panelists to promote discussion after each case, and finally take-home messages. The sessions were recorded and made available as asynchronous material.

Faculty were selected from multiple countries within the MENA region to ensure that the cases and learning objectives discussed were relevant to the participants and could be applied back in their practice. Adding a global dimension, an international AO Trauma faculty member attended the live session to offer expert insights and a different perspective on the various topics. The plenary case discussion format was chosen for several reasons. First, clinical cases are related to the surgeon's experience; therefore, it makes it relevant to them and their practice. Second, listening to different surgeons' perspective promotes reflection on a participants' practice, making them aware of underlying assumptions and biases, and influencing their thinking and actions. Third, it is highly interactive and favors

collaborative learning that incorporates and builds on the variety of knowledge, backgrounds, abilities, interests, and personalities within a typical community of practice.

Zoom was also used to hold the rehearsal sessions in which the agenda, role distribution, case presentations, intended learning outcomes, and take-home messages were agreed on, and some poll questions and quizzes were integrated. To make the best use of Zoom's functionalities, the rehearsal sessions were in some cases recorded and shared with the faculty. This was used for self-assessment, reflection, and to provide feedback, which led to some modifications of the presentations and avoidance of any duplicates in the discussions. A WhatsApp group including the speakers, panelists, and technical support staff was created for communication, brainstorming, session planning, and sharing of relevant materials, as well as necessary guidance documents, such as "how to use Zoom" video tutorials. WhatsApp was chosen because it is considered an effective tool for coordinating educational discussions, very popular, and accessible by all.<sup>14</sup>

During the live plenary case discussion sessions, participants interacted in different ways through the Zoom platform. Several poll questions were posed to the audience, and the results were shown instantaneously on screen to provide immediate feedback and promote reflection. In addition, participants were asked to raise their hands in response to inquiries and to add questions in the chat or in the Q&A box that were then addressed either in writing or verbally by one of the faculty or the moderator during the session. These functionalities were used to increase the participants' engagement, stimulate active learning, and enhance participants' intrinsic motivation in the virtual environment.<sup>15,16</sup> The chat box also provided a space for the collection of instantaneous feedback and comments from the participants at the end of the live sessions. To address the achievement of the intended learning outcomes, 3 to 5 multiple-choice assessment questions were prepared by the case presenters and sent to the participants at the end of the live session.

### Asynchronous Learning Activities

In addition to the live sessions, the Study Club offered asynchronous learning opportunities: networking activities, case discussion groups, articles, recordings of the live session, and other learning materials (eg, link to AO Trauma recorded webinars, webcasts, and practical/anatomical specimen demonstrations for different procedures). The main materials and links were provided through a course page in the learning management system (LMS) Totara Learn (Fig. 2). Cases were posted for discussion either in the discussion forum of Totara Learn or in the private group created in the myAO app. Cases could be posted by learners or faculty. The Study Club was a dynamic network of 20 faculty and 126 participants (orthopaedic trainees) from 20 countries within the MENA region (Egypt, Saudi Arabia, and the United Arab Emirates were the most represented), discussing compelling cases and exchanging experiences. Learning occurred through a social process as it regularly happens in clinical settings.<sup>8</sup> The aggregated activities of participants and faculty in Totara Learn show a

great engagement at the start of the Study Club in July 2021 that decreased over time (Fig. 3). This was probably due to the transition to case discussions in the myAO app and the fact that Zoom links were also provided through email. Another possibility is that this might have been related to return to a more normal way of life and a decreased preference of the online meetings.

### DISCUSSION

During the COVID-19 pandemic, online learning and the use of social media for learning increased exponentially. The AO had to quickly adapt their planned events to the online environment while trying to keep them effective. It was immediately clear that the need for interactivity, motivational cues, feedback, and learner support was even more necessary in online learning as compared with conventional classroom events.<sup>10</sup> The faculty not only needed to be experts in the content but also proficient in the use of online technology and in online teaching principles with a resulting major effort in the preparation and in the running of online events.

Several available video conferencing tools had integrated interactivity functions, such as virtual classroom, breakout rooms, live presentation, live text chat, instant messaging, live audio or video chat, and live quizzes. One of the most popular video conferencing tools currently is Zoom.<sup>17</sup> In addition to the standard conferencing functions, Zoom permits learners to indicate through icons agreement and ask questions if they want the tutor to speed up, slow down, or request a break. Nonverbal functions reflect their attentiveness, and agreement, and allow the tutor to provide corrective feedback.<sup>18</sup> Learners could pose questions either privately or to the whole class, in addition to student-to-student or send-to-all chats (if permitted). There are built-in recording and transcription functions for those who might miss the session or review it later.<sup>19</sup>

Zoom and other platforms are effective in achieving the learning outcomes; however, they present some barriers including family distraction (26.76%) and poor internet connectivity (21.53%).<sup>20,21</sup> Group discussions tend to take longer time, and monitoring learners’ engagement is more challenging. Learners might get “screen fatigue” making shorter sessions ideal. There are also potential security issues, for example, Zoom bombing and eavesdropping.<sup>19</sup> On the

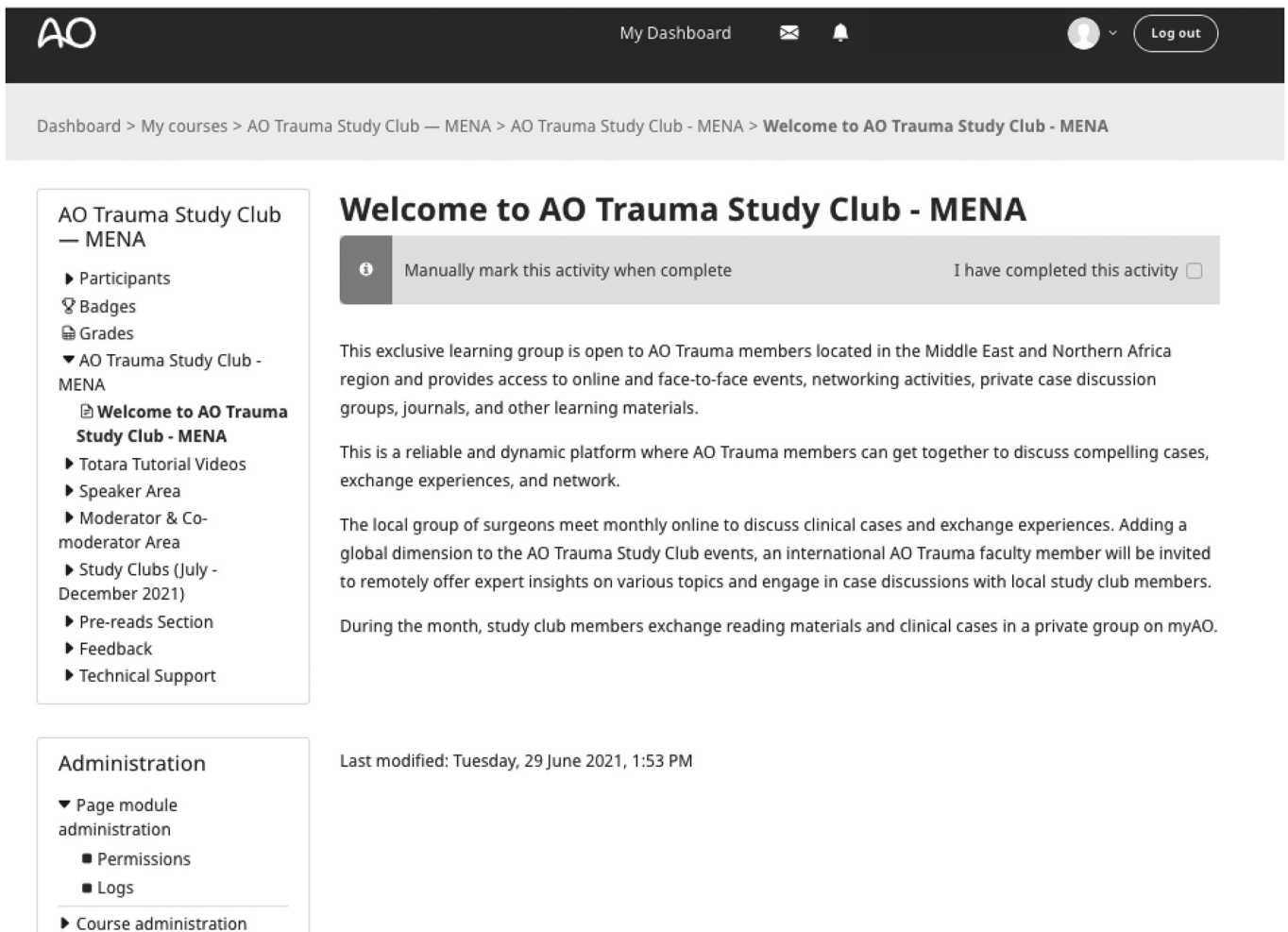
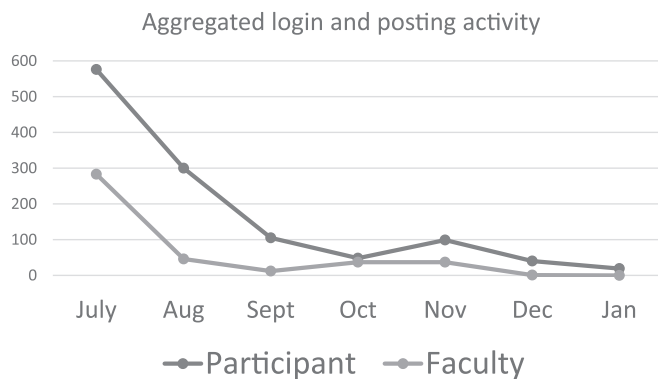


FIGURE 2. AO Trauma Study Club—MENA Totara Learn webpage.





**FIGURE 3.** Login and posting activity on the Totara Learn webpage between July 2021 and January 2022.

other hand, there are advantages associated with conferencing platforms. They are easy to access, flexible, and scalable.<sup>22</sup> In addition to the traditional video conferencing systems, educational events could be live streamed on Facebook, YouTube, or other social media increasing their reach.<sup>17</sup>

Numerous platforms and LMSs are available for asynchronous online learning in addition to the simple, social media tools such as WhatsApp, Telegram, YouTube, and Twitter, or the myAO app used in the Study Club.<sup>10</sup> The basic functions provided by an LMS such as Totara Learn are discussion boards, quizzes, emails, and the possibility to upload recorded audio or video, and recorded slides with narration. These functions allow flexibility, scalability, personalized learning, ease of access, and monitoring of learner progress.<sup>23</sup> Despite the multiple integrated interactivity functions, learning seems more impersonal and often translates into low engagement in the discussion boards. Therefore, it is essential to have committed faculty involved in driving the conversation. It is also beneficial to combine synchronous and asynchronous online learning.

Although some professionals prefer traditional learning formats that include more direct contact,<sup>24,25</sup> e-learning has the advantage of enabling healthcare professionals to review content when needed, set their own learning pace, and personalize their learning experiences. Lower costs and greater numbers of participants are additional benefits of e-learning.<sup>22</sup>

### CONCLUSIONS

In addition to the tools used to deliver education, there are several variables involved to achieving effective learning outcomes in online learning. So, it is a combination of a well-planned program, using the right platform with the right learner, and with the application of the learning principles which allow for achieving the intended learning outcomes.

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# Face-to-Face In-Person Courses to Synchronous Online: Lessons Learned

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**Summary:** In March 2020, there was a scheduled 4-day new live course planned called the AO Trauma North America Lower Extremity Deformity and Nonunion Course. However, owing to the COVID-19 pandemic leading to its cancellation, the live event was converted to a synchronous online course in the span of 2 weeks. To the best of our knowledge, this was the first synchronous online offering that AO sponsored. The activity delivered online was highly successful, and we learned several lessons along the way. The lessons that were learned included the requirements for organizing the course, choosing the right format for content delivery, engaging the faculty, and the ability and need to continuously evolve the offering in real time to meet the needs of learners and faculty. Because this format was new for AO Trauma North America, we sought regular feedback from both faculty over the 10-week period. Although COVID-19 created an educational void for orthopaedic surgeons, it created the opportunity to try new digital formats for surgical education. The positive feedback received for this synchronous virtual 10-week offering with approximately 100 participants every week, and more than 17,000 views of the content on YouTube by August 2020, made it the AO Trauma North America benchmark for future synchronous virtual events.

**Key Words:** synchronous virtual courses, surgeon education, orthopaedic trauma, online learning

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## INTRODUCTION

In early 2020, Arbeitsgemeinschaft für Osteosynthesefragen (AO) Trauma North America was faced with a dilemma due to the impact of COVID-19. The last course as we knew it was in early March, a Basic Principles of Fracture Management. As COVID-19 spread in March 2020, lockdown occurred, and all face-to-face educational events were cancelled.

Because the length of lockdown was uncertain, the AO Trauma North America Education Committee needed to make decisions on how to meet the needs of surgeon learners—residents, fellows, and practicing surgeons in the absence of

face-to-face events. All the standard face-to-face AO Trauma Courses were cancelled indefinitely. An AO Trauma North America Lower Extremity Deformity and Nonunion Course was scheduled to occur in April 2020. Based on the educational void created by COVID-19 lockdown, the decision was made to change the upcoming course from a face-to-face 3-day course with cadaveric specimens to a synchronous (live) virtual course that would span 10 weeks. To the best of our knowledge, AO had never run a full synchronous virtual course over multiple weeks. At the time, standard online offerings included webinars—varying from individual lectures or panel discussions that occurred based on a predefined schedule. Furthermore, no one had ever attempted to do a virtual discussion group using breakout rooms. Discussion groups are critical to a participant's ability to apply knowledge in the real world. Although we knew that hands-on practical exercises would not be possible, we wanted to provide more than just a webinar every week. There was no handbook on how to put all this together and deliver a successful online educational course.

Although AO prides itself on teaching, we had previously not designed and offered a completely virtual synchronous course. Having a strong background in backward planning and structuring courses and interactions based on the AO's 7 principles of adult learning<sup>1</sup> including addressing learner needs, helped us to take what was planned for the face-to-face event and transfer it to a synchronous virtual course. The purpose of this article was to share the lessons learned regarding organization, format, and logistics; development of appropriate content and learning interactions; faculty engagement; and strategies for continuous improvement.

## COURSE PLANNING

The AO Trauma North America Lower Extremity Deformity and Nonunion Course, which was a masters-level course in the AO Foundation's course organization and hierarchy, was to occur in April 2020 in North America. It was the first time in AO history that there was going to be an entire course dedicated to, what some consider a dying art, realignment and correction of lower extremity deformities and nonunion. For the planned 3-day live event, the agenda included 5 modules including discussion groups, lectures, and practical exercises. Brett Crist and Michael Sirkin were the course chairs.

The course chairs and the AO Trauma North America Education Committee had several questions. How could the existing curriculum fit into a synchronous virtual format? First, we realized that the practical exercises that included

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synthetic bone model and cadaveric exercises were impossible. Therefore, the plan was always to have a stand-alone face-to-face practical session once face-to-face events were allowed. We tentatively planned this for the fall of 2020.

The next step was to decide on how and when to run the online event. There were several questions that needed to be answered. How should the intended face-to-face course be divided? How many weeks should this course run? When would participants and faculty be available to participate—what day, what time, and how long? Would anyone attend a multiple week course?

## Platform

How should we present the material? Remember, this was March 2020. Most of the online platforms were not meant to accommodate hundreds of participants and did not have the capability to have multiple meeting rooms occurring concurrently that was required for discussion groups. We chose the Zoom (Zoom Video Communications, San Jose, CA) platform because it met the needs indicated above. A component of the precourse and debrief sessions involved reviewing software/internet connectivity challenges and solutions. All faculty became very facile with this software in the months that followed.

## Timing

After multiple online organizational meetings, we decided on the 10-week schedule that included 5 modules and 3 small-group discussions. As previously indicated, some modules spanned 2 weeks. The goal was to determine a day of the week that would be available for most participants at a time that allowed all North American time zones to participate. We determined that the primary session(s) for each module would be held every Saturday morning. As we continued to think through the curriculum, we decided that the maximum time that participants could stay engaged at any one time would be 90 minutes. In the end, Saturday 10:00–11:30 AM EST was chosen to meet the needs of participants throughout North America—ranging from 7 AM on the west coast to 10 AM on the east coast. Although we only considered North America, this time was good for most of the world. Much to our surprise, many of the participants were from all over the world. It seemed that surgeons were in dire need of something to occupy their time during the global pandemic lockdown. During this time, most elective surgery, all travel and all face-to-face meetings were cancelled. Our course turned out to fill this void. During the first session, we had

approximately 200 people logged on, and they remained logged on for the entire 90 minutes.

## Course Format

The plan was to keep the same 5 modules that were planned for the face-to-face event that covered preoperative evaluation and planning, and lower extremity osteotomy/nonunion indications and techniques broken up by the region from the femur to the distal tibia (Table 1). Three virtual discussion groups were also planned. Some modules occurred more than 2 weeks. We organized each synchronous session into 90 minutes where there would 3–4 lectures with opportunity for questions and answers. Each lecture session would end with 30-minute panel case discussions with participant questions. We were using what we knew about our face-to-face courses and modules and were translating it into the virtual form. It seemed like a reasonable plan because it worked live and face-to-face. We determined that for this course to be successful, preparation was key. Each module, and all faculty, had to be prepared even more than usual, and everyone needed to be on the same page. If disorganized or unprepared, we believed we would lose the audience and the course would be a failure. To increase faculty engagement, we planned a precourse meeting every week before the live event. During the precourse, we would discuss the logistics of the session with the online platform and timing, session learning objectives, and content and allowed the faculty to practice with the online platform to improve efficiency. Finally, the faculty would go over all the cases that would be used for the module.

Because of the complex nature of the material, we decided that it was necessary to have review session after the learners had time to reflect on the material that was presented. This session included reviewing related cases for the session, get participant questions answered, and even invited participants to submit their cases to be discussed by faculty during the session. This required the chairs and all the faculty for each module to be present another day during the week for 60 minutes. Finally, each live session and review session incorporated a debrief with faculty and technical staff, immediately after the session, to review what went well and areas of improvement for the next session. What we learned was that it was going to take more time for each faculty member and the chairs. Therefore, each session required a 2-week commitment for the involved faculty. We would try not to have all the faculty at each precourse session, only those who were participating in the upcoming weeks. To get the course heading in the right direction and help all the faculty understand expectations, the course chairs were the first 2 module chairs to make sure the modules fulfilled the vision for the course and kept the module organized. The subsequent module chairs were responsible for precourse meetings of their sessions with aid and direction from the course chairs.

## Critical Components

The precourse(s) and debrief sessions turned out to be critical. Our first precourse had about half the faculty, and we began the task of laying out our vision and gaining acceptance. The goal was to get everyone on the same page

**TABLE 1.** Course Modules

Module	Topic
1	Deformity evaluation and preoperative planning
2	Proximal femur deformity
3	Femoral diaphysis
4	Periarticular knee—distal femur and proximal tibia
5	Diaphyseal and distal tibia

and minimize risk of a poor-quality course. We began to realize this was going to take more time than an in-person course. Because the intended face-to-face course involved some of the most experienced and talented faculty in AO Trauma North America, we believed that everyone would be willing to jump on board. However, several of the experienced faculty expressed concern that it would never work, and we would not accomplish anything. Our response was, “What do we have to lose?” We quickly learned that we had to convince the faculty. We did this by presenting our vision for the course, creating the format and outline for the course, and laying this out to all the faculty. The chairs continued enthusiasm and persistence, and the experience that the faculty had during the sessions led to the hesitant faculty beginning to get more engaged. The weekly precourse meetings and postsession debriefs were critical for modifying the course in real time. We would go over the course schedule, get ideas, and shape the sessions based on the agenda each week. It allowed the course to get better each week. This worked, and after the early success and positive feedback we received, all the faculty agreed that what they had produced had a significant impact on the educators and more importantly the participants.

### Virtual Small-Group Discussion Challenges and Lessons

How should a small-group discussion be run virtually? We planned 3 discussion groups during the 10-week course. Initially, we did not know how to run small-group discussions through a virtual format. The lessons learned include:

1. Fast internet connection is required to allow all participants to use video. It is impossible to run effective small-group discussions without “looking” at the participants. We found many international participants did not feel comfortable speaking up because of the language barrier. As we realized this during the first discussion group, we incorporated faculty as participants in the discussion groups to facilitate discussion and avoid limited participation.
2. After the first discussion group, we asked the participants for their preferred method for the small-groups. Based on their feedback, we changed the small-group discussion format to expert panels composed of the faculty from the involved modules. We did this for the remaining planned discussion group sessions, and it seemed to work particularly well based on participant feedback. We found that what worked best for these sessions was to have the faculty present cases they prepared instead of having a moderator present the cases. Furthermore, the session moderator or chairs went through all the session’s cases and added slides in the appropriate area where discussion could occur from the expert panel. Questions such as “what options were you thinking about? Or why go medial and doing an opening wedge osteotomy instead of going lateral and doing a closing wedge? To create a consistent format and high quality, it was beneficial to have all of the slides reviewed and modified by a consistent person, but the content was not changed.

3. Like typical small-group discussions, it was helpful to use 2 expert panel moderators. One moderator focused on running the session and keeping forward momentum. The other moderator focused on organizing participant questions that were received through the question-and-answer function of the online platform to determine which questions should be asked of the panel that would be beneficial for all participants to hear versus responding to individual questions through the question-and-answer function. We were also not afraid to say this will be covered in a later session to keep everything on track.

### OTHER LESSONS

Other key elements contributed to the successful implementation of the course. During precourses meetings, we emphasized the technical logistics of how the session was going to proceed. We practiced turnovers, from moderator to lecturer and back again. We made sure everyone knew how to share their screen and use the mute and video buttons quickly and effectively. This might seem trivial now, but this was performed before many people had even heard of Zoom. We found it very helpful to have the speaker’s video on while running the session and giving a lecture for 2 reasons. First, because we were recording these sessions for later use, it seemed more real to see the speaker when it was not live. Second, without seeing the presenter, the slides are just talking, and this form of education seemed very impersonable and easier to lose participant engagement.

We did try to incorporate some practical exercise homework to improve participant understanding and engagement for complex topics. For the first module on preoperative planning, we assigned cases to practice preoperative planning using an existing free online digital planning software (Detroit Bonesetter, Detroit, MI). Participants were able to practice what they learned on their time and at their pace to really make sure they understood how to do radiographic preoperative planning. We reviewed the homework cases during the review session and answered participant questions to really solidify how to do preoperative planning. This turned out to be an important part of the learners understanding of these important concepts and allowed them to practice with digital templating.

### Content Access and Postevent Engagement

Over the 10 weeks, 3463 devices logged on to the course. Although we have no idea how many people attended on each device, we do know that the most “attended” Saturday session was the Periarticular Knee Deformity session with 675 separate logins, and the lowest attended Saturday session was 192. For the weekly “Ask the Experts” session, participants ranged from 108 to 191 participants. The small-group discussion sessions ranged from 33 to 46 participants. Based on registration data, we do know we had a worldwide audience. This was an unintended benefit because it was supposed to be a North American course.

### YouTube

Each session was recorded. After the live session, the recording was edited and placed on the AO Trauma North

America YouTube channel. This gave everyone who wanted a chance to review the previous week's material. The content was available as an entire session or individual presentations. In essence, we created a purely virtual course that can be viewed at the learner's pace by recording the modules and then editing them.

When the AO Trauma North America Lower Extremity Deformity and Nonunion Course went live, the AO Trauma North America YouTube was in its infancy with less than 100 subscribers. Currently, there are more than 8300 subscribers, 2 years later. The course resides in a playlist in the AO Trauma North America YouTube channel. There are 56 videos in the playlist. Each lecture can be found independently or within its original 90-minute session. There are also additional materials including the homework on preoperative planning, tutorials on digital templating, and expert panels. There have been more than 10,000 views and within the last 28 days. Currently, these videos are still on-line and available for anyone to do the didactic portion of the course on their own. Of course, we do not believe the course to be complete without live discussion or on-site practical exercises. In March of 2022, we were finally able to have a face-to-face event that emphasized the practical exercises.

### Challenges

Marketing was an issue. The original face-to-face course was planned for 30 participants because there were cadaveric practical exercises. Because a virtual course could include well more than 100 participants, the plan was to increase the touchpoints and the reach through marketing. However, there was a very short time between switching to a virtual format and the start of the event. Weekly email blasts continued to promote upcoming modules. In the end, there

was an average of approximately 100 participants for the Saturday sessions. We deemed this very successful in light of the situation.

One of the major challenges we experienced was faculty burnout. To ensure the best quality and experience for the participants, we asked a lot of the faculty during their assignments. As we pointed out, the time commitment was substantial for every faculty member, so we tried to limit the faculties commitment to a 2-week block, especially after changing the small-group discussion format.

### CONCLUSIONS

Spring of 2020 was a unique time for orthopaedic education. All learners experienced a huge void in quality education opportunities because of the pandemic. As it turned out, we were able to fill this void for surgeons from around the world who were looking for education and those who wanted to teach. It gave people something to look forward to—whether it be challenging their mind or interacting with their colleagues. When starting new educational endeavors and ways of delivering it, having passionate leaders who are committed to the process is critical to success. They become the glue that keeps everything together and moves it forward. Being able to modify things in real time based on feedback helped keep faculty and participants engaged. By the end of the 10 weeks, the faculty and participants gave incredibly positive feedback. This format and the experiences/lessons learned helped shape every AO virtual course that has been performed since.

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# Experiences From Implementing 3 Distinct Types of Online Events for Subspecialty Orthopaedic Trauma Education in the Middle East and Northern Africa

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## INTRODUCTION

**Summary:** Faced with the challenge of running face-to-face subspecialty courses for experienced surgeons in 2020 and 2021, the Middle East and Northern Africa region of Arbeitsgemeinschaft für Osteosynthesefragen Trauma decided to explore the possibility of conducting online education. Appointed faculty chairpersons were invited to design online programs and plans. Three event types were designed and implemented: live online courses delivered over multiple weeks, live online masters-level courses delivered over 3 consecutive days, and a blended course delivered over 2 consecutive days online, followed by 1 day in an anatomical specimen laboratory. Standard evaluations were implemented for each event, and faculty and participant feedback was gathered. The events were attended by 214 surgeons (averages of 42, 31, and 36 participants, respectively, for the 3 event types). The average percentages of participants who reported they “learned something new and plan to use it in my practice” were 78%, 78%, and 93%, respectively. The average percentages of participants who would recommend the event to colleagues were 94%, 97%, and 100%, respectively. The evaluation data suggest that some knowledge gaps were addressed adequately through online delivery. All 3 event types were delivered successfully, with some personal preferences by the participants for each format. Key factors for success were the relevance of the content for the participants, excellent faculty preparation, and training, low commercial bias, and strong support from event organizers and technical teams.

**Key Words:** surgeon education, orthopaedic trauma, online learning, continuing professional development, continuing medical education

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Because education plays an important part in stimulating innovation and research that the Arbeitsgemeinschaft für Osteosynthesefragen (AO) is promoting and strongly supporting, each year the AO offers globally approximately 800 educational events, supported by nearly 7000 faculty and attended by more than 55,000 learners. The events run by AO trauma can be regarded as the most comprehensive resource for life-long learning for orthopaedic trauma surgeons around the world.

The AO has recognized very early the importance of e-learning by providing very rich educational assets on its website in addition to webinars and webcasts that in 2019 made up 8% of the yearly AO trauma educational events (46 events of 482). When the world experienced the COVID-19 pandemic in early 2020, the AO faced the challenge of shifting many scheduled onsite events to a full online format. This shift was not simply a transition of the content to an online format but required a complete redesign of the courses supported by the available published evidence.<sup>1–6</sup> Chairpersons for the earliest events worked hard with AO education project managers, event organizers, educators, and curriculum developers to solve problems with event agendas, timing, teaching, and evaluation methods. The earliest events started with a variety of educational formats that evolved and developed gradually from one event to the next, integrating new approaches and technology. Gradually, a blended learning format that combines online components with a face-to-face component was introduced. In 2020, 59% of the 323 AO trauma events were online (189 online events), whereas in 2021, among the 322 AO trauma events, 30% were online (96 events), 16% were blended (53 events), and 3 events were hybrid (some participants onsite and some participants online). Comparing these with 9% in the pre-COVID era, the impact of the pandemic was noticeable.

The current retrospective study describes the earliest 6 online AO trauma educational experiences in the Middle East and Northern Africa (MENA) region in 2020 and 2021, regarding design, time frame, and methods of delivery. The aim is to answer questions about the optimal design and delivery of content, such as fully online or blended, full-day(s), or shorter session over multiple weeks. Participants' feedback and evaluation reports, as well as chairpersons' postevent reports, represented important input about these

events and should be considered with the aim of refining future online events.

**Methodology**

The education committee and regional board of AO trauma MENA selected topics for practicing surgeons to deliver as online events and appointed expert, trained faculty as chairpersons for these courses in 2020 and 2021. The events were scheduled in the event calendar for the region, and the days and times for each online module were agreed upon through local expert opinion (most online sessions in the multiple-week events were delivered between 6 and 10 PM local time while the events with longer sessions in one day tended to run between 8 AM and 5 PM).

**Design**

The event chairpersons defined the goals, learning objectives, and target audience and then selected appropriate methods and activities to deliver the knowledge and attitudes they wanted to address for online courses, as well as skills for the blended course. The most selected educational methods for synchronous online delivery were presentations, small group discussions, plenary case discussions, and faculty panels. In some events, asynchronous preparation materials were included in the form of surgical approach and procedure videos and assessment questions. Content (activities) was grouped into modules.

A structure for the multiweek events integrated presentations (maximum 10 minutes each), followed by a 1-hour small group discussion (typically had 8 participants and 2 faculty) and usually concluded with plenary case discussions where one faculty presented a case to the entire audience and then answered questions from participants and faculty.

**Faculty**

An appropriate number of national, regional, and international faculty were invited for each event. They took part in online training designed based on the principles taught in the AO Faculty Education Program and conducted by the AO Education Institute to learn how to optimize teaching online and how to use the selected technologies. They also attended a 2-hour faculty precourse meeting to review all content and delivery plans and joined the synchronous online events at least 30 minutes before the participants for each session.

**Participants**

Surgeons from the MENA region were informed about the events through the website and email advertising. They registered and paid the course fee online. Participants were offered opportunities to be guided through the online systems and testing for webcams and audio quality (the quality of internet connection and sound are critical to the successful running of online discussions).

**TABLE 1.** Description of the Online Interventions Implemented

Event Title [A, B, etc]	Content and Delivery	Duration	Participants	Faculty	Conference Platform	Fee
[A] AO trauma course—orthopedic infection (online) June and July 2020	3 modules delivered in 2 sessions per week over 3 wk: general principles, fracture-related infections (FRI), infections in special situations	10 h	36	13	Adobe connect	Free
[B] AO trauma course—soft tissue care in trauma August 2020	4 modules delivered in 2 sessions per week over 4 wk: basics of soft-tissue care, acute management of soft-tissue injuries, soft-tissue reconstruction, limb salvage/amputations	12 h	48	10	Adobe connect	Free
[C] AO trauma online masters course—knee October 3–5, 2020	Preparation videos (approaches and procedures). Five modules over 3 consecutive days: tibial plateau fractures, distal femoral fractures, knee deformities, deformities around the knee, post-traumatic knee deformities	11 h	44	11	Newrow	200 USD
[D] AO trauma masters course—shoulder (online) October 30–November 1, 2020	6 modules over 3 consecutive days: clavicle and AC joint, scapula, proximal humerus, humeral shaft, complications, meet the experts	12 h	26	11	Newrow	200 USD
[E] AO trauma masters course—foot and ankle (online) November 20–22, 2020	6 modules over 3 consecutive days: ankle fractures, pilon fractures, talar fractures, calcaneal fractures, midfoot trauma, and sports injuries	12 h	24	8	Newrow	200 USD
[F] AO trauma blended masters course—lower extremity trauma (with anatomical specimens) November 2021	7 modules delivered online over 2 consecutive days: femoral head and neck, trochanter, distal femur, knee, proximal tibia, tibial shaft, distal tibia, and pilon 1 d in the anatomical specimen lab	14 h (7 online and 7 face-to-face)	36	12	Newrow	950 USD



### Delivery

These online activities were delivered using video conferencing and online meeting systems for synchronous delivery, using their plenary and breakout room functionalities (Adobe Connect and Newrow). A technical team member and an event organizer supported each session. A learning management system (Totara Learn) and survey software were also used to deliver materials, offer a home page with links to the live activities, and gather data.

### Evaluation

The standard AO evaluation and assessment system and questions were administered, with participants being invited by email to complete pre-event and postevent questions

online.<sup>7</sup> Additional questions were administered weekly in the early events to monitor what was going well and to identify what could be done differently.

### Ethical Approval

Ethics exemption was granted from the Ethics Committee of the Canton of Zurich (Req-2022-01402).

## RESULTS

To respond to the challenge of running face-to-face subspecialty courses during the COVID-19 pandemic, 6 new courses were designed and delivered using 3 distinct approaches in the AO trauma MENA region between June 2020 and November 2021 (Table 1): (1) live online course

**TABLE 2.** Profile of Participants in the Courses

Question (Courses Listed A to F from Table 1)	A	B	C	D	E	F
Years of experience: When did you graduate from medical school?						
0–2 y ago	9%	2%	3%	0%	0%	0%
3–5 y ago	9%	14%	8%	12%	6%	22%
6–10 y ago	34%	33%	19%	18%	22%	44%
11–15 y ago	13%	24%	30%	35%	22%	22%
More than 15 y ago	34%	26%	41%	35%	50%	13%
Type of practice: I do mostly ... (>50% of time)						
Orthopaedic trauma	84%	74%	70%	65%	61%	78%
General orthopaedics (joint replacement, etc)	9%	12%	8%	0%	11%	13%
General trauma	0%	2%	5%	6%	6%	0%
Specialty orthopaedics (eg, sports injuries, shoulder surgery, pelvis surgery)	6%	7%	14%	29%	11%	9%
Others	0%	5%	3%	0%	11%	0%
How many cases do you treat on average per month on the topic(s) covered in this event?						
0 cases	0%	2%	0%	0%	0%	0%
1–5 cases	50%	24%	27%	18%	33%	22%
6–10 cases	25%	33%	27%	18%	39%	38%
11–15 cases	13%	24%	19%	24%	17%	19%
16–20 cases	13%	12%	11%	18%	6%	9%
More than 20	0%	5%	16%	24%	6%	13%
What is your main practice location?						
Level I trauma center	16%	17%	22%	29%	28%	31%
Level II trauma center	28%	19%	27%	24%	22%	16%
Local or community hospital	16%	26%	24%	12%	22%	9%
University hospital	34%	33%	8%	12%	6%	16%
Private practice	6%	2%	16%	24%	17%	25%
Others	0%	2%	3%	0%	6%	3%
Motivation to learn by event objective: what is your present and desired level of ability for the following event objectives?						
Largest reported gap	2.2	1.6	1.9	1.4	1.8	1.5
Smallest reported gap	1.5	1.4	1.3	1.2	1.1	0.9
Average pre-event reported gap	1.758	1.47	1.63	1.31	1.41	1.23

A = AO trauma course—orthopedic infection, B = AO trauma course—soft-tissue care in trauma, C = AO trauma online masters course—knee, D = AO trauma masters course—shoulder, E = AO trauma masters course—foot and ankle (online), F = AO trauma blended masters course—lower extremity trauma (with anatomical specimens).

delivered over multiple weeks (infection and soft tissue), (2) live online course delivered over 3 consecutive days (knee, shoulder, and foot and ankle trauma), and (3) blended course delivered over 2 days live online, followed by 1 day in an anatomical specimen laboratory (lower extremity trauma). A total of 214 participants and 65 faculty attended the 6 courses (Table 1). The educational structure and participant profiles are shown in Tables 1 and 2. The course participants were diverse for the level of experience (years after graduation and number of cases), practice type, and location. This reflects the level of the courses, for example, masters-level courses are aimed at more experienced surgeons.

To define the overall impact of the courses, we considered 3 main aspects. First, we analyzed whether the courses met the audience’s needs. In all courses, most

participants learned something new and planned to use it in their practice (range 68%–93%), and the content was useful to their daily practice (Table 3). Second, we analyzed how well the course competencies/objectives were met. In all courses, learning objectives were met for most participants with an average score above 4.05 on a Likert scale of 1–5 (Table 3). The third aspect we analyzed was the participants’ present and desired level of ability (the “gap score” shows the motivation to learn) for each of the competencies/learning objectives both precourse and postcourse.<sup>8,9</sup> In all courses, the gap between the present and desired level of ability for each competency was reduced postcourse (range of reduction of 0.39–0.72) (Table 3), suggesting that learning occurred.

To measure the satisfaction of participants, we analyzed the effectiveness of the faculty (range 3.79–4.55 on a Likert

**TABLE 3.** Summary of Participant Evaluation Data From the Online and Blended Courses

Question (Courses Listed A to F from Table 1)	A	B	C	D	E	F
Response rate	80%	80%	68%	88%	83%	88%
What was the overall impact of this educational event?						
I learned something new and plan to use it in my practice	80%	68%	83%	77%	75%	93%
It reconfirmed that what I do in my practice setting is appropriate	17%	13%	13%	18%	15%	7%
To what degree were the stated objectives met? 1 = not met at all, 5 = fully met						
Highest rating of an objective	4.60	4.13	4.37	4.45	4.65	4.67
Lowest rating of an objective	4.33	4.00	4.23	4.09	4.40	3.50
Average for all objectives	4.53	4.05	4.31	4.17	4.53	4.34
How useful was the content to your daily practice?	4.07	3.69	4.03	4.05	4.40	4.50
How effective were all faculty in the role they played?	3.97	3.79	4.10	4.23	4.55	4.37
Would you recommend this event to your colleagues?	97%	93%	97%	95%	100%	100%
Did you perceive this event to be commercially biased? (5 = no bias)	4.40	4.51	4.57	4.68	4.75	4.17
Please rate the venue/location (or online experience)	3.50	3.21	3.10	3.45	3.20	3.40
Participants who reported the venue or location met or exceeded their expectations	87%	79%	77%	86%	85%	90%
Who covered the overall cost of you participating in this event?	Free	Free				
Paid by myself	—	—	80%	95%	70%	47%
All costs covered by hospital	—	—	0%	0%	10%	13%
All costs covered by the industry	—	—	17%	0%	10%	20%
Combined sources of funding	—	—	3%	5%	10%	20%
Postevent gap scores by event objective: what is your present and desired level of ability for the following event objectives?						
Largest reported gap	1.1	0.8	1.2	0.9	0.9	1.0
Smallest reported gap	0.7	0.7	0.7	0.7	0.6	0.7
Average postevent reported gap	0.792	0.71	1.02	0.80	0.69	0.84
Gap reduction (pre-post)	0.966	0.76	0.62	0.51	0.72	0.39

A = AO trauma course—orthopedic infection, B = AO trauma course—soft-tissue care in trauma, C = AO trauma online masters course—knee, D = AO trauma masters course—shoulder, E = AO trauma masters course—foot and ankle (online), F = AO trauma blended masters course—lower extremity trauma (with anatomical specimens).

scale of 1–5), the online experience (venue; range 3.2–4.35 on a Likert scale of 1–5), and if the participant would recommend the event to a colleague (range 95%–100%) (Table 3). Table 4 shows data from weekly ratings of the activities by both participants and faculty for 2 of the courses. Lectures, small group discussions, and plenary case discussions were well rated. Figure 1 shows the end of event feedback data regarding the time allocated to methods/formats (lectures, small group discussions, plenary case discussions, questions, etc.) used during the 2 courses delivered over multiple weeks. The data show that there are personal preferences for each format.

### DISCUSSION

In this article, we show that all 3 online course types (carried over several weeks, over 3 consecutive days, or blended) designed and implemented in the AO trauma MENA region in 2020–2021 were delivered successfully. Key factors for success were the relevance of the content for the participants, excellent faculty preparation and training, low commercial bias, and strong support from event organizers and technical teams. The evaluation data of the 6 AO trauma MENA courses suggested that some knowledge gaps were addressed adequately through online delivery. Any changes in attitudes or skills through online activities alone are difficult to prove, although the higher ratings with the blended course may suggest this is an optimal approach when technical skills are involved.

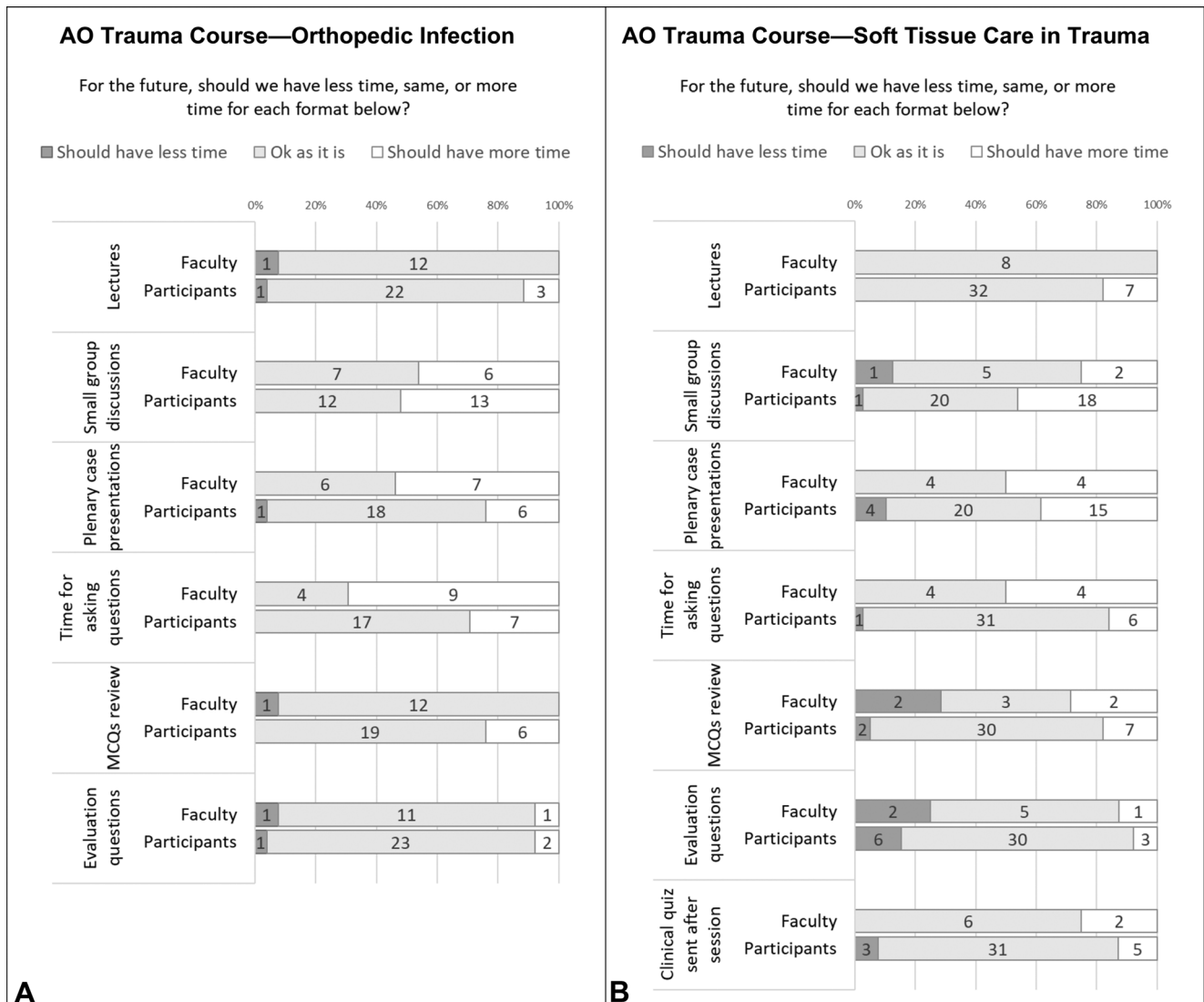
The major challenge encountered at the beginning of the pandemic was how to transform the format of AO events without losing the ability to achieve the learning objectives stated and ultimately the expected outcome. Traditionally, technical skills were mostly taught hands-on in a face-to-face

setting, and AO practical exercises and anatomical specimen laboratories were major attractions for participants at AO events. Interactive face-to-face small group case discussions represented an additional significant attraction for participants. The transformation to online courses had to involve methods of delivery, implementation, and evaluation. The earliest events started with a variety of educational methods based on the available evidence at that time (AO Principles of Teaching and Learning, 2005).<sup>10</sup> Formats evolved and developed gradually from one event to the next based on our experience, evaluation data, and newly generated evidence. One of the first learnings was that staying on schedule was a challenge during online events because both online lectures and case discussions in small groups took more time than onsite discussions and because of technical problems. As a consequence, a bit of buffer time in the program was added to subsequent events, and a suggestion was made for shorter presentations and fewer cases to allocate more time per case in the discussions. Another suggestion was to include fewer lectures and add more small group discussions and plenary case discussions which are more interactive and engaging. In addition, a break of 2 hours or longer should be included in the session. The added buffer time and breaks helped also with the resolution of technical challenges for faculty and participants. For the same reason, few strategies to address connection problems were implemented, such as assigning a standby faculty to take over presentations or small group discussions, assigning a chat moderator to answer questions, involving participants that could not join live discussions because of microphone problems, and creating a WhatsApp (Meta Platforms, Menlo Park, CA) group for easy and instant communication among faculty. In addition, clearer instructions for participants were sent before the course including how to use the online platform, how to check and optimize

**TABLE 4.** Weekly and Overall Evaluation Ratings of Activity Types (by Participants and Faculty) for the 2 Courses Delivered Over Several Weeks\*

<b>Ratings in Course A</b>	<b>June 18</b>	<b>June 22</b>	<b>June 25</b>	<b>June 28</b>	<b>July 2</b>	<b>July 6</b>	<b>Average</b>		
Lectures—participant responses	3.71	—	4.02	—	4.16	—	3.96		
Lectures—faculty responses	4.37	—	4.44	—	4.45	—	4.42		
Small group discussions—participant responses	4.39	—	4.04	—	4.24	—	4.22		
Small group discussions—faculty responses	4.33	—	4.2	—	4.45	—	4.32		
Plenary case discussions—participant responses	—	3.92	—	4.13	—	4.11	4.05		
Plenary case discussions—faculty responses	—	4.57	—	4.80	—	4.54	4.63		
<b>Ratings in Course B</b>	<b>July 9</b>	<b>July 13</b>	<b>July 16</b>	<b>July 20</b>	<b>July 23</b>	<b>July 27</b>	<b>July 30</b>	<b>Aug 3</b>	<b>Average</b>
Lectures—participant responses	3.75	—	3.86	—	4.00	—	3.93	—	3.89
Lectures—faculty responses	4.29	—	4.5	—	4.38	—	4.40	—	4.39
Small group discussions—participant responses	3.79	—	3.88	—	3.91	—	3.53	—	3.78
Small group discussions—faculty responses	4.13	—	4.29	—	4.14	—	4.40	—	4.24
Plenary case discussions—participant responses	—	4.48	—	3.92	—	4.00	—	3.85	4.06
Plenary case discussions—faculty responses	—	—	—	4.67	—	4.67	—	4.75	4.70

\*Two courses: AO trauma course—orthopedic infection (A) and AO trauma course—soft-tissue care in trauma (B).



**FIGURE 1.** Responses regarding time spent on each format (white = should have more time) for the 2 courses delivered over several weeks.

internet connectivity, and rules and instructions for online discussions.

It was also clear from the first courses that the optimal number of participants per group in the small group discussion was 6–8 participants with 1 or 2 faculty. This was also reported in the study by Roels et al<sup>11</sup> was based on feedback from both learners and instructors.

It is interesting to note that the first 2 courses stretched over many weeks had the lowest faculty rating. It has been previously reported that experienced surgeons participating in an 8-week course would have preferred a more compact delivery format.<sup>11</sup> Therefore, we can speculate that the low-faculty ratings in the multiweek courses were possibly because of fatigue of both faculty and participants resulting in less engagement. However, Azi et al<sup>12</sup> describes the effectiveness of an online infection course run in Latin America similar to the one delivered in the MENA region. The 12-hour

course included lectures, small-group clinical case discussions, and panel case discussions divided into 4 3-hour modules, once a week for 4 consecutive weeks.<sup>12</sup> It is also important to consider that in the study by Roels et al<sup>11</sup> surgeons still in training or early in their career preferred spaced education to have more time to digest the information. Therefore, the decision for a compact version or stretching an event over multiple weeks should be mainly based on the target audience and their preferences. The following 3 AO trauma MENA courses delivered over 3 consecutive days were masters-level courses targeted at more experienced surgeons as shown by the participants’ profiles.

Another possible explanation for the lower-faculty rating is that in the first courses, the faculty still had to familiarize themselves with the new online environment and were less effective.<sup>13</sup> The faculty training to introduce the online teaching principles and the video conference platforms

combined with the increased experience with online teaching could account for the improvement.

## CONCLUSION

This retrospective study showed that all 3 online education formats described can be a good alternative to traditional face-to-face, onsite teaching. However, online education is suitable for selected topics, mainly those where factual knowledge, discussions, and debates play an important role.

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# AO Trauma Latin America Research Talk-Show—A New Tool for Medical Research Education

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**Summary:** In recent years, especially driven by concerns generated by the COVID-19 pandemic, there has been a growing interest in online activities for the training of orthopaedic surgeons of all ages and levels of expertise. In this context, continuing education also focuses on improving research knowledge with several online courses promoted by different medical associations. AO Educational Events have been recognized for offering several courses to develop specific competencies related to medical research, such as AOPEER, Continuous Education Program Research, AOne, among others. Despite the high quality of these courses, many orthopaedic surgeons are disinterested in the academic rigor of the programs which are outside of their everyday reality, ultimately missing the chance to become more familiar with medical research, especially in an online environment. Recently,

AO Trauma Latin America (AOTLAT) started a new educational activity in a chat format, interviewing renowned medical researchers in a more relaxed, but no less academic way, focusing on aspects related to research. Since its inception, several physicians have been interviewed at the AOTLAT Research Talk-show, with satisfactory results both in terms of number of participants and feedback. In the present study, we describe the dynamics of this activity and report our results 2 years after its completion.

**Key Words:** online medical education, medical research education, research progress, member development

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## INTRODUCTION

Medicine is a dynamic science that requires ongoing education throughout the working life, and research is essential to improve the interface between medical education and practice.<sup>1</sup> In addition, modern medicine is based on the search for evidence that leads to specific diagnoses and treatments, requiring physicians to know the importance of scientific research and understand the process for the formation of evidence.<sup>1,2</sup>

Carberry et al<sup>3</sup> highlighted the importance of teaching scientific research during the medical student's undergraduate period, and depicted that recent educational tools have been successfully used, such as web-based seminars, gamification, laboratory training, and other curriculum initiatives to enhance research skills acquisition. However, this is not reflected into medical professionals' lives, with few pursuing an academic career.<sup>1</sup> Moreover, although the main focus remains on students entering medical school, both educators and surgeons need to understand that an undergraduate course only takes a few years, while professional activity continues for decades (Fig. 1).<sup>4</sup>

In this scenario, understanding the factors contributing to the lack of interest in research among physicians is crucial and intriguing. Research is an act of resistance, which requires several characteristics beyond the individual dedication and self-awareness, such as scientific training, funding, institutional resources, approval of ethics committee, and time.<sup>5</sup> While these barriers have been successfully recognized and gradually addressed in higher-income countries, problems and obstacles remain active in most low and middle-

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### Evolution and Broadening of Scientific Knowledge

**FIGURE 1.** Evolution and broadening of scientific knowledge throughout life. Image used with permission from Asdrubal Falavigna, MD, PhD.

income countries.<sup>5,6</sup> Therefore, increasing the educational offerings in medical research is necessary to ensure cost-effective, high-quality health care to their population.

In the present article, the authors briefly present the educational actions in research carried out in Latin America since the beginning of the COVID-19 pandemic and specifically describe the creation, implementation, and dynamics of Talk-Show activities, reporting our results 2 years after its completion.

### Research Support Group

With the beginning of the pandemic in December 2019, the concept of distance education needed to be accelerated, greatly influenced by the uncertainties brought about by the new disease. As a result, the way of working also needed to be different, moving from something more personal, based on the individual perception of what needs to be taught, to a workforce concept, bringing together a group of experts in each discipline and optimizing the form of medical education. In this scenario, the AO (Arbeitsgemeinschaft für Osteosynthesefragen) Foundation has been fully committed to consistent and continuous medical education, with several online synchronous and asynchronous activities. In Latin America, the board of AO Trauma (AOTLAT) created the Research Support Group (GAI—*Grupo de Apoyo a la Investigación*), with professionals from different countries in the region and of different age groups, all members of the AO, with great interest in both scientific research and continuing medical education.

The group composed of 10 members and a chair began working together in August 2020, with monthly online meetings. Among the primary GAI's attributions were the creation and development of different lines of research, the evaluation and support of projects submitted with a request for financial support (pilot grants), if approved after evaluation by the group, and the creation and development of new educational tools for the AO community of the Latin American region.

In Latin America, driven by concerns generated by the COVID-19 pandemic, there has been a growing interest in online educational activities, regardless of age and expertise. In this context, continuing education also focuses on improving research knowledge with several online courses promoted by different medical associations.<sup>7,8</sup> AO Educational Events has been recognized for hosting some of these events, offering several opportunities to develop specific competencies related to medical research, such as AOPEER, Continuous Education Program Research, AOne, among others. Despite the offered content, orthopaedic surgeons and residents have

little or no interest in the extremely academic programs of something outside their everyday reality, missing the chance to become a more familiar with medical research, especially in an online environment.

Following the trend and audience success achieved by the newly created podcasts and other web tools for medical education,<sup>9</sup> GAI developed an online chat activity with promising AO surgeons around the world, with outstanding recognition as researchers. In an informal and relaxed way different aspects of scientific research were discussed; the aim was to show the audience that research is an integral part of continuing medical education. Moreover, we wanted to demystify the image that only researchers publish, showing everyone that research is a necessary and growing aspect of medicine.

### AOTLAT Research Talk-Show

In August 2020, AOTLAT started the new educational activity in a webinar format, interviewing renowned medical researchers in a more relaxed, but no less academic way, focusing on practical aspects related to research.

We adopted the Zoom platform (Zoom Video Communications, Inc, California, CA), a globally recognized web conferencing tool that allows attendees to listen, interact, ask questions, text chat, and reply to polls, among other possibilities, with an individual private account maintained by the AOTLAT for all online educational activities and board meetings. An individual link to join as an attendee was sent to all registered participants, which allowed the expected number of participants to be predicted before each webinar. For the Talk-Shows, attendees were a view-only participant, thus not allowed to start video, share their screen, activate their microphones, or record. They were encouraged in the beginning of each webinar to intensely interact with the host and the panelists through the Q&A and the chat. Each webinar was designed to last 90 minutes, with a start time adjusted to cover all countries in the region at a time after the workday. This allowed us to always have an average captive audience of 80 attendees, ranging from 50 to 120, depending on the season, topic, and guest(s). The first Talk-Show took place in November 2020 and the last in March 2022, for a total of 7 webinars to date.

In the first 2 Talk-Shows, 3 regional guests (2 AO Trauma members and 1 AO Spine member in each webinar), who were all senior surgeons and directly involved with scientific research, discussed extensively why the activity was created and its potential use as an important tool for demystifying the fear of “being a researcher” in face of the certainty of “being a doctor.” Attention was drawn repeatedly to the need for research as an integral and individual part of the professional growth process, with examples from the guests themselves of how and why they became interested in research, and how much research has improved their academic career and success as a doctor. In addition, 3 basic and complex issues were discussed in the organization of any study: the approval of the project in an ethics committee, the preparation and application of the informed consent form, and the performance of financial impact studies. Specifically, financial impact studies are quite critical in Latin America,

known for being a region with countries considered to be low and middle-income, according to the World Bank Country and Lending Groups classification,<sup>10</sup> and with very few cost-effectiveness studies in orthopaedics and in other areas of medicine.

From the third to the sixth Talk-show, 4 researchers (2 from Europe and 2 from North America) all journal editors involved with numerous publications, reviews of scientific articles, and academic guidance, were invited. As the webinar was to give a space to Latin American surgeons and researchers, in this new stage, 1 to 2 regional co-hosts were always invited in addition to the host. In the third Talk-Show, guest Professor Peter Giannoudis from Leeds (UK), Editor-in-Chief of *Injury*, discussed the main reasons why scientific articles are rejected and strategies to reduce rejections. To paraphrase Professor Giannoudis, "A good study is like gold, but it takes more, it takes turning this gold into chocolate." Thus, in a fun and informative way, the guest gave the attendees tips and roadmaps to go from a good idea to a good scientific article. The fourth Talk-Show was attended by Professor Richard Buckley from Calgary (Canada), editor of several fundamental books in orthopaedics. In this webinar, the focus was on the worldwide example of joint work given by the Canadian Orthopaedic Trauma Society, with numerous publications that defined directions for the treatment of various traumatic musculoskeletal conditions. The role of organization, actions, and results in science was openly discussed, shedding light on the Latin American scenario, where there is still a low number of publications and multicenter clinical studies. With the objective of enhancing the collaborative efforts of Latin American centers to increase not only the number, but the impact of their publications, in the fifth Talk-Show, the guest was Professor Theodore Miclau from San Francisco (USA), Past President of the Orthopedic Research Society and the Orthopaedic Trauma Association, Steering Committee Chair of the International Orthopedic Trauma Association and Trustee of the AO Foundation, among other academic and associative assignments. Projects developed by Professor Miclau, such as ACTUAR (*Asociación de Cirujanos Traumatólogos de las Américas*; [www.actuarla.org](http://www.actuarla.org)), the Latin American Research Consortium representing 18 countries in the region, and the need for their active participation in medical associations, such as the OTA International and the AO Foundation, are considered as a transformative measure in understanding the importance of scientific research and continuous education for the surgeon. Professor R. Geoff Richards, Executive Director Research & Development for the AO Foundation, Director of AO Research Institute (ARI) Davos at the AO Foundation (Switzerland), and Editor-in-Chief, webmaster, webeditor, and co-founder eCM journal, was the guest of the sixth Talk-Show. In this webinar, the discussion was about how to translate the findings coming from basic science to clinical practice, with greater focus on the numerous publications that have recently emerged from the ARI on fracture-related infections. The chat was attended by 2 regional co-hosts, both former ARI research fellows, with Professor Richards as a mentor during their time in Davos, demonstrating the existing opportunities for Latin American surgeons who really want to

improve their educational training in scientific research, with logistical, professional, and financial support.

In the last Talk-Show to date, the guests were 2 orthopaedic surgeons, leaders in the Latin American orthopaedic scenario, extensively and dedicatedly involved in medical education and research. In this webinar, whose secondary motto was to show the strength and empowerment of women in a specialty mostly chosen by the opposite sex, their role in opening doors for other women who arrive and gradually occupy prominent positions in the region was discussed. The triad of leadership, education and research was extensively explored, discussing each of these topics and their importance when combined. **Supplemental Digital Content 1** (see **Figure 1**, <http://links.lww.com/JOT/B889>) shows the posts of all activities carried out to date.

### Analyzing the Strengths and Limitations of the Project

Since its inception, several physicians have been interviewed at the AOTLAT Research Talk-show, with satisfactory results both in terms of number of participants and feedback (Table 1). Since the first AOTLAT Research Talk-show, we have seen a gradual increase in the number of participants, both in attendance and in active participation during the activities. In a short time, we are experiencing greater demand for training and education in medical research, which we expect will translate in the increased number and quality of publications carried out in Latin America in the next years. There is a growing interest in research education, with great demand for courses and activities, such as the aforementioned AOPEER, AOne, and Continuous Education Program in Research and, at a local intra-institutional level, the Hospital-Based Seminars in Research. This has been demonstrated by the increased number of investigations being carried out on orthopaedic trauma in the last 2 years with members of the AO as principal investigators.

Certain limitations were observed in the first 2 years of the project. The hour of the activity, which is always held at the end of the day, results in a smaller number of attendees both from the eastern and western countries of the region. The time in Bogotá, Colombia is used as the base time, starting the Talk Shows at 6 PM at this location which is too late for countries to the east and too early for countries to the west. In one of the talk-shows, for example, the local time of the European interviewee was midnight, which can be identified as a potential fragility of this synchronous educational method. One of the solutions discussed within the GAI is recording the webinar so that they can be asynchronously accessed by members of AOTLAT and other regions at any time. Another limitation is the English language when chatting to guests from outside Latin America. Although most younger surgeons have good fluency in the English language, we have seen that more senior surgeons sometimes fail to participate secondary to this barrier. The solution lies in the use of real-time translators, an option that already exists within the Zoom digital communication tool. Finally, reconciling schedules with guests from regions other than the Americas, such as those in Europe, Middle East, and Asia-



**TABLE 1.** Numbers of the AOTLAT Research Talk-Show Until Today

Talk-Show	Number of Pre-Enrolled	Number of Attendees	Length of Stay in the Activity, Median (Min–Max), in Minutes	Senior Surgeons/AO Trauma Members* (%)	Junior Surgeons/AO Trauma Members† (%)	5-Point Likert Scale (%)
1	251	130	80 (45–90)	58	42	“Not at all” 0 “Not much” 0 “Neutral” 5 “Somewhat” 5 “Very much so” 90
2	92	122	82 (40–90)	58	42	“Not at all” 0 “Not much” 0 “Neutral” 5 “Somewhat” 5 “Very much so” 90
3	56	257	85 (59–90)	69	31	“Not at all” 0 “Not much” 0 “Neutral” 0 “Somewhat” 0 “Very much so” 100
4	165	116	84 (54–90)	66	34	“Not at all” 0 “Not much” 0 “Neutral” 0 “Somewhat” 5 “Very much so” 95
5	80	105	82 (45–90)	61	39	“Not at all” 0 “Not much” 0 “Neutral” 0 “Somewhat” 5 “Very much so” 95
6	101	139	81 (46–90)	63	37	“Not at all” 0 “Not much” 0 “Neutral” 5 “Somewhat” 5 “Very much so” 90
7	125	172	85 (52–90)	56	44	“Not at all” 0 “Not much” 0 “Neutral” 0 “Somewhat” 5 “Very much so” 95

\*Senior surgeons/AO members were defined as those with more than 10 y of specialty and/or AO membership.

†Junior surgeons were defined as those with equal or less than 10 y of specialty and/or AO membership.

%, Percentage (percentages were calculated based on the absolute number of attendees for each webinar); min, minimum; max, maximum.

Pacific are difficult. Due to the time zone differences, invariably the start time of the activity ends up in or even starting at dawn for many guests. In these cases, GAI members have discussed the possibility of holding and pre-recording the chat at another time and presenting the program within the normal schedule on a different day. If this is the measure to be adopted, unfortunately, the interaction with the attendees, which has been one of the highlights of the program, is expected to be lost. This is particularly important as positive feedback has been received from participants. The educational value of each Talk-Show experience was evaluated using the 5-point Likert scale items, with 1 indicating “not at all” and 5 indicating “very much so.” The information collected regularly in each Talk-Show shows not only that participants are enjoying

the activity, but also recommending it to other colleagues (Table 1). Ultimately, this encourages us to continue the research education work for surgeons in Latin America, using the Talk-Show and other well-established tools.

### CONCLUSIONS

The AOTLAT Research Talk-show was developed to assist in research education for AO Trauma members and surgeons in Latin America, being an online tool in chat format with renowned surgeons and researchers from different parts of the globe. The AOTLAT Research Talk-show intends to broadly discuss numerous topics related to research in a more informal way, thus meeting the specific needs of each

attendee based on doubts, fears, difficulties, and gaps in the design of a project until its final execution. Furthermore, the educational tool aims to demystify scientific research as a synonym for publication, reiterating it as necessary for any physician during training and professional activity throughout his/her life. Initial evaluation has shown satisfactory results both in terms of number of participants and feedback.

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