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Application of Universal Design for Learning (UDL) Principles to Surgical Education During the COVID-19 Pandemic

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OBJECTIVE: During the COVID-19 pandemic in 2020, we have faced unprecedented challenges in the delivery of surgical education. At the time of writing, changes to the structure and nature of the surgical workforce are occurring rapidly, even daily. Surgical educators are utilizing remote learning solutions, including flipped classroom approaches, online educational materials, telemedicine, and simulations, to continue education for surgical residents despite cancelations of face-to-face instruction. Our objective is to delineate an interdisciplinary strategy, utilizing the principles of Universal Design for Learning (UDL), by which we can optimize learning during this pandemic.

DESIGN: This perspective describes the UDL framework which can be used to situate solutions to issues with delivery of surgical education during this pandemic within the broader view of strategic inclusive instructional design to meet diverse learning needs.

CONCLUSION: The principles of UDL can inform curricular and pedagogical changes in surgical education that may be employed during a time of social distancing, isolation, and quarantine. UDL involves planning flexibility into curricular design from the outset, recognizing that learners are varied in their learning preferences and capabilities, motivational characteristics, and environmental constraints. Viewing the design of remote learning opportunities through the UDL lens aims to remove barriers to learning during this pandemic by targeting three areas: expansion of the means that information is communicated, ways that learners are supported and motivated, and approaches to assessing learning through available distance learning technologies (J Surg Ed 77:1008–1012. © 2020 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

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COMPETENCIES: Practice-Based Learning and Improvement, Patient Care, Medical Knowledge

COVID-19 PANDEMIC AND SURGICAL EDUCATION

The rapidly evolving global pandemic has affected the way our healthcare system operates during this crisis, and potentially beyond. In the shorter term, we are dealing with the challenges of maintaining high-quality surgical education with reduced operating volumes due to elective case triage,1 a lack of in-person activities,2 and implementation of social distancing and quarantine measures.3 It is unclear how long these changes will affect surgical education, and it is essential to strategize robust educational alternatives for residents. Further, timely interdisciplinary collaboration can offer insight and solutions. As such, we offer this perspective that connects surgical education with conceptions grounded more broadly in architectural design and education.

UNIVERSAL DESIGN FOR LEARNING (UDL)

The framework of Universal Design for Learning (UDL) originated in the 1990s and is informed by neuroscience research and elements of universal design (UD).4 Ron Mace’s UD principles speak to how a physical
environment can be designed to be maximally accessible for all users, particularly those with physical limitations and disabilities. As a continuation of these concepts, the Center for Applied Special Technology (CAST) applied the UD principles to the educational environment by aligning instructional approaches to the 3 brain networks (affective, recognition, and strategic). UD acknowledges that a “standard learner” does not exist, as learners vary across their neural networks, which impacts their learning processes. David Rose, CAST co-founder, asserts that learner performance is context-dependent and based not just on “individual strengths and weaknesses but also on the affordances and barriers in their learning environment.”

Learner variability can involve differences in learning preferences and capabilities, motivational characteristics, and environmental constraints. Consideration for the varied needs of surgical residents is particularly pertinent to education during COVID-19, as some may be working in isolation, quarantine, “skeleton” teams, or redeployed to emergency departments or intensive care units. Although the current learning environment may represent unchartered waters, UD principles can serve as a compass to identify barriers and to maximize learning experiences for the multiple contexts of residents during this pandemic.

The 3 core principles of UDL are the provision of multiple means of engagement, multiple means of representation, and multiple means of action and expression. The principles address key aspects of curricular planning for educational experiences, that is, how learners are motivated and supported (engagement), how content is communicated (representation), and how learning is demonstrated and assessed (action and expression).

**Figure 1.** Universal Design for Learning Guidelines developed by CAST. Attributed to CAST (2018). Universal design for learning guidelines version 2.2 [graphic organizer]. Wakefield, MA: Author.
Ultimately, incorporating the principles as part of curricular design positions learners to be “purposeful, knowledgeable, strategic and effective” as they work toward their learning goals (Figure 1). The principles, guidelines, and checkpoints can be connected to key learning theories regarding multiple modalities in learning and approaches to structuring educational experiences that are organized and outcome-oriented (Table 1). The goal of the UDL approach is to be able to provide inclusive and accessible education to all, which is the current challenge posed by the necessary structural re-organization of education in residency programs.

**APPLICATION OF UDL PRINCIPLES TO SURGICAL EDUCATION**

In modern surgical education, didactic teaching is integrated with innovations such as simulation, online resources (e.g., Surgical Council on Resident Education curriculum [SCORE]), and telementoring. Such approaches that do not involve in-person contact are essential during this pandemic. Selecting and developing a variety of information formats (including text, visuals, audio, and video) enables learners to perceive varied representations of the content. Present challenges of limited in-person operating room experiences can be addressed through providing multiple means of physical action and synthesis of knowledge in patient management plans. Examples in these areas will be described next.

**UDL and Online Educational Materials and Methods**

Open education resources for surgical residents include formal curricula such as SCORE and Fundamentals of Endoscopic Surgery (FES), question banks (e.g., True-Learn) and social media channels (including Resident and Associate Society of the ACS virtual hangouts and @SAGES_Updates webinars and YouTube resources). Additionally, mobile applications (apps), such as Touch Surgery, offer interactive surgical education experiences, though efficacy and validity evidence for these apps is variable.

Being able to conduct assessments on resident application of critical thinking and decision-making is difficult with imposed limitations on face-to-face contact. Within the principle of action and expression, the UDL guideline 5 recommends expanding options for learner expression and communication. For surgical educators, expanded options in remote format can involve attending-led synchronous and asynchronous discussion sessions that can be text-based using LMS tools such as Blackboard and Canvas, as well as video-based via Flipgrid, Zoom or Microsoft Teams. Strategically varying the format and timing of discussions can support differing affective learner needs during quarantine isolation while also being cognizant of demands on learner time and schedule. Asynchronous-formatted discussions offer flexibility that may appeal to residents working nights or who are clinically busy. Leveraging video and imagery into asynchronous discussions, such as through the sharing of pictures and recording video postings, can incorporate meaningful social-emotional connections. Collaborative mind mapping tools, such as Mindomo, can be used in small group asynchronous exercises in which senior residents engage in peer mentorship and groups of learners build maps of relationships and components of focal concepts.

Synchronous sessions can be used for delivering content and demonstrating skills in real time, facilitating conversation through whole-group chat and small group breakout rooms, and enabling active learning and reflective activities. Surgical educators should be aware of privacy threats (such as “Zoombombing”) and strategize to

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**TABLE 1. Connections Between Key Learning and Instructional Theories and UDL (Adapted From Dalton EM**

| Key Learning and Instructional Theories | Multi-Sensory Instruction | Multiple Intelligences | Bloom’s taxonomy | Conditions of Learning |
|----------------------------------------|---------------------------|-----------------------|------------------|-----------------------|
| Multiple methods and materials for instruction: Visual-Auditory-Kinesthetic-Tactile | Nine types, unique to the learner. Instructional techniques should provide materials/methods aligned with these and allow learner to pursue those aligned with their unique mixture of intelligence | Knowledge | Receiving stimulus |
| Provide materials to support the learner’s primary modality, but also strengthen links to less preferred modalities of learning | | Comprehension | Acquisition |
| | | Application | Storage |
| | | Analysis | Retrieval |
| | | Synthesis | Ensure the teaching is orderly and addresses learning objectives |
| | | Evaluation | |
| | | Ensure instruction is balanced and covers all levels and domains | |
increase security in synchronous sessions, such as using waiting rooms, recognizing all attendees upon entry, and applying unique meeting links and passwords. Live closed captioning is available in some synchronous tools, such as Microsoft Teams, which not only supports accessibility for individuals with hearing impairments but also aligns with the UDL representation principle, guideline 1 of providing options for perception. In recorded sessions, the auto-captioning feature also affords benefits of being able to search and review the session transcript. Recording synchronous sessions provides flexibility for those unable to attend, and follow-up asynchronous discussion forums can further engage students in processing and applying concepts presented during sessions.

UDL and Simulation
During the COVID-19 pandemic, elective surgeries in many areas have been triaged to ensure availability of resources for treating infected patients, and this has reduced operative exposure for residents. In addition, simulation labs may not be accessible to quarantined residents, and non-COVID-19 simulation events have been cancelled. The limitations for residents to practice and maintain their technical skills can contribute to a learning gap, and enabling isolated and quarantined residents to have equivalent access and educational opportunities, as their health permits, is a key aim of providing inclusive education for all residents at this time. Home box trainers, such as Taskit, and resident simulation labs with distancing measures can facilitate multiple means of action and expression for the practice of technical skills. There is also a lower resource option available that requires only a smartphone, tablet, and laparoscopic instruments.

Resident self-assessments and faculty assessments of simulated tasks using home-recorded video tools can be incorporated into a virtual classroom design, providing multiple means of engagement to stimulate learner self-regulation (UDL guideline 9). Providing options for sustaining effort and persistence (UDL guideline 8) is another aspect of the engagement principle in which challenges in skills curricula can be optimized by setting operative tasks according to resident seniority. In this way, assessments can be conducted via faculty evaluation of a senior resident’s recorded performance or via a senior resident’s critique of a junior resident’s operative skills. Through each option for demonstrating mastery, performance can be assessed consistently with a learning-objective focused rubric.

Meaningful use of simulation involves consideration of technology’s purpose in the learning experience. Technology may act as a direct tool substitute, augment the learning experience by providing functional improvements, modify the task design within the learning experience significantly, or redefine the learning experience through the creation of new tasks (the “SAMR” technology integration model). Applied to the use of virtual simulation, a simulation experience of a surgical procedure can serve as a substitute for a physical observation, or it could augment, modify, or even redefine what is possible in learning through repeated and varied experiential practice.

CONTINUING QUALITY EDUCATION IN THE PANDEMIC
The challenges to surgical education that are surfacing through the COVID-19 pandemic require solutions that are able to flex with waves of change and varied demands upon instructors and learners. Communication among instructors and learners of all levels can help to identify disconnects and inform the effectiveness of remote learning approaches and materials. Residents’ needs are likely to continue to change through the tightening and relaxing of local lockdowns, beginning and ending of quarantines, and potential experiencing of future peaks to come. Surgical educators have the task of continuing quality education in this evolving working and learning environment, and the UDL framework provides a lens for strategically planning curricular and pedagogical decisions. By incorporating flexibility into curricular design from the outset, the varied needs, characteristics, and environmental constraints can be addressed, enabling continuation of quality surgical education at this difficult time.

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