ORIGINAL REPORTS

Developing Cognitive Task Analysis–based Educational Videos for Basic Surgical Skills in Plastic Surgery ☆

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OBJECTIVE: To describe the development of cognitive task analysis (CTA)-based multimedia educational videos for surgical trainees in plastic surgery.

DESIGN: A needs assessment survey was used to identify 5 plastic surgery skills on which to focus the educational videos. Three plastic surgeons were video-recorded performing each skill while describing the procedure, and were interviewed with probing questions. Three medical student reviewers coded transcripts and categorized each step into "action," "decision," or "assessment," and created a cognitive demands table (CDT) for each skill. The CDTs were combined into 1 table that was reviewed by the surgeons performing each skill to ensure accuracy. The final CDTs were compared against each surgeon's original transcripts. The total number of steps identified, percentage of steps shared, and the average percentage of steps omitted were calculated.

SETTING: Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada, an urban tertiary care teaching center.

PARTICIPANTS: Canadian junior plastic surgery residents ($n = 78$) were sent a needs assessment survey. Four plastic surgeons and 1 orthopedic surgeon performed the skills.

RESULTS: Twenty-eight residents responded to the survey (36%). Subcuticular suturing, horizontal and vertical mattress suturing, hand splinting, digital nerve block, and excisional biopsy had the most number of residents (>80%) rank the skills as being skills that students should be able to perform before entering residency. The number of steps identified through CTA ranged from 12 to 29. Percentage of steps shared by all 3 surgeons for each skill ranged from 30% to 48%, while the average percentage of steps that were omitted by each surgeon ranged from 27% to 40%.

CONCLUSIONS: Instructional videos for basic surgical skills may be generated using CTA to help experts provide comprehensive descriptions of a procedure. A CTA-based educational tool may give trainees access to a broader, objective body of knowledge, allowing them to learn decision-making processes before entering the operating room. (J Surg Ed ▮:▮▮▮-▮▮▮. © 2017 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: cognitive task analysis, e-learning, educational videos, basic surgical skills, plastic surgery, decision-making skills

COMPETENCY: Practice-based Learning

INTRODUCTION

Teaching procedural decision-making is a constant challenge for surgeon-educators. As a surgeon gains expertise, crucial skills and knowledge may become unintentionally automated. This can be explained by Fitts and Posner's theory of motor skill acquisition. This theory comprises the following 3 sequential phases: the cognitive phase (when skills are learned); the associative phase (when performances become more skilled); and the autonomous phase (when skills have become automatic).[1] Experts are often in the autonomous phase and are, therefore, faced with the challenge of transferring automated knowledge and skills to learners. Teaching in surgery is further limited by

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restrictions on trainee work hours, faculty time, and most importantly, a need for patient safety and transparency.[2]

Cognitive task analysis (CTA) is a method used in a number of disciplines to deconstruct tasks requiring high cognitive demand.[3] In surgical education, CTA has been used to provide trainees with access to knowledge and decision-making that may be unintentionally automated by experts who are teaching while performing a procedure. The articulation of clinical knowledge, action steps, and decision points in surgical training is of particular importance as the omission of crucial information may prohibit knowledge transfer and prevent learners from achieving competence.[3] Previous investigators have demonstrated the benefits of CTA for both surgeon-educators and surgical trainees. For example, evidence suggests that CTA increases the completeness and accuracy of surgeons' instructional descriptions of procedures.[2] CTA-informed surgical training curricula have also been associated with improvement in knowledge and technical skills in new surgical interns,[4] greater command of problem-solving,[5] and better performance and self-efficacy scores among residents and medical students.[6]

The use of multimedia platforms for surgical training is also supported in the literature.[7,8] Multimedia-based education is highly accessible to learners and can lead to improvements in basic technical skills.[7] In surgical training, multimedia provides an effective self-directed learning resource for cognitive skill acquisition and is well-accepted as a teaching tool outside of the operating room.[8-11] The use of multimedia as a teaching modality offers a number of advantages as it is self-paced,[12] it provides learners with a safe and structured learning environment, and it supports learners of all training levels.[13] The creation of a multimedia platform for teaching key surgical skills would also enable any level of trainee in any location to learn or practice the skill without time-related or geographical restrictions.

Although the benefits of multimedia resources have been studied extensively,[8-13] a large number of the educational videos that are currently available online have yet to be validated. Furthermore, decision-making skills in these videos are typically not emphasized. The development of CTA-based instructional resources may afford medical students and other trainees the extra opportunity to gain early exposure to the nontechnical skills involved in performing surgical skills. Using a multimedia format for delivery will provide this opportunity to students at institutions not offering formal training in key surgical skills. Creating a multimedia platform of educational videos using CTA would also ensure that the resource is generated based on the combined expertise of multiple surgeons.

The creation of a learning resource using the input of multiple faculty members and learners may help reduce variation in the way surgical skills are taught, ensuring consistency in teaching content with an additional focus on procedural decision-making. Implementing this platform may also align with the increasing shift to competency-based medical education. The use of CTA to dissect a procedure provides the learner and the educator with predefined competencies for each skill, facilitating objective assessment and informing relevant feedback.

This report describes the use of CTA to develop a series of educational videos for basic plastic surgery–related skills. To achieve the overall goal of developing CTA-based educational videos, the following objectives were met: (1) to identify critical basic surgical skills for students to be able to perform independently before entering plastic surgery residency; (2) to generate combined cognitive demands tables (CDTs) for each skill; (3) to examine the omission of steps and shared steps between the surgeons performing each skill; and (4) to generate educational videos using the CDTs.

MATERIAL AND METHODS

Needs Assessment Survey

Institutional ethics approval was received from the Research Ethics Board of Sunnybrook Health Sciences Centre to conduct this study. A needs assessment survey was conducted to identify the surgical skills on which to focus the educational videos. Junior plastic surgery residents were asked to indicate from a predetermined list of skills,[14] the level of competence required for each skill before starting residency. Junior residents were approached as they may better understand current expectations and the needs of the target audience relative to senior residents or faculty. Participants were asked to identify the skills that they felt medical students should be able to perform independently before entering residency. The list of skills was categorized into 5 domains of plastic surgery–related skills, including basic skills, hand surgery, anesthesia, cutaneous surgery, and craniofacial surgery.

The skills and procedures listed on the survey were identified by Canadian plastic surgery program directors as skills/procedures expected of junior and senior residents. To create a further exhaustive list for the survey, skills identified by a group of surgeons across Canada as being necessary for fourth-year students to learn by the end of medical school were also included.[15] The needs assessment survey was sent to all medical students entering plastic surgery residency programs in Canada ($n = 26$) and to all junior plastic surgery residents in Canada ($n = 52$) to maximize the number of responses received and to achieve a comprehensive understanding of learner needs. From the survey responses, 5 skills that had the most number of participants rank "able to perform independently" were identified.

Generating Cognitive Demands Tables

Five surgeons (4 plastic surgeons and 1 orthopedic surgeon) were approached to teach the basic surgical skills. The surgeons were selected from various training backgrounds