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Confidence, Competence, and Self-Awareness in Surgical Training: Re-Examining the Dunning-Kruger Effect in the Era of Competency-Based Education and Robotic Surgery

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Abstract

Background: Accurate self-assessment is fundamental to safe surgical practice. Surgical trainees must continuously evaluate their abilities, recognize limitations, and seek assistance when necessary. The Dunning–Kruger effect, first described in cognitive psychology, refers to the tendency of individuals with limited competence to overestimate their abilities, while highly competent individuals may underestimate their relative expertise. [1, 2, 3] Although originally described outside healthcare, the phenomenon has important implications for surgical education, competency development, and patient safety.

Objective: To examine the relevance of the Dunning–Kruger effect in surgical training, explore its relationship with competency development and patient safety, and discuss educational strategies that may improve calibration between confidence and competence.

Methods: Narrative review of literature from cognitive psychology, medical education, surgical training, competency-based medical education, simulation science, patient safety, robotic surgery, and paediatric surgical education.

Results: Evidence suggests that discrepancies between perceived and actual competence are common during surgical training, particularly during early skill acquisition. Objective assessment, simulation-based training, structured feedback, mentorship, and reflective practice improve self-awareness and promote more accurate self-assessment. Competency-based educational frameworks provide mechanisms for aligning confidence with demonstrated competence.

Conclusion: The Dunning–Kruger effect offers a useful conceptual framework for understanding confidence–competence miscalibration in surgical education. Modern surgical training should cultivate technical proficiency alongside metacognitive awareness, reflective practice, and professional humility. The ultimate goal is the development of surgeons whose confidence is grounded in competence and whose judgment is informed by continuous self-reflection.

Keywords: Dunning-Kruger Effect, Surgical Education, Competency-Based Medical Education, Self-Assessment, Metacognition, Patient Safety, Robotic Surgery, Paediatric Surgery

Introduction

Surgical training represents one of the most demanding educational journeys in medicine. The acquisition of technical expertise, clinical judgment, professionalism, communication skills, and leadership abilities occurs over many years and requires continual adaptation. While considerable emphasis is placed upon procedural competence, the ability to accurately evaluate one's own performance is equally important.

Safe surgical practice depends upon recognizing not only what one knows but also what one does not know. Surgeons must decide when they can safely operate independently, when additional supervision is required, and when assistance should be sought. Such decisions depend fundamentally upon self-awareness.

Research in cognitive psychology has demonstrated that self-assessment is often inaccurate [5, 6]. Individuals frequently overestimate or underestimate their abilities, particularly in complex domains requiring specialized expertise. Among the most influential explanations for this phenomenon is the Dunning–Kruger effect, first described by Kruger and Dunning in 1999 [1].

Their work demonstrated that individuals performing poorly within specific domains often substantially overestimated their abilities because they lacked the metacognitive skills necessary to recognize deficiencies.

Within surgery, inaccurate self-assessment may have consequences extending beyond educational performance. Confidence unsupported by competence may jeopardize patient safety, whereas excessive self-doubt may impair learning and professional development. Understanding how confidence and competence interact throughout surgical training is therefore of considerable importance.

This review explores the relevance of the Dunning–Kruger effect in surgical education and examines its implications for competency development, patient safety, simulation-based learning, robotic surgery, and paediatric surgical training.

Origins and Evolution of the Dunning–Kruger Effect

The Dunning–Kruger effect emerged from investigations into metacognition and self-evaluation [1]. Kruger and Dunning demonstrated that individuals with limited competence often overestimated performance because the same deficits responsible for poor performance also impaired self-assessment.

The concept rapidly gained prominence within educational psychology because it challenged assumptions regarding the reliability of self-evaluation [2, 3]. Subsequent studies expanded the theory to professional education, leadership, business, and healthcare.

At its core, the Dunning–Kruger effect is not merely a problem of confidence but of insight. Competence enables individuals to recognize quality performance, identify deficiencies, and appreciate complexity. Without sufficient competence, learners may lack the cognitive framework necessary for accurate self-assessment.

Contemporary researchers have emphasized that the effect should not be interpreted simplistically [3]. Confidence–competence discrepancies exist on a continuum and are influenced by multiple factors including experience, culture, personality, educational environment, and feedback quality. Nevertheless, the broader principle remains highly relevant to professional education: self-assessment cannot be assumed to be accurate.

Metacognition and Self-Assessment in Medical Education

Metacognition refers to awareness and regulation of one's own cognitive processes [4]. In medical education, metacognition enables learners to identify knowledge gaps, evaluate performance, and direct future learning.

Several studies have demonstrated that physicians often struggle to accurately assess their own competence [5, 6]. Poor performers are particularly likely to overestimate abilities, whereas highly competent clinicians frequently underestimate their relative expertise. These findings suggest that metacognitive limitations may persist even among highly educated professionals.

The implications for surgical education are significant. Surgical competence encompasses technical skills, anatomical knowledge, communication, leadership, situational awareness, professionalism, and decision-making. Accurate self-assessment across all these domains is inherently challenging.

Consequently, modern educational frameworks increasingly emphasize objective assessment, structured feedback, and reflective practice rather than reliance upon self-assessment alone.

Evidence of the Dunning–Kruger Effect in Surgical Training

Research within surgical education consistently demonstrates discrepancies between trainee self-assessment and external evaluation [5, 6]. Junior residents frequently rate technical performance more favourably than faculty assessors, whereas senior trainees generally demonstrate greater calibration.

Several factors contribute to this phenomenon. Early procedural success may create an impression of competence despite limited exposure to complications, anatomical variation, and operative decision-making. Furthermore, learners often lack sufficient experience to recognize the standards by which expert performance should be judged.

Simulation-based studies have shown that objective performance feedback improves self-assessment accuracy [13]. As trainees receive structured evaluations and gain experience, confidence becomes increasingly aligned with competence.

Importantly, not all self-assessment inaccuracies represent pure manifestations of the Dunning–Kruger effect. Social desirability, anxiety, cultural influences, and educational context may also influence confidence ratings. Nevertheless, the phenomenon provides a useful framework for understanding why confidence and competence frequently diverge during training.

Confidence, Competence, and Technical Skill Acquisition

Confidence and competence are related but distinct constructs. Competence reflects demonstrated ability, whereas confidence reflects belief in one's ability.

Theories of skill acquisition suggest that learners progress through stages characterized by varying relationships between confidence and competence. Early exposure often produces rapid gains in confidence despite limited proficiency. As awareness of complexity increases, confidence may temporarily decline before rising again alongside competence.

Ericsson's theory of deliberate practice emphasizes that expertise develops through focused repetition, feedback, and correction rather than experience alone [12]. Accurate recognition of deficiencies is therefore essential to professional development.

The Dunning–Kruger effect is particularly relevant during early skill acquisition because learners frequently lack sufficient experience to appreciate procedural complexity [1, 3]. Consequently, confidence may outpace competence until objective feedback and continued experience promote recalibration.

Learning Curves in Open, Laparoscopic, and Robotic Surgery

Learning curves represent progressive improvements in performance resulting from repeated practice [11]. In surgery, learning curves are typically measured through operative times, complication rates, conversion rates, and objective skill assessments.

The transition from open surgery to minimally invasive and robotic techniques has introduced new educational challenges. Laparoscopic surgery requires adaptation to altered visualization, reduced tactile feedback, and complex psychomotor demands. Robotic surgery introduces additional technological complexity while simultaneously facilitating certain technical tasks.

One educational concern is that robotic platforms may create rapid increases in confidence due to intuitive controls and enhanced visualization. However, technical fluency at the console does not necessarily equate to comprehensive surgical competence.

Competency-based robotic training programmes increasingly employ proficiency-based progression models requiring objective demonstration of competence before independent clinical performance.

Impact on Patient Safety

Patient safety depends not only on technical skill but also on accurate recognition of personal limitations [14]. Overconfidence may contribute to inappropriate autonomy, delayed help-seeking, and inadequate recognition of complications. Conversely, underconfidence may impair decision-making and limit educational opportunities.

The concept of calibrated confidence is therefore central to safe practice. Calibrated clinicians possess realistic understanding of their capabilities and seek assistance when circumstances exceed their expertise.

Human factors research demonstrates that communication failures, situational awareness deficits, and cognitive biases contribute substantially to adverse events. Improving self-awareness may therefore enhance patient safety alongside technical training.

Competency-Based Medical Education and Entrustable Professional Activities

Competency-Based Medical Education (CBME) represents a paradigm shift from time-based progression toward outcome-based training [7]. Progression depends upon demonstration of competence rather than duration of training.

Entrustable Professional Activities (EPAs) further operationalize this concept by defining clinical tasks that trainees may perform independently once competence has been demonstrated [8, 9].

These frameworks are particularly valuable in addressing confidence–competence miscalibration because they emphasize objective assessment rather than self-perceived readiness. Workplace-based assessments, procedural evaluations, simulation metrics, and entrustment decisions provide external measures of performance that complement self-assessment.

Simulation, Objective Assessment, and Feedback

Simulation-based education has transformed surgical training [13]. Modern simulators permit repetitive practice without patient risk while generating objective performance data.

Tools such as Objective Structured Assessment of Technical Skills (OSATS) provide standardized evaluation of technical performance [10]. Immediate feedback allows trainees to compare perceived performance with objective outcomes and identify areas for improvement.

Simulation is particularly valuable because it exposes confidence–competence discrepancies in a safe environment [11, 13]. Through deliberate practice and structured feedback, learners gradually develop more accurate self-awareness.

Beyond the Dunning–Kruger Effect

Although the Dunning–Kruger effect provides a useful framework, contemporary scholarship has identified important limitations. Statistical artefacts, regression toward the mean, measurement constraints, and contextual influences may contribute to observed confidence–competence discrepancies.

Furthermore, confidence and competence are multidimensional constructs influenced by culture, personality, educational environment, and emotional factors. The impostor phenomenon, for example, represents the opposite pattern in which highly competent individuals underestimate abilities despite objective success.

Therefore, educational efforts should focus not merely on reducing overconfidence but on improving calibration between self-perception and objective performance.

Human Factors and Surgical Judgment

Technical skill alone does not determine surgical outcomes [14]. Communication, teamwork, leadership, situational awareness, and decision-making contribute significantly to performance.

Expert surgeons differ from novices not only in technical capability but also in their ability to recognize uncertainty, anticipate complications, and adapt strategies in response to changing circumstances.

Interestingly, increasing expertise often produces greater awareness of complexity and uncertainty. This observation may explain why experienced clinicians frequently display greater humility than trainees despite superior competence.

Artificial Intelligence and Digital Assessment

Artificial intelligence offers new opportunities for objective assessment of surgical competence [15]. Machine learning systems can analyse motion efficiency, instrument trajectories, procedural flow, and error patterns.

Robotic platforms generate extensive performance data that may facilitate individualized feedback and personalized learning pathways [15]. Such technologies have the potential to improve self-awareness by providing objective measures of performance.

Nevertheless, competence extends beyond technical execution. Communication, professionalism, empathy, and judgment remain essential components of surgical expertise that cannot be fully captured through technological assessment alone.

Relevance to Paediatric Surgery

The principles discussed throughout this review are particularly relevant to paediatric surgery. Procedural volumes may be lower, learning curves longer, and anatomical complexity greater than in many adult specialties.

Paediatric surgeons must often manage rare conditions, congenital anomalies, and highly specialized procedures. Accurate recognition of limitations is therefore essential to safe practice.

In addition, communication with families requires humility, empathy, and transparent discussion of uncertainty. Consequently, self-awareness influences not only operative performance but also patient-centred care.

Future Directions

Future research should focus on interventions capable of improving calibration between confidence and competence. Longitudinal studies examining the evolution of self-assessment throughout training may provide valuable insights.

Artificial intelligence, virtual reality, simulation-based mastery learning, and digital performance analytics offer promising opportunities for objective assessment [15]. However, technological innovation should complement rather than replace mentorship and reflective practice.

The future surgeon will require not only technical excellence but also metacognitive sophistication, adaptability, and lifelong commitment to learning.

Conclusion

The Dunning–Kruger effect provides a valuable conceptual framework for understanding confidence–competence relationships in surgical training [1, 2, 3]. While not the sole explanation for inaccurate self-assessment, it highlights the importance of metacognitive awareness within professional development.

Modern surgical education increasingly recognizes that competence extends beyond technical proficiency. Safe and effective practice requires accurate self-awareness, reflective capacity, sound judgment, and willingness to seek assistance when necessary.

Competency-based education [7, 8, 9], simulation [13], structured feedback, mentorship, objective assessment [10], and emerging technologies [15] provide powerful tools for improving calibration between confidence and competence.

Ultimately, surgical excellence is not defined by confidence alone, nor by technical mastery in isolation. Rather, it emerges from the continual alignment of competence, judgment, and self-awareness—a process that transforms trainees into reflective practitioners capable of delivering safe, effective, and compassionate surgical care.

Conflict of Interest

The author declares no conflict of interest.

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Author Contributions

Dr. Vivek Viswanathan conceived the manuscript, reviewed the literature, interpreted the evidence, and prepared the final manuscript.

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