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Highlights

Impact of an in-person small group surgical skills course for preclinical medical students in an era of increased e-learning

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• There is high demand for a surgical skills course for early-year medical students.
• This is a novel low-cost in-person surgical skills course following COVID-19.
• There was a significant increase in student confidence for all taught skills.
• Students are more confident that they possess sufficient skills for clinical placements.
• This course provides a framework for incorporation into medical school curricula.

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Impact of an in-person small group surgical skills course for preclinical medical students in an era of increased e-learning

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ABSTRACT

Objective: The COVID-19 pandemic led to a dramatic decrease in face-to-face teaching. This can particularly impact medical students’ skills development. This prompted development of an in-person surgical skills course as guided by the General Medical Council “Outcomes for Graduates” facilitated by tutors with surgical experience.

This study aimed to primarily assess participant confidence in surgical skills following the course.

Design: This was an interventional study assessing both qualitative and quantitative data collected prior to, during, and post course completion. Data were collected from students via online forms, which included a mixture of “Yes/No” responses, self-assessed confidence levels via Likert scales, and free type questions.

Setting: The study assessed feedback for a 5-session surgical skills course delivered at the authors’ institution. This is a newly designed course using low-cost materials which was free for all attendees.

Participants: Participants were all in the first or second year of medical school. There was capacity for 60 students, and all attendees provided informed consent to participate.

Results: A total of 446 students applied for the course with 58 participants in the final study, 31% of whom had prior surgical skills experience. There was a statistically significant increase in student confidence levels following the course for all taught surgical skills (P = .0001). Participants were more confident that they possessed the skills required for clinical placements (P = .0001) and to work as a junior doctor (P = .01). Thematic qualitative analysis revealed a reliance on third parties for previous surgical experience; this course improved knowledge and skills for future practice. Limitations included session duration and equipment choice.

Conclusion: This study demonstrates high demand and student satisfaction from this course, offering a potential framework to improve undergraduate surgical skills teaching. The results presented here have the potential to inform wider curricula development across medical schools in the future.

Competencies: Medical knowledge; practice-based learning and Improvement.

INTRODUCTION

The General Medical Council (GMC) “Outcomes for Graduates” [1] stipulates that all graduating doctors acquire surgical and procedural skill competence. This has recently been highlighted by the Royal College of Surgeons in their development of a “National Undergraduate Curriculum in Surgery” [2] which seeks to raise standards by defining a minimum level of surgical achievement on completion of medical school. Cited outcomes include an ability to recognize common surgical presentations and competence in practical skills such as the use of local anesthetics, skin suturing, and wound care. A robust surgical education for all undergraduate medical students is essential irrespective of subsequent career path. Not only do surgical conditions represent a significant proportion of elective and emergency referrals within the National Health Service [3,4], but surgical principles and skills are transferable within all aspects of medicine including interventional specialties, emergency medicine, and general practice [5]. Effective surgical education is therefore imperative for the continued provision of safe care for future patients.

A national United Kingdom review of surgical and procedural skills training at medical schools conducted in 2014 [6] found that skills cross-referenced against GMC documentation were provided by medical schools and supplemented by extracurricular student surgical societies. Basic surgical skills modules incorporated as part of an undergraduate curriculum for first year students have been found to have a positive impact on technical skill development [7]. Furthermore,
greater benefit has been demonstrated when surgical skills teaching is
provided in a distributive manner with weekly practice when compared
with an intense 1-day course [8]. These studies suggest the efficacy of
surgical skills introduced and practiced early in medical schools. Estab-
lished educational theory applied in the context of surgical education
[9] include the (1) acquisition and retention of motor skills [10], (2) im-
portance of availability of expert assistance [11], and (3) learning within
communities of practice [12].

The educational landscape has rapidly evolved due to the recent
COVID-19 pandemic [13]. In an era with reduced opportunity for in-
person teaching, there has been an exponential growth of online “e-
learning” which offers the additional benefits of flexible scheduling
and increased accessibility to educational materials. E-learning has a dem-
onstrable role within surgical education as an educational tool [14];
the use of virtual patients, graphics, and videos can significantly enrich
the learning experience of trainees. However, e-learning may offer little
in the way of hands-on skills or individualized instruction and perfor-
mance feedback [15]. This supports previous literature in favor of “blended” learning strategies integrating both traditional in-person
teaching with online learning [13,16,17].

The reduced availability of in-person teaching during the COVID-19
pandemic has prompted our development of an in-person surgical skills
course. Herein, we aim to provide early-year medical students with for-
malized teaching on basic surgical skills as guided by the GMC “Out-
comes for Graduates” facilitated by tutors with surgical experience.
Primary outcomes include an assessment of participant confidence in
surgical skills, early consideration of a career in surgery, and engage-
ment with the course. Secondary outcomes relate to student percep-
tions of current in-person and online teaching modalities during the
pandemic.

MATERIAL AND METHODS

Participants. The surgical skills program was offered to medical stu-
dents in phase 1 of their study at Queen Mary University of London.
Phase 1 refers to first and second year undergraduate program students
and first year Graduate Entry Program students. We advertised to all
phase 1 students via their cohort mailing list. An online sign-up form
using Microsoft Forms was distributed to this cohort of students, and se-
lection was based on a first-come-first-served basis. There was capacity
for a total of 60 students to complete the course. Of those that signed up
to the course, participation in the study was voluntary. All attendees re-
ceived a written information sheet regarding the study (see Appendix
1) and provided written informed consent to participate. Ethical ap-
proval for the study was obtained from the Queen Mary Ethics of Re-
search Committee and the Institute for Health Sciences Education Peer
Review Committee.

Course Design. The course consisted of five 1-hour sessions and was
free to attend. Each session was modeled on the Practical Skills and Pro-
cedures subsection of the GMC “Outcomes for Graduates” [1], and the
structure of each session is outlined in Table 1. These sessions took
place on the university campus when students had no other scheduled
university teaching. Each session had the capacity for 20 students and
was repeated 3 times to accommodate all participants. The course ran
from November 2021 to March 2022. Sessions were delivered by 6 cur-
rent or past clinical teaching fellows at the medical school. All tutors had
completed their UK Foundation training and had clinical experience in
all procedural skills covered in this course through surgical or emer-
dency department jobs. Sessions were designed such that there were
7–8 students per tutor. Sessions contained practical components
where students could attempt all taught skills. Students were assessed
in an informal manner with verbal feedback provided by the tutors at
the time. This included the use of tasks to review and assess students’
competencies such as a quiz in the final session (Table 1).

Equipment and Resources. Consumable equipment was supplied by
either local surgical departments or course tutors. All other equipment
was available within the department. Artificial wounds were made
using the RCS-approved low-cost construct for suturing practice [18]
as seen in Fig 1.

Data Collection. Data were collected from the participants via online,
anonymized feedback using a Microsoft Form. As part of this, partici-
pants used a random number generator to acquire a unique identifier
which was used on all feedback forms to allow pairing of these data.
These were completed before the course, after each session, and after
the course’s conclusion, allowing comparison between the various
stages of course progression. Feedback was collected using a mixture
of dichotomous questions, Likert scales, and open questions (Appendix 1).
Using various approaches allowed us to collect data that were easily comparable, such as via Likert scales, but also subjective
opinion-based responses that could be analyzed using thematic qualita-
tive analysis. These same data from open-ended questions could also be
used to improve the sessions as we went along, thus enhancing the ex-
perience of the students. Students were provided with the link to the
feedback forms at the end of every session for postsession question-
naires; for the pre- and postcourse questionnaires, the links were pro-
vided via email.

Data Analysis. Pre- and postcourse questionnaire responses were ana-
yzed using R (version 3.6.1) [19]. For those who completed both pre-
and postcourse questionnaires, nonparametric statistical testing was
carried out using a paired Wilcoxon signed-rank test with Holm correc-
tion. Comparison of career considerations was carried out using Fisher
exact test. Results reported include the test statistic (Z), P value, and
corrected P value. For qualitative analysis, we conducted thematic anal-
ysis of the 4 free text questions within the postcourse questionnaire
using Braun and Clarke’s [20] established method. The intention of
this process is to seek understanding of the experiences and thoughts
of student participants. Responses to each question were analyzed for
their semantic meaning and coded accordingly. Themes were then con-
structed from these codes through an iterative process. The approach to
the thematic analysis was inductive, though we note that the relatively
short answers provided by respondents’ limit the scope of analysis.

RESULTS

Demographics. A total of 446 individuals applied to attend the course,
for which there was available space for 60 participants. The final cohort
of course participants consisted of 55.2% Year 1 students, 39.7% Year 2
students, and 5.2% Graduate Entry Programme Year 1 students, which
was roughly equal to the proportion of students in these years currently enrolled at the university. Of those who attended
the course, 96.7% (n = 58) completed the precourse questionnaire,
51.7% (n = 30) of whom we were able to pair with a corresponding
postcourse questionnaire.

Prior to the course, participants reported having considered a range
career paths as shown in Table 2.

Eighteen students (31.0%) had previous experience in surgical skills,
88.9% of which was mostly or entirely delivered in an in-person setting.
Free text responses from all students who had experience in surgical
skills reported that this experience had taken place outside the MBBS
curriculum. Of those that had prior surgical skills experience, 11.1% had
experience in scrubbing and infection control, 5.6% had experience
with basic surgical equipment, 55.6% had experience suturing, 22.2%
had experience knot tying, 5.6% had experience with local anesthetics,
and 11.1% had experience with wound management and dressing.

Teaching Modality. The precourse questionnaire, distributed in Octo-
ber 2021 when teaching remained multimodal due to the COVID-19
pandemic and associated restrictions, showed that most students prefer
multimodal (55.2%) or in-person (41.4%) teaching delivery methods. The perceived proportion of teaching delivered in-person at the time is shown in Fig 2.

**Surgical Skills Course Impact.** The increase in student confidence levels postcourse, as compared to precourse, was statistically significant for all surgical skills outcomes, as outlined in the GMC "Outcomes for Graduates" (Fig 3). They were also more confident that they had the skills required for clinical placements and to later work as a junior doctor. Although they overall felt that the course increased their exposure to surgery and surgical teaching, it had no apparent impact on whether they had considered a career in surgery (Table 3).

Following each session, feedback was obtained from participants on the session itself including session content, design, and delivery, the median scores of which are shown in Table 4.

Overall, following the course, 63.3% of participants felt that the surgical skills course had a very or extremely large impact on their overall confidence levels carrying out basic surgical skills.

**Qualitative Thematic Analysis**

**Reliance on Third Parties for Surgical Experience**

All respondents identified that existing surgical teaching within the phase 1 curriculum was lacking, although it should be noted that there is variability in the experience of respondents because this course was offered to students from years 1 to 2. Demand for surgical education is high, with a significant number of respondents seeking out surgical education opportunities from third parties such as societies, work experience, and student-selected components to meet this gap.

Aside from this course there is not much exposure to surgical teaching in pre-clinical years. I have had to sign up to extra curricular...
The familiarity with scrubbing in and aseptic equipment handling has been hugely beneficial. I recently undertook a two week placement with a surgical team and was given the opportunity to scrub in and assist. Being able to have done this before was great and really allowed me to have confidence going in to this experience.

Moreover, several students reported that being taught by junior doctors gave them a better insight into the realities of life as a junior doctor and how their new skills might be employed.

A more realistic idea of what small procedures and jobs doctors do in their day and that early exposure will help me improve these skills for real patients.

Several highlighted that they felt the course content would be relevant to all students and not just to those with a desire to pursue a surgical career.

"Really enjoyed the course. As GEPs we don’t get much opportunity for the applicable part of medicine in our first year, and I think it’s to the detriment of the university course. A course like this would be really appreciated for the whole year I think, even those not necessarily interested in surgery."

Well designed and helpful course, I highly recommend to all, even those with no interest in surgery because of the practical skills and knowledge taken away from it.

**Limitations.** There were, however, limitations to the benefit of the course. The most common area that students highlighted was the need for more time to practice the new and complex skills they were learning. In addition, several highlighted that they would prefer more realistic prosthetic materials for practicing suturing and anaesthetic infiltration.

Time and equipment were limited. Maybe working with more skin like models could have been useful. But I understand timings and budget may be issues! So not much of a complaint. Learning-wise, it was super useful. More suturing practice could have been fun. That felt a little rushed.

**DISCUSSION**

This study has shown that there is an unmet desire for preclinical surgical skills education and high demand for this course. Both quantitative and qualitative data show increased confidence levels postcourse among participants in all core GMC "Outcomes for Graduates" [1] covered by the course, which was statistically significant for all skills taught. Participants also felt more prepared for future practice in medical student clinical placements as well as beyond. Moreover, through familiarization with some of these surgical skills, students felt more comfortable seeking opportunities on placements. Additionally, the results show that students prefer at least a proportion of their teaching to be in-person, which appeared to correlate with the positive feedback received for the sessions of this in-person surgical skills course.

Most students that undertook the course had no prior surgical experience. This reflects a general trend in the limited availability of undergraduate surgical education in the UK resulting in graduates feeling ill-prepared for surgical Foundation jobs [21]. The study shows that participants who did have prior surgical experience had accessed it through noncore opportunities such as student-selected components, societies, and taster sessions. Several studies have found similar results, with aspiring surgeons relying on student societies to gain sufficient experience in skills which the GMC mandates as essential [1,6,22]. Unsurprisingly, students who had attended previous surgical skills courses had higher self-confidence ratings regarding technical skills.

**Table 2**

| Career path                           | Precourse Number (n = 58) | Precourse Percentage (%) | Postcourse Number (n = 30) | Postcourse Percentage (%) | Fisher exact P value |
|---------------------------------------|---------------------------|---------------------------|-----------------------------|---------------------------|----------------------|
| Surgery                               | 48                        | 82.8                      | 23                          | 76.7                      | .5722                |
| Medicine                              | 19                        | 32.8                      | 13                          | 43.3                      | .3512                |
| General practice                      | 11                        | 19.0                      | 5                           | 16.7                      | 1.0000               |
| Anesthesiology/critical care          | 19                        | 32.8                      | 10                          | 33.3                      | 1.0000               |
| Obstetrics and gynecology             | 16                        | 27.6                      | 5                           | 16.7                      | .3014                |
| Pediatrics                            | 12                        | 20.7                      | 2                           | 6.6                       | .1259                |
| Psychiatry                            | 7                         | 12.1                      | 0                           | 0                         | .0902                |
| Other                                 | 3                         | 5.2                       | 1                           | 3.3                       | 1.0000               |

**Fig. 2.** A. Perceived current proportion of teaching delivered in-person. B. Satisfaction with current ratio of in-person to online teaching.
This course was led by early-career doctors who had recently completed the Foundation program. Our results contribute to the growing body of evidence demonstrating positive outcomes from surgical skills courses run by junior doctors and senior medical students [27,30]. Near-peer-led courses offer a relaxed learning environment for participants with evidence of increased educational attainment [31]. They confer the additional benefit of reducing the burden on senior surgeons of teaching relatively simple surgical concepts while offering valuable teaching opportunities to junior doctors [30]. These factors provide a strong pedagogical and practical rationale for implementing a junior-led course.

The study took place at a time when the increased use of online learning strategies has become the norm. Participants in this study favored multimodal teaching above online-only tuition, in line with findings that medical students desire increased face-to-face teaching postpandemic [32]. The COVID-19 pandemic accelerated research in e-learning, and the switch to online learning is likely to persist in many aspects of medical education thanks to positive findings for knowledge-based learning [33,34]. However, data to support the use of e-learning in surgical skills tuition have been equivocal, with only 1 study in a systematic review reporting noninferior objective outcomes compared to an in-person course [35]. The success of e-learning courses is highly contingent on robust technological resources, equipment dissemination, and complicated logistics such as to review the quality of student suturing [35]. These challenges are compounded by the more general problems associated with distance learning, including distractions at home and internet issues, both of which will impact students from lower socioeconomic groups to a greater extent [36,37].

### Table 3

| Category                               | Sample size (n) | Test statistic (Z) | P value  | Adjusted P value | Significance (adjusted P value) |
|----------------------------------------|-----------------|--------------------|----------|------------------|-------------------------------|
| Have had sufficient exposure to surgical teaching so far | 30              | 229                | 0.005    | 0.014            | *                             |
| Have had the opportunity to meet current surgeons       | 30              | 22                 | 0.005    | 0.014            | *                             |
| Have considered a surgical career                         | 30              | 0                  | 0.346    | 0.346            | NS                            |

This course was the first introduction to surgical skills for many participants and specifically targeted preclinical medical students. Although it is evidently not representative of a career in surgery, students reported that their informal interactions with course tutors gave them an insight into the realities of life as a junior doctor. A primary aim of this phase 1 course was to facilitate greater student participation during surgical attachments due to increased confidence in basic skills, a process which can increase self-efficacy and student learning [23]. These results support existing literature demonstrating that early exposure to surgical specialties increases student engagement during medical school [24]. Specifically, students reported that undertaking a surgical skills course prior to surgical attachments would maximize the educational benefit [25]. Helping students to develop basic surgical skills prior to their clinical placements increases self-efficacy and confidence, permitting them to make use of real-life learning opportunities [25]. This is especially pertinent in an era when the time medical students spend in the clinical environment is declining, along with opportunities to practice surgical skills.

Data from the study do not support previous findings that undergraduate surgical skills courses can increase desire to pursue surgical careers [26–28]. This may be partially explained by the relatively small sample size. Furthermore, the precourse proportion of students interested in a surgical career was already high. That said, the benefit of a preclinical surgical skills course extends beyond those who wish to pursue surgical careers, however. The techniques taught in this course are applicable to other specialties including aspiring GPs who wish to undertake minor procedures, dermatologists, and emergency department clinicians [29].
Session design and delivery feedback: median score shown; Likert scale from 1, strongly disagree, to 5, strongly agree

|                  | 1  | 2  | 3  | 4  | 5  |
|------------------|----|----|----|----|----|
| Content was at an appropriate level | 5  | 5  | 5  | 5  | 5  |
| Content was relevant | 5  | 5  | 5  | 5  | 5  |
| Clear introduction | 5  | 5  | 5  | 5  | 5  |
| Aims and objectives outlined | 5  | 5  | 5  | 5  | 5  |
| Well-organized session | 5  | 5  | 5  | 5  | 5  |
| Clear summary | 5  | 5  | 5  | 5  | 5  |
| Interactivity | 5  | 5  | 5  | 5  | 5  |
| Effective use of resources | 4  | 4  | 5  | 4.5 | 5  |
| Session pacing | 5  | 5  | 5  | 5  | 5  |
| Session duration | 5  | 5  | 5  | 5  | 5  |

A viable alternative to the classical model is the Visual Analog Scale as suggested by Bishop et al [38]. This system requires participants to grade themselves on a scale between 2 set points, allowing the representation of smaller changes. However, this scale is more subjective, and what counts as confident for one student may be at a different point in the scale for another.

Finally, as participants were phase 1 students, they were likely to have low confidence levels initially due to a shown lack of surgical exposure. Therefore, any surgical teaching has a high chance of improving this. This could have been addressed by assessing confidence levels among more senior medical students who had experienced clinical placements in surgery, in addition to the participant cohort. Alternatively, confidence levels of the participant cohort could be reassessed following commencement of clinical placements and compared to colleagues who had not completed the course.

In conclusion, this study has shown that there is benefit in incorporating a surgical skills course to improve student exposure and confidence in basic surgical skills prior to starting surgical placements. Additionally, we have shown that there is benefit to this being delivered in an in-person setting in the context of the COVID-19 pandemic. Future work could assess similar outcomes across all enrolled year 1 and 2 medical students following a trial of this course incorporated within a phase 1 curriculum. Furthermore, in addition to assessing confidence levels, ability to perform surgical skills could be assessed prior to and following the course. If a positive impact continues to be shown from this proposed future work, in the long-term, we envision a course such as this being incorporated within all medical school curriculums.

Author Contribution

Louise Kuo: Conceptualization, Methodology, Formal analysis, Writing – original draft. Nadia Liber Salloum: Conceptualization, Methodology, Writing – original draft. Benjamin Kennard: Conceptualization, Methodology, Writing – original draft. James Robb: Methodology, Writing – original draft. Paula Vickerton: Writing – reviewing & editing.

Funding Source

None.

Ethics Approval

Approval for this study has been provided by the Queen Mary Ethics Committee.

Conflict of Interest

None.

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Appendix 1. Questionnaire

Surgical Skills Course Questionnaire

PRECURSE QUESTIONNAIRE

Random number generator
Please go to RANDOM.ORG - True Random Number Service and set the number generator range from 1 to 10,000. Generate random number.
571 3. Please answer all the statements according to the following scale
(strongly disagree, disagree, neutral, agree, strongly agree)
572 a. The content was at an appropriate level
573 b. The content was relevant to my training
574 c. There was a clear introduction to the subject
575 d. The aims and objectives were clearly stated
576 e. The material was well organized
577 f. There was a clear summary and conclusion
578 g. The presenter appeared well informed about the subject
579 h. The presenter appeared enthusiastic about the subject
580 i. Audience participation and interaction were encouraged
581 j. There was effective use of audiovisual aids/handouts
582 k. The presentation was given at the right pace
583 l. The presentation was of a reasonable length
584 m. Overall, this teaching session was of a high quality
585 4. Relevant question(s) to the specific session from:
586 - How confident do you feel with surgical scrubbing techniques and
considering infection control measures?
587 - How confident do you feel with managing surgical equipment such
as sutures, forceps, scalpels, etc.
588 - How confident do you feel with deciding on and administering local
anesthetic?
589 - How confident do you feel with carrying out basic sutures
(interrupted and mattress)?
590 - How confident do you feel with basic surgical knot tying?
591 - How confident do you feel managing surgical wounds?
592 - How confident do you feel about different wound dressings?
593 5. I liked the following things about the session: (free text)
594 6. The session might be improved by: (free text)
595 7. Other comments? (free text)
596
597 POSTCOURSE QUESTIONNAIRE
598 1. Personal course ID number
599 2. How confident do you feel with surgical scrubbing techniques and
considering infection control measures? (not at all, slightly, moderate, very,
extremely)
600 3. How confident do you feel with managing surgical equipment such
as sutures, forceps, scalpels, etc? (not at all, slightly, moderate, very,
extremely)
601 4. How confident do you feel with deciding on and administering local
anesthetic? (not at all, slightly, moderate, very, extremely)
602 5. I liked the following things about the session: (free text)
603 6. The session might be improved by: (free text)
604 7. Other comments? (free text)
605
606 POSTSESSION QUESTIONNAIRE
607 1. Name of session
608 2. Personal course ID number
24. How confident are you that you have the surgical skills required for starting your clinical placements? (not at all, slightly, moderate, very, extremely)

25. How confident are you that you have the surgical skills required for starting as a junior doctor? (not at all, slightly, moderate, very, extremely)

26. Do you feel you have had the opportunity to meet/talk to current surgeons as part of your training? (not at all, slightly, moderate, very, extremely)

11. Overall, how much of an impact do you feel this course had on your confidence carrying out basic surgical skills? (not at all, slightly, moderate, very, extremely)

12. What do you feel you have gained most from this course? (free text)

13. What do you feel has been least useful for your learning from this course? (free text)

14. Other comments. (free text)

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[13] What do you feel has been least useful for your learning from this course? (free text)

[14] Other comments. (free text)