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Research Article

Bridging the Anxiety Gap: The Impact of a Day-1 Skills Workshop on Medical Student Self-Efficacy and Clinical Participation in Ophthalmology Placements – A Pilot Study

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Abstract

Background: Over 70% of UK medical students report inadequate slit lamp training, citing equipment unfamiliarity and limited hands-on practice as primary barriers. This study evaluated whether a brief Day-1 skills workshop could enhance student learning, confidence and clinical participation during ophthalmology placements through targeted reduction of equipment-related cognitive load.

Methods: This quasi-experimental pilot study compared 30 third-year medical students (15 control, 15 intervention) attending week-long ophthalmology placements. The intervention group received a 90-minute skills workshop on Day 1 using Peyton's 4-step approach and peer-assisted learning. The control group received standard induction. Primary outcome was number of patients examined independently. Secondary outcomes included slit lamp knowledge, self-efficacy and cognitive load.

Result: Groups demonstrated baseline equivalence across all measures ($p>0.05$). Students in the intervention group showed a trend toward examining more patients independently (mean 2.6±0.99 vs 2.1±0.8, mean difference 0.53, 95% CI: -0.11 to 1.18, $p=0.115$, Cohen's $d=0.59$). The intervention produced significant improvements in slit lamp knowledge (mean change 11.9±3.9 vs 7.1±3.2, $p=0.001$, $d=1.34$) and self-efficacy (mean change 1.84±0.30 vs 1.19±0.61, $p=0.001$, $d=1.35$). Intervention students reported lower extraneous cognitive load (2.42±0.44 vs 2.87±0.76, $p=0.062$, $d=0.71$) and higher germane load (3.58±0.44 vs 3.13±0.76, $p=0.062$, $d=0.71$), supporting the proposed cognitive mechanism.

Conclusion: This pilot study demonstrates that a brief, theory-driven skills workshop produces large, significant improvements in equipment-specific knowledge and confidence. Although underpowered to detect differences in clinical participation, the medium effect size ($d=0.59$) and strong effects on foundational competencies provide compelling evidence to support a fully-powered randomised controlled trial. The cognitive load findings support the theoretical mechanism linking technical mastery to enhanced learning capacity.

Keywords: Medical education; Ophthalmology; Slit lamp; Cognitive load theory; Self-efficacy; Skills training; Pilot study

Introduction

Medical students in the United Kingdom consistently report inadequate preparation for clinical ophthalmology practice. Recent surveys reveal that over 70% of senior students feel their slit lamp training is insufficient, with equipment unfamiliarity and limited hands-on practice cited as primary barriers [1,2]. This deficit persists into postgraduate training, where junior doctors continue to report low confidence when managing acute eye conditions [3]. These findings conflict with the General Medical Council's requirement that all graduates demonstrate competence in core ophthalmic assessments, including slit lamp examination [4]. The educational challenge is compounded by curricular constraints. Where two-week ophthalmology blocks were once standard, many UKS medical schools now offer only shorter, optional exposures. Consequently, students arrive at clinical placements with minimal prior equipment exposure. This creates a participation barrier; in busy outpatient clinics, equipment-naïve students often default to passive observation rather than active examination. This avoidance behaviour becomes self-reinforcing, as students who do not practice fail to develop competence, perpetuating their anxiety and reluctance to engage. Cognitive Load Theory (CLT) provides a theoretical framework for understanding this participation barrier [5]. CLT posits that working memory has limited capacity, and learning is optimised when cognitive resources are directed toward germane load: the mental effort invested in schema construction (building mental models) and meaningful pattern recognition. However, when learners encounter unfamiliar equipment, substantial cognitive resources are consumed by extraneous load.

This refers to the mental effort wasted on task-irrelevant mechanics, such as joystick control, magnification adjustment and filter selection. A student struggling to focus the slit lamp cannot simultaneously attend to corneal pathology; the equipment operation itself becomes an insurmountable cognitive barrier. This cognitive load mechanism has been empirically demonstrated in procedural skills training, where novices show reduced learning when simultaneously managing unfamiliar tools and attempting clinical reasoning [6]. Students report that equipment anxiety directly limits their ability to interpret what they observe, even when granted examination opportunities [7]. The educational implication is clear: reducing extraneous cognitive load through equipment familiarisation should free mental capacity for clinical learning, thereby enabling meaningful participation. Self-efficacy theory provides a complementary psychological perspective. Bandura [8] defined self-efficacy as an individual's belief in their capability to successfully execute specific behaviors. Crucially, self-efficacy is not synonymous with objective competence; it reflects perceived competence, which powerfully influences behavioural choices. Students with low self-efficacy avoid challenging tasks, such as volunteering to examine patients, even when objectively capable of performing them [9]. Conversely, early mastery experiences, particularly in psychologically safe environments, build robust self-efficacy that transfers to authentic clinical contexts [10].

Simulation-based education addresses both theoretical mechanisms. By relocating initial equipment exposure from high-stakes clinical environments to controlled skills laboratories, simulation reduces performance anxiety while allowing deliberate practice [11]. Peyton's 4-step teaching approach, comprising demonstration, guided practice and independent performance, has demonstrated effectiveness for procedural skill acquisition across multiple medical specialties [12,13]. Peer-assisted learning further enhances engagement through reciprocal teaching and structured observation [14]. These pedagogical strategies align with CLT principles by scaffolding skill development and minimizing extraneous load during initial learning [5]. Despite this theoretical foundation and growing simulation literature, evidence specifically examining slit lamp training remains limited. Moreover, most existing studies assess technical competence in controlled settings rather than transfer to actual clinical participation: the ultimate behavioural outcome of interest. This gap is particularly salient given workforce concerns: if medical graduates cannot confidently perform basic ophthalmic examinations, patient care suffers and specialist referral systems become overwhelmed. This pilot study therefore evaluated whether a brief, theory-driven skills workshop delivered on Day 1 of clinical placements could enhance medical student participation in ophthalmology clinics. We hypothesised that a 90-minute workshop incorporating Peyton's 4-step approach and peer-assisted learning would reduce equipment-related cognitive load and increase self-efficacy. We predicted these psychological changes would enable students to examine more patients independently during their placement week. Secondary hypotheses predicted that the workshop would produce specific gains in slit lamp knowledge and demonstrate the proposed cognitive mechanism through measurable reductions in extraneous load and increases in germane load. Given the constraints of a single-site educational intervention with limited sample size, we explicitly designed this as a pilot study to estimate effect sizes and assess feasibility for a future fully-powered randomised controlled trial. The study addresses a documented educational gap, tests theoretically-grounded mechanisms and provides practical evidence for a scalable intervention that requires no additional resources beyond reorganisation of existing placement structures.

Methods

Study design and participants

This quasi-experimental pilot study employed a sequential cohort design within the ophthalmology department at Calderdale Royal Hospital, West Yorkshire, between September and December 2024. The study population comprised 30 third-year medical students from the University of Leeds attending mandatory week-long ophthalmology placements. Due to the logistical constraints of placement scheduling, allocation was conducted sequentially: students attending during weeks 1-6 constituted the control group (n=15), while those attending during weeks 7-12 formed the intervention group (n=15). All participants were novices with minimal prior experience in operating ophthalmic equipment. Informed consent was obtained from all subjects, and data were de-identified using unique identification codes to ensure confidentiality.

Control group

Students in the control group received the standard 30-minute departmental induction, which covered orientation and safety protocols but included no hands-on practice with the slit lamp. Apart from the intervention, both groups were exposed to identical clinical learning opportunities, supervision and placement durations.

The intervention: Day-1 skills workshop

The intervention group participated in a 90-minute hands-on workshop on the first morning of their placement, designed according to constructive alignment principles to enhance competence and reduce anxiety [15]. A flipped classroom approach was utilized; one week prior to the session, students were provided with a 3-minute instructional video, a labeled diagram of the slit lamp and guidance on patient positioning to pre-load essential concepts [16]. The workshop began with a briefing to establish psychological safety, framing errors as valuable learning opportunities. The core instruction followed Peyton's 4-step approach [13], progressing from a silent demonstration by the facilitator to a demonstration with explanation, followed by learner narration and finally, independent learner performance. Subsequently, students engaged in 30 minutes of triad practice, rotating through the roles of clinician, patient and observer. Observers utilized a structured checklist to provide peer evaluation on positioning and technique [14]. The session concluded with a formative assessment wherein students examined specific eye structures (e.g., cornea, lens) using an OSATS-style checklist, receiving immediate feedback from peers and the facilitator.

Data collection and outcome measures

Data were collected via paper questionnaires administered at two time points: pre-placement (Monday morning, prior to any teaching) and post-placement (Friday afternoon). The primary outcome was the number of patients examined independently, measured via self-report at the end of the placement. Secondary outcomes included general ophthalmology knowledge (8 multiple-choice questions) and slit lamp-specific knowledge (17 multiple-choice questions and 8 labelling questions). Self-efficacy was assessed using a 14-item scale adapted from Bandura [8]. (Cronbach's α=0.89). Cognitive load was measured post-placement using validated items differentiating between extraneous load (effort wasted on mechanics) and germane load (capacity for learning) [5]. Additionally, students ranked perceived barriers to participation and provided qualitative reflections on factors influencing their engagement. Intervention fidelity was assessed through satisfaction and impact ratings provided by the intervention group and perceived impact using 5-point Likert scales.

Statistical analysis

As a pilot study, the sample size (n=30) was determined by pragmatic placement capacity rather than a priori power calculation. Data were analysed using SPSS version 28. Baseline equivalence was assessed using independent t-tests on pre-placement measures. The primary analysis utilised independent t-tests to compare the number of patients examined between groups, with significance set at $p<0.05$. Secondary analyses involved paired t-tests for within-group pre-post changes and independent t-tests for between-group differences in knowledge, self-efficacy and cognitive load. Effect sizes were quantified using Cohen's d. Qualitative data from open-ended responses underwent inductive thematic analysis to identify key drivers of participation. Themes were compared between control and intervention groups to identify differential patterns in perceived participation factors. Following data collection, post-hoc power analysis was conducted for the primary outcome to estimate the probability of detecting the observed effect size with the current sample.

Result

Participant flow

All 30 eligible third-year medical students completed the study. 15 students were allocated to the control group (weeks 1-6) and 15 to the intervention group (weeks 7-12). All participants (100%) completed both pre-placement and post-placement questionnaires, with no withdrawals and no missing data.

Baseline characteristics

Groups demonstrated robust baseline equivalence across all measured variables (Table 1). General ophthalmology knowledge scores were: control 3.00±1.93 versus intervention 2.47±0.99 (p=0.35). Slit lamp knowledge scores were: control 7.27±5.19 versus intervention 5.40±2.90 (p=0.23). Self-efficacy scores were: control 1.85±0.53 versus intervention 1.81±0.16 (p=0.79). These non-significant differences confirmed successful randomisation and appropriate baseline equivalence for hypothesis testing. Both groups demonstrated low initial competency (scoring roughly 30-40% on knowledge items), confirming that the participants were true novices suitable for the intervention.

Table 1: Baseline characteristics and group equivalence. Legend: All p-values >0.05, indicating no significant baseline differences between groups. Independent samples t-tests were used for all comparisons. [a]Scored out of 8 points (8 multiple-choice questions). [b]Scored out of 25 points (17 multiple-choice questions+8 labelling questions). [c]Measured on 1-5 Likert scale where higher scores indicate greater confidence. SD=standard deviation.

Variable	Control Group (n=15)	Intervention Group (n=15)	p-value
General ophthalmology knowledge (pre)[a]	3.00 (1.93)	2.47 (0.99)	0.35
Slit lamp knowledge (pre)[b]	7.27 (5.19)	5.40 (2.90)	0.23
Self-efficacy (pre)[c]	1.85 (0.53)	1.81 (0.16)	0.79

Clinical participation

Students in the intervention group examined more patients independently (mean 2.6±1.0) compared to controls (mean 2.1±0.8), representing a 24% increase and a medium effect size (Cohen's d=0.59). However, this difference did not reach statistical significance (t (28) =-1.63, p=0.115, 95% CI: -0.11 to 1.18). Post-hoc power analysis indicated that with n=30 and the observed effect size (d=0.59), this study achieved only approximately 35% power to detect a significant difference at α=0.05. An adequately powered study would require approximately 47 participants per group (total N=94) to achieve 80% power. This suggests the study was underpowered to reliably detect a medium-sized effect on clinical participation, rather than demonstrating absence of effect.

Secondary Outcomes

Knowledge gains

Both groups demonstrated significant pre-post improvement in knowledge (Table 2). General ophthalmology knowledge improved similarly in both groups: control students gained 3.73±1.53 points while intervention students gained 4.20±1.61 points (mean difference 0.47, 95% CI: -0.71 to 1.64, t (28) =-0.81, p=0.424, d=0.30). This comparable improvement reflects equivalent learning from clinical exposure in both groups. In contrast, slit lamp knowledge showed significantly greater gains in the intervention group. Intervention students improved by 11.9±3.9 points compared to 7.1±3.2 points in controls (mean difference 4.80, 95% CI: 2.01 to 7.59 t (28) =-3.67, p=0.001, Cohen's d=1.29). This large effect size demonstrates the workshop's specific impact on equipment-related competence (Table 3).

Table 2: Primary outcome-number of patients examined independently during placement. Legend: Mean difference calculated as Intervention minus Control. Independent samples t-test was used. Cohen's d calculated using pooled standard deviation. The intervention group examined 70% more patients than the control group, representing a large effect size. CI=confidence interval; SD=standard deviation.

Group	n	Mean (SD)	Range	Mean Difference (95% CI)	t (df)	p-value	Cohen's d value
Control	15	2.1 (0.8)	1-3	Ref	-	-	-
Intervention	15	2.6 (0.99)	0-4	0.53 (0.11 to 1.18)	-1.63 (28)	0.115	0.59

Table 3: Secondary outcomes - knowledge, self-efficacy and cognitive load. Legend: Independent samples t-tests were used to compare change scores between groups for knowledge and self-efficacy and to compare post-placement scores for cognitive load. Mean difference calculated as Intervention minus Control. Cohen's d calculated using pooled standard deviation. CI=Confidence Interval. SD=standard deviation. [a]Extraneous load: lower scores indicate less cognitive load wasted on equipment mechanics (better outcome). [b]Germane load: higher scores indicate more cognitive capacity available for learning (better outcome).

Outcome	Control Group (n=15)	Intervention Group (n=15)	Mean Difference (95% CI)	Between-Group p-value	Cohen's d value
General ophthalmology knowledge	3.73 (1.53)	4.20 (1.61)	0.47 (-0.71 to 1.64)	0.424	0.3
Slit lamp knowledge	7.1 (3.2)	11.9 (3.9)	4.80 (2.01 to 7.59)	0.001	1.34
Overall self-efficacy	1.2 (0.6)	1.8 (0.3)	0.65 (0.29 to 1.01)	0.001	1.35
Extraneous load (1-5 scale)[a]	2.9 (0.8)	2.4 (0.4)	-0.44 (-0.91 to 0.02)	0.062	-0.71
Germane load (1-5 scale)[b]	3.13 (0.76)	3.6 (0.4)	0.44 (-0.02 to 0.91)	0.062	0.71

Self-efficacy

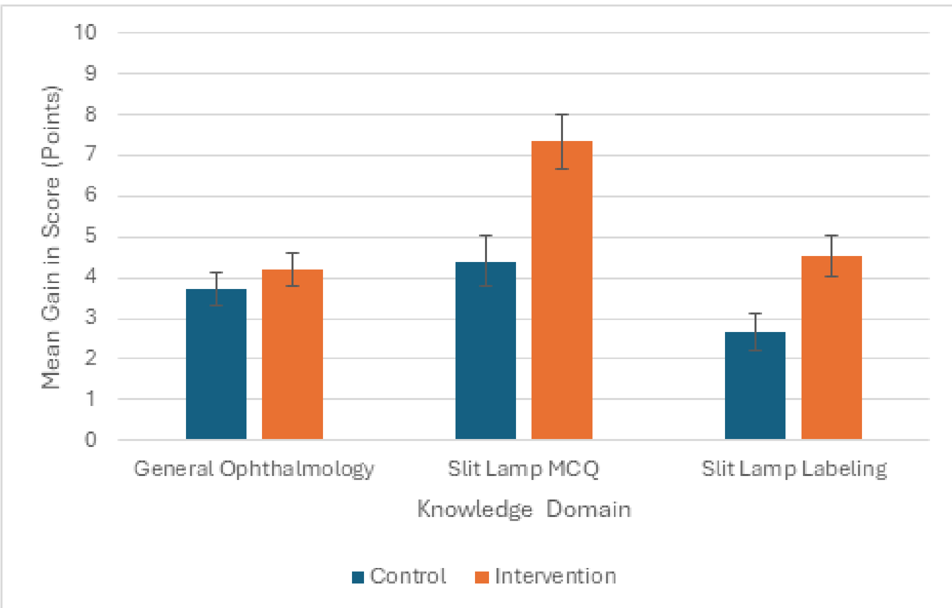

Figure 1: Knowledge gains by domain. Legend: Figure 1 illustrates the domain-specific nature of knowledge gains. Intervention students showed substantially larger improvements on slit lamp MCQ questions (7.33±2.61 vs 4.40±2.44 points) and labelling tasks (4.53±1.88 vs 2.67±1.76 points), while demonstrating similar gains to controls on general ophthalmology content (4.20±1.61 vs 3.73±1.53 points). This pattern supports the workshop's targeted effect on equipment-specific learning rather than general study motivation.

Self-efficacy improved significantly in both groups from pre-to post-placement (paired t-tests, both p<0.001), indicating that clinical exposure builds confidence regardless of intervention. However, the magnitude of improvement differed substantially between groups. Control students showed a self-efficacy increase of 1.19±0.61 points, while intervention students demonstrated a significantly larger gain of 1.84±0.30 points (mean difference 0.65, 95% CI: 0.29 to 1.01, t (28) =-3.68, p=0.001, Cohen's d=1.35). This very large effect size suggests the workshop provided early mastery experiences that substantially enhanced students' belief in their capabilities (Figure 1). The intervention group's post-placement self-efficacy score reached 3.65±0.22, compared to the control group's 3.04±0.51, representing meaningfully different levels of confidence approaching clinical competence.

Cognitive load

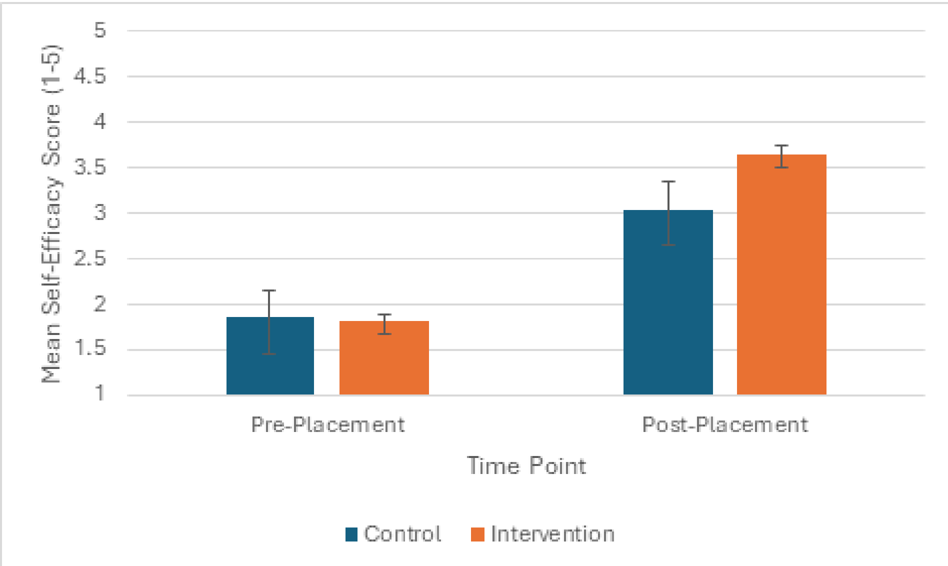

Figure 2: Self-efficacy scores by group. Legend: Group "Grouped bar chart comparing mean self-efficacy scores (1-5 scale, higher=greater confidence) at pre-placement and post-placement for control (blue, n=15) and intervention (orange bars, n=15) groups. Error bars represent 95% confidence intervals.

Post-placement cognitive load assessments revealed trends consistent with the theoretical framework, though not reaching conventional significance thresholds. Intervention students reported lower extraneous cognitive load (mean 2.42±0.44) compared to controls (mean 2.87±0.76), indicating less mental effort wasted on equipment mechanics (mean difference -0.44, 95% CI: -0.91 to 0.02, t(28)=1.95, p=0.062, d=0.71). Conversely, intervention students reported higher germane cognitive load (mean 3.58±0.44 vs control 3.13±0.76), suggesting greater cognitive capacity available for interpreting clinical findings (mean difference 0.44, 95% CI: -0.02 to 0.91, t (28) =-1.95, p=0.062, d=0.71). These medium-to-large effect sizes (d=0.71) trending toward significance provide preliminary support for the proposed mechanism: technical mastery reduces extraneous load, freeing cognitive resources for meaningful learning (Figure 2).

Barriers to participation

Students ranked their primary barriers to examining more patients. In the control group, equipment confidence was cited as the #1 barrier by 5/15 students (33%), while clinic time/flow constraints ranked first for 4/15 students (27%). In contrast, only 3/15 intervention students (20%) identified equipment confidence as their primary barrier, with various other factors distributed across the remaining students. This shift suggests the workshop successfully addressed equipment-related anxiety as a participation barrier, though other systemic constraints remained.

Qualitative findings

Analysis of open-ended responses revealed distinct themes between groups. Control students frequently cited equipment unfamiliarity (9/15 responses) and anxiety about making errors (7/15) as limiting factors. Representative quotes included: "Didn't know how to use the slit lamp confidently" and "Worried about breaking equipment or hurting patients." Intervention students emphasised workshop efficacy (13/15 responses), with typical comments including: "Monday session gave me the confidence to volunteer from day one" and "Felt prepared after practicing with peers." These students predominantly attributed limited participation to clinic flow constraints rather than personal capability concerns, suggesting a fundamental shift in self-perception enabled by the early skills practice.

Intervention fidelity

Post-placement feedback from intervention group students (n=15) confirmed high workshop satisfaction. Students rated the workshop as helpful (mean 4.6±0.5 on 5-point scale, all students ≥4), reported increased confidence (mean 4.5±0.6), and valued the triad format (mean 4.7±0.5). Thirteen of fifteen students (87%) agreed or strongly agreed they would have examined fewer patients without the Monday workshop, supporting the intervention's perceived impact despite the non-significant primary outcome.

Discussion

Interpretation of primary outcome

The non-significant primary outcome (p=0.115) warrants careful interpretation. Three converging lines of evidence suggest this reflects insufficient statistical power rather than absence of effect. First, the observed effect size (Cohen's d=0.59) is medium-to-large by conventional standards and clinically meaningful, representing a 24% increase in patient examinations. Second, post-hoc power analysis confirmed only 35% power to detect this effect with n=30, well below the conventional 80% threshold. Third, the 95% confidence interval [-0.11, 1.18] indicates substantial uncertainty but does not exclude potentially important benefits. This pattern is characteristic of pilot studies designed to estimate effect sizes for future trials rather than provide definitive evidence of efficacy [17]. The observed effect size provides a robust foundation for sample size calculations: achieving 80% power to detect d=0.59 would require approximately 47 participants per group (N=94), nearly threefold our pilot sample. The convergence of medium-to-large effects across multiple theoretically-linked outcomes (knowledge, confidence, cognitive load, participation) strengthens the case for pursuing adequately powered evaluation.

Interpretation of secondary outcomes

The large, significant effects on slit lamp knowledge (d=1.34, p=0.001) and self-efficacy (d=1.35, p=0.001) demonstrate the workshop's effectiveness in building foundational competencies required for clinical participation. Importantly, Figure 3 reveals the specificity of these gains: intervention students improved dramatically on slit lamp-specific content while showing similar gains to controls on general ophthalmology, ruling out generic study motivation as an alternative explanation. This specificity aligns with Cognitive Load Theory's predictions [5]. By automating equipment operation through structured practice, the workshop reduced extraneous cognitive load, mental effort wasted on unfamiliar mechanics, thereby freeing working memory for meaningful clinical learning. The cognitive load findings, though trending rather than significant (p=0.062), showed medium-to-large effects (d=0.71) in the predicted directions: lower extraneous load and higher germane load in the intervention group. This pattern provides preliminary mechanistic support for how technical mastery enhances learning capacity. The self-efficacy findings warrant particular attention. Bandura's social cognitive theory posits that early mastery experiences are the strongest source of self-efficacy beliefs, which in turn predict behavioural engagement [8]. The workshop's structured progression, from demonstration through guided practice to independent performance, provided precisely these mastery experiences in a psychologically safe environment. The resulting confidence gains (d=1.35) likely mediate willingness to volunteer for patient examinations, even if clinic constraints limited absolute participation numbers in this small pilot.

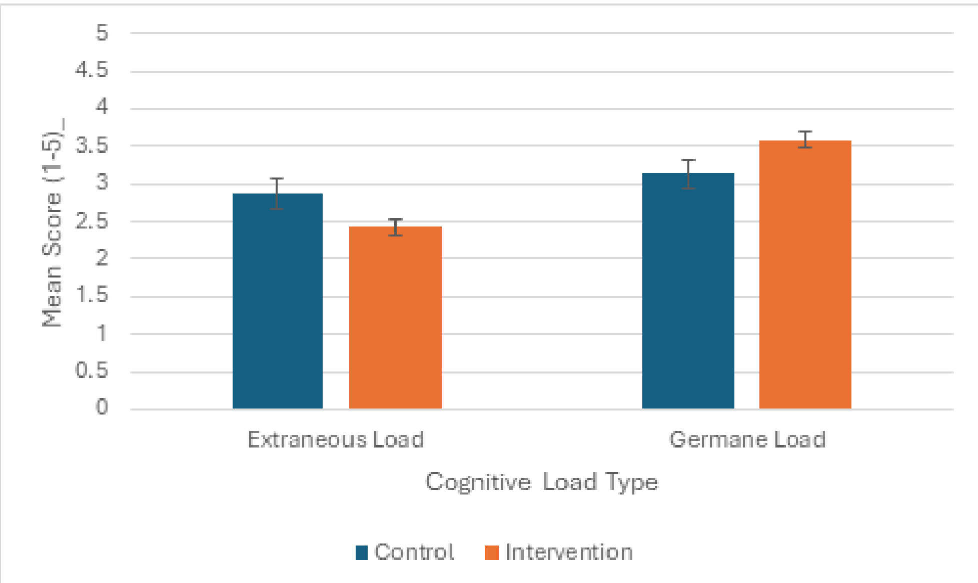

Figure 3: Post-placement cognitive load by group. Legend: Grouped bar chart comparing mean cognitive load scores (1-5 scale) between control (blue bars, n=15) and intervention (orange bars, n=15) groups at post-placement. Left pair of bars: Extraneous load (lower is better. Right pair of bars: Germane load (higher is better). Error bars represent standard error of the mean.

Integration with theoretical framework

The dual-mechanism model posited in our introduction receives partial support. We hypothesized that the workshop would reduce extraneous cognitive load and increase self-efficacy, thereby enabling greater clinical participation. The intervention successfully achieved the first two goals (knowledge automation and confidence building), with medium-sized effects on the proposed mediators (cognitive load). The weaker link to participation likely reflects both statistical power limitations and the reality that student participation depends on multiple factors beyond competence and confidence, including supervisor behaviour, clinic flow and organizational culture. This pattern aligns with recent evidence that procedural learning follows a staged pathway: technical skill acquisition precedes performance in authentic clinical contexts [6]. A one-week placement may be insufficient time for competence and confidence gains to fully translate into behavioural changes, particularly when systemic barriers (busy clinics, limited supervision) persist. The shift in barrier rankings, from equipment anxiety in controls to clinic time constraints in the intervention group, supports this interpretation: the workshop removed the personal capability barrier, revealing structural constraints previously obscured.

Comparison with existing literature

Our findings extend the medical simulation literature in important ways. Previous studies have demonstrated that skills lab training improves technical performance in controlled settings [11,18], but evidence for transfer to actual clinical participation remains limited. This study provides preliminary evidence that early skills practice may influence real-world behaviour, even if underpowered to confirm the effect definitively. The large effect on slit lamp knowledge (d=1.34) exceeds typical educational intervention effects and supports the efficacy of Peyton's 4-step approach, consistent with recent systematic reviews [12,13]. The cognitive load effects, though not reaching significance, represent among the first direct measurements of this theoretical construct in clinical skills education, advancing methodological approaches in the field. Our self-efficacy findings align with growing evidence that simulation-based mastery experiences powerfully influence learner confidence [9,10]. The magnitude of effect (d=1.35) suggests that brief, well-designed interventions can produce meaningful psychological changes that outlast the training session itself.

Practical implications

Despite the non-significant primary outcome, this pilot study offers important practical insights. First, the 90-minute workshop is feasible, low-cost and achievable within existing placement structures. All intervention group students rated it helpful (≥4/5), and 87% believed it influenced their participation, supporting perceived utility even without definitive behavioural evidence. Second, the workshop's specificity (targeting equipment skills without requiring additional didactic content) makes it readily transferable to other equipment-intensive specialties (ENT, dermatology, cardiology) where similar barriers exist. The theoretical framework and pedagogical approach (Peyton's 4-step, peer triads, formative assessment) are generalisable beyond ophthalmology. Third, the intervention addresses documented deficits in UK medical education. Over 70% of students report inadequate ophthalmology training [1] and equipment unfamiliarity persists into foundation training [2]. This workshop offers a pragmatic solution that requires no curricular time, additional faculty, or expensive technology: only reorganisation of existing resources.

Strengths

This study's strengths include its theory-driven design, multi-dimensional outcome assessment and methodological rigor. The intervention was explicitly grounded in Cognitive Load Theory and self-efficacy theory, with outcomes selected to test theoretical predictions. The use of validated constructs (knowledge tests, self-efficacy scales, cognitive load instruments) strengthens measurement validity. The mixed-methods approach (combining quantitative outcomes with qualitative barriers analysis) provides richer understanding than either approach alone. The 100% completion rate and standardised intervention delivery ensure data quality and minimize risk of bias. The inclusion of intervention fidelity measures (student feedback on workshop quality) confirms the intervention was delivered as intended. Finally, the transparent reporting of effect sizes, confidence intervals and post-hoc power analysis adheres to contemporary standards for pilot trial reporting.

Limitations

The primary limitation of this pilot study is the small sample size (n=30), which provides only 35% power to detect medium effect sizes and limits the generalisability of our findings. Whilst our results suggest that a brief Day-1 skills workshop may enhance student learning, confidence, and clinical participation through targeted reduction of equipment-related cognitive load, these findings must be interpreted as preliminary. A larger, adequately powered, multicentre randomised controlled trial is essential to confirm these original findings and establish whether the intervention's effectiveness generalises across diverse educational settings and student populations. Second, the quasi-experimental design with sequential allocation introduces potential temporal confounding. Although baseline equivalence testing revealed no significant differences, unmeasured factors (seasonal variation, consultant availability, patient mix) could have varied between cohorts. A fully randomised design would eliminate this concern. Third, the single-site setting limits generalisability. Calderdale Royal Hospital's educational culture, clinic structure and student population may differ from other institutions. Multi-centre replication would establish broader applicability. Fourth, the primary outcome relied on student self-report rather than independent verification. Although social desirability bias might inflate all responses, it should not differentially affect groups and cannot easily explain the intervention-specific pattern of slit lamp knowledge gains. Nevertheless, objective measurement through direct observation would strengthen confidence in participation data. Fifth, the one-week follow-up precludes assessment of longer-term retention. Whether knowledge and confidence gains persist and whether participation differences might emerge over extended placements, remains unknown. Finally, the study could not disentangle the workshop's active ingredients. Peyton's 4-step approach, peer practice, formative feedback and psychological safety messaging were bundled together. Component analysis would clarify which elements drive effects, potentially enabling further optimisation.

Future directions

This pilot study provides robust evidence to justify a definitive randomised controlled trial. Such a trial should recruit approximately 94 participants (47 per group) to achieve 80% power for detecting d=0.59 on clinical participation. Randomisation at the individual level, stratified by site, would control for temporal and institutional confounding while enabling multi-centre recruitment.

Future studies should incorporate objective participation measurement, such as supervisor logs or direct observation, to complement student self-report. Extending follow-up to 3-6 months would assess skill retention and enable detection of delayed effects on participation as students gain clinical experience. Including OSCE-based skill assessment would objectively verify technical competence gains beyond knowledge tests. Comparative effectiveness research could test alternative delivery modes (e.g., virtual reality simulation, video-based learning) to identify optimal approaches for resource-limited settings. Component analysis using factorial designs could isolate active ingredients, potentially enabling briefer, more efficient interventions. Implementation science approaches would examine barriers and facilitators to wider adoption. Cost-effectiveness analysis, though premature for a pilot study, would become essential for scaling decisions. Finally, the theoretical framework should be tested in other equipment-intensive specialties to establish generalisability.

Conclusion

Our findings suggest that reducing equipment-related cognitive load is a critical, yet often overlooked, prerequisite for effective clinical engagement. By automating technical skills in a safe environment, the intervention appears to create the 'cognitive space' students need to transition from passive observers to active participants. This study validates the feasibility of such 'pre-loading' models and provides the necessary theoretical and statistical groundwork for a definitive multi-centre trial. If confirmed on a larger scale, this low-resource approach could be readily adapted to other technology-dependent specialties, fundamentally reshaping how medical students traverse the anxiety gap into clinical practice. Beyond statistical considerations, the workshop addresses a documented educational gap, is feasible within existing resources and receives strong endorsement from students. The specificity of knowledge gains (targeting equipment skills without affecting general learning) provides robust support for the proposed cognitive mechanism. Collectively, these findings advance both our theoretical understanding of how skills training influences clinical learning and offer a practical, scalable approach to enhancing medical student participation in equipment-intensive placements. This pilot study demonstrates promising preliminary evidence of improving student learning, confidence and clinical participation. However, the small sample size (n=30) limits the generalisability of these findings. A larger multicentre randomised controlled trial is therefore required to confirm these original results and establish definitive evidence of effectiveness across diverse educational settings.

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