

A Blended-Learning Two-Day Trauma Course Compared with the Traditional Three-Day Trauma Course: A Retrospective Non-Inferiority Study

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Abstract

Background

During the multidisciplinary Definitive Surgical and Anaesthetic Trauma Care (DSATC) course, trauma specialists are trained to apply damage control principles to polytrauma patients. The course transitioned in 2020 from a three-day, traditional format to a two-day format that combines online and traditional learning methods to enhance course quality and learning outcomes. Considering that learning opportunities on the work floor are scarce, continuous course evaluation is crucial to ensure benefits for medical professionals and their patients.

Methods

This retrospective non-inferiority study compared self-assessed confidence in technical and non-technical skills between a cohort in the traditional DSATC course and a cohort in the blended-learning DSATC course. Self-assessed confidence ratings were collected through quantitative pre-course and post-course questionnaires. Mean changes in confidence ratings were calculated and compared using independent samples t-tests with a non-inferiority margin of -0.5. Sub-analyses investigated differences between participants of the same profession, between physicians with different levels of experience, and investigated the influence of individual preparation on self-assessed confidence in skills before on-site training.

Results

A total of 180 (21%) participants completed the pre-course and one-day post-course questionnaires completely. Both cohorts showed increased self-assessed confidence in skills following course completion, with the blended-learning DSATC cohort demonstrating non-inferior improvements compared with the traditional cohort in general technical skills (mean difference (MD) 0.07, 97.5%-confidence interval (CI) lower confidence bound - 0.14, $p < 0.001$) and in general non-technical skills (MD 0.09, 97.5%-CI lower confidence bound - 0.09, $p < 0.001$). Self-assessed confidence in non-technical skills declined in the blended-learning cohort following individual preparation (MD -0.21, $p = 0.042$).

Conclusions

The blended-learning format of the DSATC course is at least as effective as the traditional model in improving self-assessed confidence in technical and non-technical skills. Individual pre-course preparation by participants may increase awareness of learning needs, fostering self-directed learning. The findings underscore the need to move beyond a traditional, one-size-fits-all approach to training and toward competency-based, individualized learning pathways, supported by blended-learning methods. Further research into the effectiveness of such pathways in multidisciplinary trauma education and patient outcomes is needed.

Introduction

The effective treatment of critically injured patients requires an integrated set of technical and non-technical skills, such as acute surgical skills, communication, and teamwork [1–3]. Educational opportunities aimed at the treatment of polytrauma patients are crucial to improve the readiness and competence of medical professionals in trauma care, since this influences the quality of care provided to patients [4–6]. However, learning opportunities in the clinical work environment are often limited by factors such as increased nonoperative management and the unpredictable and time-sensitive nature of trauma cases, which complicate the planning and delivery of educational initiatives, resulting in a lack of on-the-job learning opportunities [6–8].

In recognition of the need for trauma care education, various courses have been developed. Examples include Advanced Trauma Life Support (ATLS), Advanced Surgical Skills for Exposure in Trauma (ASSET), Definitive Surgical Trauma Care (DSTC) and Definitive Anaesthetic Trauma Care (DATC) courses [9–12]. Participation in such courses can enhance self-assessed competence, clinical performance, knowledge, and the efficiency of team-based patient care [1, 12–14].

The Dutch DSTC and DATC courses were the first to be combined into one multidisciplinary course: the Definitive Surgical and Anaesthetic Trauma Care (DSATC) course [15]. The Dutch DSATC course has been in place since 2009 and provides learning opportunities to national and international participants involved in trauma care, such as intensivists, scrub nurses, anesthesia nurses, surgeons and anesthesiologists. The intention is to equip participants with knowledge and skills regarding the application of damage control principles to polytrauma patients through interactive workshops, group discussions, and lectures [15–16]. Hands-on experience with trauma cases is offered through simulation in a regulated environment, enabling skill development while eliminating risks for individual patients [10, 17–18]. The unique multidisciplinary approach, which distinguishes the DSATC course, improves teamwork and team-based care for severely injured patients [1, 10, 14, 19].

In 2020, the traditional three-day on-site DSATC course was redesigned into a blended-learning format that combines online modules with two days of in-person training, while maintaining the amount of hands-on experience. This shift, prompted by the COVID-19 pandemic and guided by previous faculty and participant feedback, can enhance learning by offering greater flexibility for individual learners' needs, reinforcing theoretical knowledge, and improving preparation for practical training [20–21]. The preparation for the previous course consisted mainly of theoretical preparation through course manuals, whereas the current format provides preparatory material through the renewed DSATC manual [22] and an online learning environment, comprising pre-recorded lectures, e-learning and virtual simulation (Appendix A). Online learning complements traditional methods but cannot replace hands-on learning [20–21, 23]. Given the significance of educational quality for participant development and, consequently, its potential implications for patient outcomes, it is essential to evaluate how differences in course design influence educational quality and learners' self-efficacy [14, 24–25].

Therefore, the objective of this study is to compare self-assessed confidence in skills between participants who attended a previous traditional DSATC course and those who completed the new blended-learning DSATC course. With this approach, the study aims to generate actionable learning points applicable to the DSATC and

similar courses. To our knowledge, few studies have examined both technical and non-technical skills within such multidisciplinary settings. Previous studies also highlighted the need for research on the multidisciplinary aspects of trauma care courses. These points have been identified as gaps in research [1, 19, 26–27], which this study seeks to address.

Methods

Study design and setting

This retrospective non-inferiority cohort study included two cohorts of attendees from the DSATC course at the Radboud University Medical Centre (Radboudumc) in Nijmegen, the Netherlands. Cohort 1 consisted of participants from traditional DSATC courses between 2016 and 2019. Cohort 2 consisted of participants who took part in the new blended-learning DSATC course between 2021 and 2024.

Participants

The study population comprised all participants ($n = 843$) in the DSATC course at Radboudumc between 2016 and 2024. The participants included were mainly attending and resident surgeons and anesthesiologists, scrub nurses and anesthesia nurses from various countries.

Course participants were informed about the conduction of research throughout the DSATC courses and were requested to complete the corresponding questionnaires. Subsequently, consent to participate in this study was implied by the voluntary completion of the questionnaires. This study was determined to be exempt from the Dutch Medical Research Involving Human Subjects Act (WMO) by a Medical Ethics Committee.

Data collection

All course participants received an invitational email to anonymously fill out quantitative digital questionnaires at five instances: one day before the course, and one day, three months, one year, and two years after the course. Reminders were sent four weeks later. The participants from the 2024 blended-learning DSATC course group received an additional questionnaire before receiving access to the individual preparatory materials. Answers were automatically collected and organized yearly into secure data files on Radboudumc servers by the Department of Surgery. Participants who wished not to participate could opt to be unsubscribed to future invitations and withdraw at any time.

The questionnaires were identical at each timepoint (Appendix B) and data from the questionnaires were analyzed to reveal actionable learning points for the DSATC and similar multidisciplinary courses. The questions encompassed participant characteristics, including sex, age, and profession, as well as technical skills (e.g. trauma laparotomy, treating head trauma) and non-technical skills (communication, teamwork, leadership). Participants assessed their confidence in each skill using a five-point Likert scale (1 not confident – 5 very confident). Skills questions concerned general skills that applied to all participants, as well as specific skills for each of the main professions, namely surgeons (including orthopedic surgeons), anesthesiologists and anesthesia/scrub nurses. The questionnaires were based on previous resources consisting of course

objectives and content, expert opinions, and a similar questionnaire utilized in a study by Gaarder et al. in 2005 [9]. Previous studies have utilized and published on the questionnaire [9–10, 17]. Minor differences existed between the traditional and blended-learning course questionnaires, mainly regarding the newly developed individual preparations. The previous questionnaire was published in the 2020 study by Tan et al. [10].

Data analysis

Participant characteristics and mean evaluation grades, collected from annual digital course evaluations, were analyzed descriptively. These are presented as the mean $\pm$ standard deviation (SD) or as numbers with percentages. Participant characteristics were analyzed comparatively between the traditional and blended-learning cohorts via a chi square test for categorical data and an independent samples t-test or one-sample t-test for numerical data. Prominent participant feedback from the evaluations and overall self-assessed skills progression observed throughout the surveys were also reported descriptively.

The primary outcome measures were the mean changes in self-assessed confidence in general technical and non-technical skills, compared between the cohorts. For the comparative analysis, self-assessed confidence ratings of general skills questions were combined to compute the primary outcome variables: confidence in general technical and non-technical skills. Mean confidence ratings were calculated from the pre-course and one-day post-course questionnaires for each cohort. The data had been previously collected.

Additional sub-analyses were conducted. One sub-analysis compared the mean change in self-assessed confidence in skills between the cohorts for each of the main professions: surgeons (including orthopedic surgeons), anesthesiologists and anesthesia/scrub nurses. The outcome variables were computed from specific skills questions from the pre-course and one-day post-course questionnaires. Surgeons' non-technical skills covered leadership and teamwork, while nurses' and anesthesiologists' non-technical skills exclusively covered teamwork. A second sub-analysis compared the mean change in self-assessed confidence from pre-course to one-day post-course between attending and resident physicians within each cohort. A final sub-analysis was conducted using data from the 2024 DSATC course group ($n = 49$), to assess how individual preparations might have influenced self-assessed confidence in general technical and non-technical skills before the on-site training.

Participants who completed both the pre-course and one-day post-course questionnaires were included in the statistical analysis. Those who did not complete both or only completed them partly were excluded (Fig. 1). The questionnaires beginning three-months post-course were not analyzed statistically because of low response rates. Furthermore, participants of whom it was unclear which questionnaire they intended to complete were excluded, and missing answers were excluded per analysis.

An independent samples t-test was deemed the appropriate statistical method for all analyses except the final sub-analysis, for which a paired samples t-test was used. All inferential statistics were conducted using IBM SPSS Statistics (version 29). For the primary analysis, a one-sided 97.5%-confidence interval (CI) was used to test the hypothesis that the results after the blended-learning course are not inferior to those of the traditional course, with a non-inferiority margin of -0.5 based on previous findings [10, 17]. For the sub-analyses and analysis of participant characteristics, a two-sided $\alpha \leq 0.05$ was used.

Results

Participation and response rates

An overview of the study population before and after the application of the inclusion criteria is depicted in Fig. 1. Participants of whom it was unclear which questionnaire they intended to complete were labeled non-respondents in the figure ($n = 4$). Among the 843 DSATC course participants between 2016 and 2024, 180 (21%) participants completed both the pre-course and one-day post-course questionnaires. The number of participants who completed each subsequent questionnaire declined, with 85 (10%) responses up to three-months post-course, 31 (4%) responses up to one-year post-course, and 9 (1%) responses up to two-years post-course. In total, 667 (79%) individuals completed at least one questionnaire. A comprehensive respondent distribution can be consulted in Appendix C.

Descriptive analysis

Table 1 presents the background characteristics of the respondents who completed both the pre-course and one-day post-course surveys. Compared with the traditional course cohort, the blended-learning course cohort included a greater number of male participants ($p = 0.021$) and had a different distribution of professional roles: the blended-learning course cohort had a lower proportion of nurses ($n = 15\%$ vs. $n = 27\%$) and a greater number of orthopedic surgeons ($n = 31$ vs. $n = 8$) ($p = 0.048$). The blended-learning course cohort also included more resident physicians ($n = 35, 31\%$) than did the traditional course cohort ($n = 9, 18\%$) ($p = 0.025$).

Characteristic	Traditional DSATC course	Blended-learning DSATC course	Total
	<i>n</i> = 67	<i>n</i> = 113	<i>n</i> = 180
Sex (<i>n</i> , %) *			
Male	36 (46%)	80 (71%)	116 (64%)
Female	31 (54%)	33 (29%)	64 (36%)
Age in years (<i>mean</i> , <i>SD</i>)	40.3 (9.1)	40.3 (7.9)	40.3 (8.3)
Profession (<i>n</i> , %) *			
Surgeon	23 (34%)	34 (30%)	57 (32%)
Nurse	18 (27%)	17 (15%)	35 (19%)
Anesthesiologist	18 (27%)	31 (27%)	49 (27%)
Orthopedic surgeon	8 (12%)	31 (27%)	39 (22%)
Current clinical work position ^a (<i>n</i> , %) *			
Attending physician	40 (82%)	61 (54%)	101 (56%)
Resident physician	9 (18%)	35 (31%)	44 (24%)
Years of work experience ^b (<i>mean</i> , <i>SD</i>)	15.2 (8.3)	16.1 (7.1)	15.8 (7.5)
Hospital of employment (<i>n</i> , %)			
Academic or military	28 (42%)	44 (39%)	72 (40%)
Peripheral or teaching	33 (49%)	67 (59%)	100 (56%)
Other	3 (5%)	0 (0%)	3 (2%)
Missing	3 (5%)	2 (2%)	5 (3%)
Employed at a level 1 trauma center (<i>n</i> , %)			
Yes	29 (43%)	63 (56%)	92 (51%)
No	5 (8%)	49 (43%)	54 (30%)
Missing	33 (49%)	1 (1%)	34 (19%)

Table 1 Background characteristics of respondents

SD standard deviation, *N.A.* not applicable, *n* number of respondents

Percentages are rounded

^a Only applicable to surgeons, orthopedic surgeons and anesthesiologists

^b Only applicable to anesthesia nurses and scrub nurses

* Statistical analysis on the variable demonstrated significant differences between the cohorts

Figure 2 depicts the longitudinal effect of both course formats on participants' self-assessed confidence in skills. Compared with the blended-learning DSATC cohort, the traditional DSATC cohort consistently demonstrated higher confidence levels, but the mean self-assessed confidence levels remained higher than the pre-course confidence levels throughout the follow-up period in both cohorts. However, this was not analyzed statistically.

Additionally, participants in the blended-learning course cohort were asked to rate their level of agreement with the statement '*individual preparation is not necessary prior to the course*' on a five-point Likert scale (1 completely disagree – 5 completely agree). The respondents demonstrated a mean change in agreement of -0.04 (SD 1.1) toward greater disagreement with the statement after completing the course than before the course ($p = 0.002$). The mean preparation time in this cohort was 14.2 hours (SD 7.9) for the online preparation modules and 18.3 hours (SD 11.8) in total, including course manuals and additional preparation.

Primary analysis

For the primary analysis, the mean changes in self-assessed confidence in general technical and non-technical skills were compared between the traditional learning DSATC group ($n = 67$) and the blended-learning DSATC group ($n = 113$) (Table 2). For general technical skills, the mean difference (MD) between the groups was 0.07, with a greater increase in self-assessed confidence in the blended-learning DSATC group. The lower bound of the 97.5%-CI was -0.14 ($p < 0.001$). For general non-technical skills, the MD between the groups was 0.09, again with a greater increase in self-assessed confidence in the blended-learning DSATC group. The lower bound of the 97.5%-CI for this difference was -0.09 ($p < 0.001$). Neither of the lower limits of the 97.5%-CI exceeded the pre-specified non-inferiority margin of -0.5.

Table 2
Self-assessed confidence in general skills compared between two DSATC course formats

General skills ^c	Traditional DSATC			Blended-learning DSATC			Mean difference (CI) ^e	<i>p</i> value
	<i>n</i> = 67			<i>n</i> = 113				
	Mean rating (SD) ^d			Mean rating (SD) ^d				
	Pre-course	One-day post-course	Mean change (SE)	Pre-course	One-day post-course	Mean change (SE)		
Non-technical								
Communication	3.9 (0.6)	4.1 (0.6)	0.25 (0.08)	3.8 (0.7)	4.1 (0.6)	0.36 (0.06)	0.11 (-0.08,0.30)	< 0.001
Teamwork	3.6 (0.6)	4.1 (0.6)	0.51 (0.08)	3.5 (0.7)	4.0 (0.5)	0.52 (0.07)	0.01 (-0.20,0.22)	< 0.001
Technical								
Trauma laparotomy	3.3 (1.2)	4.2 (0.9)	0.94 (0.13)	2.5 (1.3)	3.7 (1.2)	1.19 (0.11)	0.26 (-0.08,0.59)	< 0.001
Damage control surgery	3.2 (1.2)	4.0 (0.9)	0.81 (0.12)	2.5 (1.2)	3.5 (1.2)	1.01 (0.10)	0.20 (-0.13,0.52)	< 0.001
Head trauma	3.0 (1.0)	3.6 (1.0)	0.55 (0.11)	2.8 (1.2)	3.2 (1.1)	0.42 (0.10)	- 0.13 (-0.43,0.18)	0.009
Neck trauma	2.9 (0.9)	3.6 (0.8)	0.73 (0.11)	2.7 (1.1)	3.4 (0.8)	0.70 (0.10)	- 0.03 (-0.34,0.27)	0.001
Blast injury	2.5 (0.9)	3.4 (0.9)	0.97 (0.10)	2.2 (1.0)	3.2 (1.0)	0.96 (0.09)	- 0.01 (-0.29,0.28)	< 0.001
Ballistic/penetrating injury	2.7 (0.8)	3.5 (0.9)	0.79 (0.09)	2.4 (1.1)	3.5 (1.0)	1.07 (0.10)	0.28 (0.02,0.54)	< 0.001
Burn injury	2.8 (0.8)	3.6 (0.8)	0.75 (0.09)	2.7 (1.0)	3.4 (1.0)	0.66 (0.08)	- 0.09 (-0.33,0.16)	< 0.001
Pooled non-technical	3.8 (0.5)	4.1 (0.6)	0.32 (0.07)	3.7 (0.6)	4.1 (0.5)	0.41 (0.05)	0.09 (-0.09,0.26)	< 0.001
Pooled technical	2.9 (0.7)	3.7 (0.7)	0.80 (0.07)	2.5 (0.9)	3.4 (0.8)	0.86 (0.07)	0.07 (-0.14,0.27)	< 0.001
Combined	3.4 (0.5)	3.9 (0.6)	0.56 (0.06)	3.1 (0.6)	3.8 (0.6)	0.64 (0.05)	0.08 (-0.07,0.23)	< 0.001

SD standard deviation, *SE* standard error of the mean, *n* number of respondents

Level of significance $\alpha \leq 0.025$

^c Absence of questions about teamwork, trauma laparotomy, damage control surgery and burn injury in the traditional course of 2019 reduced the number of respondents to $n = 64$ for these general skills

^d Scale: 1 completely disagree – 5 completely agree

^e Mean difference between cohorts in the change in self-assessed confidence in skills from pre-course to one-day post-course, with negative values indicating a greater change in self-assessed confidence among traditional DSATC participants compared to blended-learning DSATC participants

Sub-analysis

The first sub-analysis revealed no significant differences between the cohorts in self-assessed confidence in either technical or non-technical skills for each of the main professional groups.

The second sub-analysis examined differences in the mean change in self-assessed confidence between residents and attending physicians. In both cohorts, residents demonstrated a greater increase in self-assessed confidence in both technical and non-technical skills than did attending physicians, although the difference was not statistically significant. In the traditional DSATC group, the mean increase for residents exceeded that of attending physicians by 0.14 ($p = 0.498$) for technical skills and 0.28 ($p = 0.175$) for non-technical skills. In the blended-learning DSATC group, the differences were 0.20 ($p = 0.134$) and 0.07 ($p = 0.518$) for technical and non-technical skills, respectively.

The final sub-analysis assessed the impact of completing the online individual preparations on participants' self-assessed confidence prior to the on-site sessions of the 2024 blended-learning DSATC course. For both general technical and non-technical skills, self-assessed confidence declined after completing individual preparations. While the decline in confidence in technical skills was not significant (MD -0.06, $p = 0.597$), the decline in self-assessed confidence in non-technical skills was indeed significant (MD -0.21, $p = 0.042$).

Course evaluations

The evaluation scores for the DSATC courses are summarized in Table 3. The 2017 traditional course received the lowest grade (mean $8.37 \pm \text{SD } 1.46$), whereas the 2024 blended-learning course received the highest (mean $8.67 \pm \text{SD } 0.74$). Generally, the blended-learning courses received higher grades than the traditional courses did.

Table 3
Annual DSATC course evaluation grades with response rates

	Course year							
	2016	2017	2018	2019	2021	2022	2023	2024
Grade	8.50	8.37	8.49	8.41	8.56	8.63	8.50	8.67
(mean, SD) ^f	(0.88)	(1.46)	(0.75)	(0.76)	(0.73)	(0.71)	(0.73)	(0.74)
Response rate (% n/total)	96% (53/55)	67% (41/61)	92% (82/89)	91% (79/87)	64% (90/140)	54% (73/134)	72% (101/141)	63% (85/136)

SD standard deviation, (*n/total*) number of respondents/number of invitees

Percentages are rounded

^f Scale: 1 very poor – 10 excellent

Participants highlighted the importance of practical surgical skills and problem-solving across all evaluations. Despite this, participants from both course formats noted that the integration of crew resource management (CRM) principles into the individual preparation and on-site training remains underdeveloped. These principles cover non-technical skills such as problem-solving, leadership, situational awareness and decision-making [3]. While some found the anatomy and operative porcine laboratories morally challenging, they were considered indispensable by traditional course participants and very beneficial by blended-learning course participants. Practical workshops were consistently rated as the best feature, whereas the quantity and quality of presentations were rated lower. Language barriers hindered the effective application of CRM principles.

Participant feedback on the individual preparation of the blended-learning course revealed mixed views. While some found it useful and interactive, others, particularly nurses, indicated that it was too extensive, beyond their expertise and mostly aimed at surgeons. Non-technical skills preparation was seen as insufficient. Moreover, disparities in professional backgrounds affected perceptions of course relevance: nurses felt inadequately involved, anesthesiologists expressed a wish for more depth or cross-disciplinary insights, and orthopedic surgeons and lower-level trauma center participants reported feeling out of place. Despite this, practical workshops increased confidence in trauma management for some participants. Suggestions for course improvement differed by cohort, with traditional DSATC course participants favoring a reduction in on-site training by one day, whereas blended-learning DSATC course participants favored less individual preparation or an additional on-site training day.

Discussion

This study explored the impact of transitioning a multidisciplinary trauma care course from a three-day, traditional learning format to a two-day, blended-learning format on participants' self-assessed confidence in their technical and non-technical skills. The findings indicate that the blended-learning format is at least as effective as the traditional format in enhancing Dutch DSATC course participants' self-assessed confidence,

with both cohorts reporting increased confidence following course completion. Notably, participants in the blended-learning cohort reported greater gains in non-technical skills and several technical skills.

The effectiveness of blended learning in healthcare education has been well established, with its success often attributed to factors such as personalized learning, enhancement of knowledge, facilitation of skill acquisition, and the reinforced connection between theory and practice [20–21, 28]. For example, a study by Bergmans et al. demonstrated the non-inferiority of a blended-learning approach in the context of technical skill acquisition and retention in the European Trauma Course (ETC) compared with traditional face-to-face teaching [29]. Even so, however, the effectiveness depends on course design, skill complexity and participant characteristics such as motivation, time management and digital experience [21, 29]. The mixed perceptions expressed in the DSATC course participants' feedback highlight how differences in the design, delivery and individual engagement with blended-learning programs can lead to varied educational outcomes. This underscores the idea that online education – despite its benefits – cannot fully replace all aspects of in-person curricula and that both should be customized with the individual learner in mind [20–21, 23, 27].

The individual preparations of the blended-learning DSATC course further illustrate both the potential and challenges of blended learning. The cohort that completed the newly developed individual preparatory material presented lower baseline confidence in non-technical skills (i.e., prior to the on-site training sessions). According to Kolb's Learning Theory, the preparatory phase may have primarily engaged participants in reflective observation and abstract conceptualization, as they were exposed to theoretical material without the benefit of hands-on experience [30]. This could have increased the perceived complexity of the material or heightened participants' awareness of their knowledge gaps, which, in turn, may have contributed to lower pre-course confidence ratings [31].

Nevertheless, this phase is a necessary and effective component of the learning process, as it encourages active and critical reflection on one's understanding. This facilitates the recognition and formulation of learning needs and goals, laying the foundation for goal-directed actions [30]. Smyth et al. (2012) reported that postgraduate students in a blended-learning program described developing an increased sense of responsibility for their own learning [32]. In support of this, participants in the blended-learning DSATC cohort – despite the initial report of lower self-assessed confidence before the on-site training – showed greater gains in self-assessed confidence after the course. Following the on-site training, respondents from this cohort also deemed individual preparation to be more necessary than they had initially deemed it before the course. In contrast, the traditional preparatory course manual, which was also distributed prior to the pre-course questionnaire, was reported to be underutilized and likely had minimal impact on participants' learning process and self-perceived readiness.

Finally, some of the findings could be explained by differences between the cohorts. The blended-learning cohort included more resident physicians than attending physicians. Although not statistically significant, resident physicians had a greater increase in self-assessed confidence in both technical and non-technical skills. Experience may influence self-efficacy, as less experienced participants often exhibit lower pre-course self-efficacy but are just as likely to achieve competence as more experienced participants [33]. Another source of heterogeneity was sex: compared with the traditional learning cohort, the blended-learning cohort comprised significantly more male participants than female participants. Differences in sex have been shown

to influence self-perception in clinical education, with some studies indicating that women may underestimate their competence despite their performance being equivalent or superior to the performance of male colleagues [34–35].

Strengths and limitations

This study extends previous observations by investigating how course modifications affect participants' self-assessed confidence in skills in a multidisciplinary educational setting. As recommended by other studies, all trauma team members [1, 19] and various technical and non-technical skills were included (Appendix B) [19, 26–27]. Additionally, the inclusion of attending physicians is noteworthy since they can also benefit from such courses due to the scarcity of on-the-job learning opportunities, but there is a paucity of literature reporting on attending physicians as trainees [26]. The diversity of participants in terms of profession and professional experience enhances the potential generalizability of the findings to other multidisciplinary trauma training contexts, particularly those aiming to integrate blended learning.

With 180 participants in the primary analysis, this study is among the larger evaluations of trauma professionals' self-assessed confidence in skills following a multidisciplinary trauma course. Despite the group sizes, comparisons between the cohorts were sometimes challenging, resulting in missing answers (Table 2). This was mainly due to simplifications and alterations made to the questionnaires, although the overall intent remained the same. Heterogeneity between the cohorts also played a role.

Finally, the results were based on self-assessments, which should be considered with some caution when interpreting them. Self-assessments are essential in adult educational processes to enhance learning but are subject to various factors that influence accuracy, such as work experience and self-perceived competence [34–36]. Objective assessments using procedure-specific checklists or global rating scales, or the use of video playback could be more reliable [37–38]. Moreover, the effectiveness of trauma care education on performance through, for example, increased confidence and teamwork has been observed [9, 39], but it is unknown exactly to what extent and precisely how increased confidence translates to improved performance in daily practice and, most importantly, improved patient outcomes [13, 39–41]. To our knowledge, few studies have proven the effectiveness of such training in reducing patient morbidity and mortality [5]. While improved patient outcomes are the main goal of trauma care courses, such as the DSATC course, they remain a challenging area to investigate because of the many environmental variables [5, 42].

Conclusion

This study highlights the potential advantages of a blended-learning model in multidisciplinary trauma education, as demonstrated by the Dutch DSATC course. Both the traditional and blended-learning cohorts showed increased confidence following the course, with the blended-learning format proving to be at least as effective as the traditional format. The quantitative data and participant feedback offer complementary insights into the educational effectiveness of this approach, emphasizing the role of individual learner backgrounds and preferences in cultivating self-efficacy in both technical and non-technical skills.

Given the critical importance of a multidisciplinary approach in preparing trauma teams for the effective treatment of critically injured patients, current educational methods, particularly the individual preparation

component, may need further alignment with the needs of individuals from diverse professional backgrounds. Future research should explore the influence of participant characteristics and incorporate long-term follow-up to evaluate the impact of blended learning on skill retention and patient outcomes in trauma care courses.

Abbreviations

ATLS

Advanced Trauma Life Support

ASSET

Advanced Surgical Skills for Exposure in Trauma

DSTC

Definitive Surgical Trauma Care

DATC

Definitive Anaesthetic Trauma Care

DSATC

Definitive Surgical and Anaesthetic Trauma Care

Radboudumc

Radboud University Medical Center

WMO

Dutch Medical Research Involving Human Subjects Act

SD

standard deviation

CI

confidence interval

MD

mean difference

CRM

Crew Resource Management

ETC

European Trauma Course

Declarations

Ethics approval and consent to participate: This study was reviewed by METC Oost-Nederland (Medical Research Ethics Committee), which determined it does not fall under the Dutch Medical Research Involving Human Subjects Act (WMO) as participants are not subjected to WMO-relevant procedures or burdens.

Consent for publication: Not applicable.

Availability of data and materials: All data generated or analyzed during this study are included in the published article and its supplementary information files. The primary research data are not publicly available and are owned by the Department of Surgery of the Radboud University Medical Center (Radboudumc) in Nijmegen, the Netherlands.

Competing interests: LMGG and SJAvB are currently the course directors of the Dutch DSATC course. ECTHT is vice chair of the DSATC course.

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Authors' contributions:

MI: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Project administration.

FJCH: Conceptualization, Methodology, Validation, Resources, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision.

LMGG: Conceptualization, Investigation, Writing – review & editing, Supervision.

SJAvB: Conceptualization, Investigation, Writing – review & editing, Supervision.

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All authors read and approved the final manuscript.

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Figures

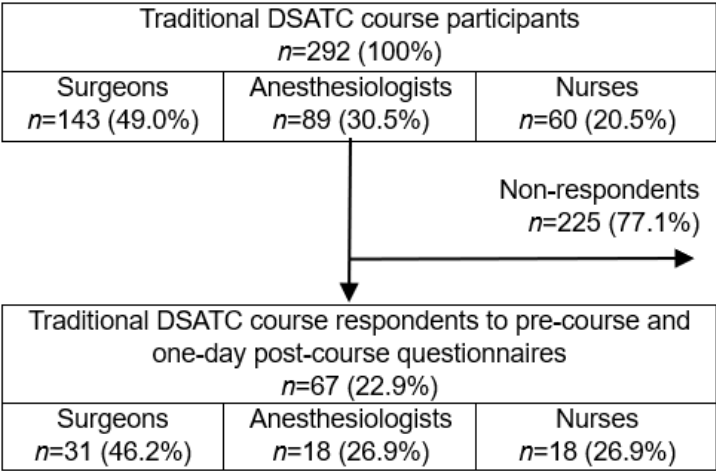


Figure 1a Cohort 1 participant and respondent distribution
n number of respondents
Percentages are rounded
Surgeons include orthopedic surgeons

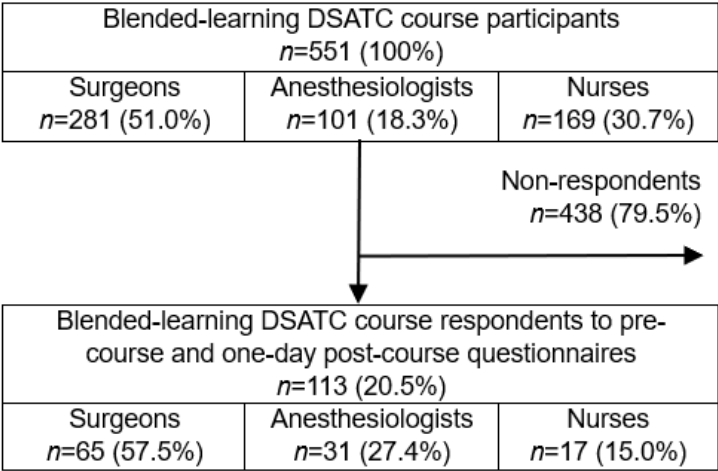


Figure 1b Cohort 2 participant and respondent distribution
n number of respondents
Percentages are rounded
Surgeons include orthopedic surgeons

Figure 1

See image above for figure legend

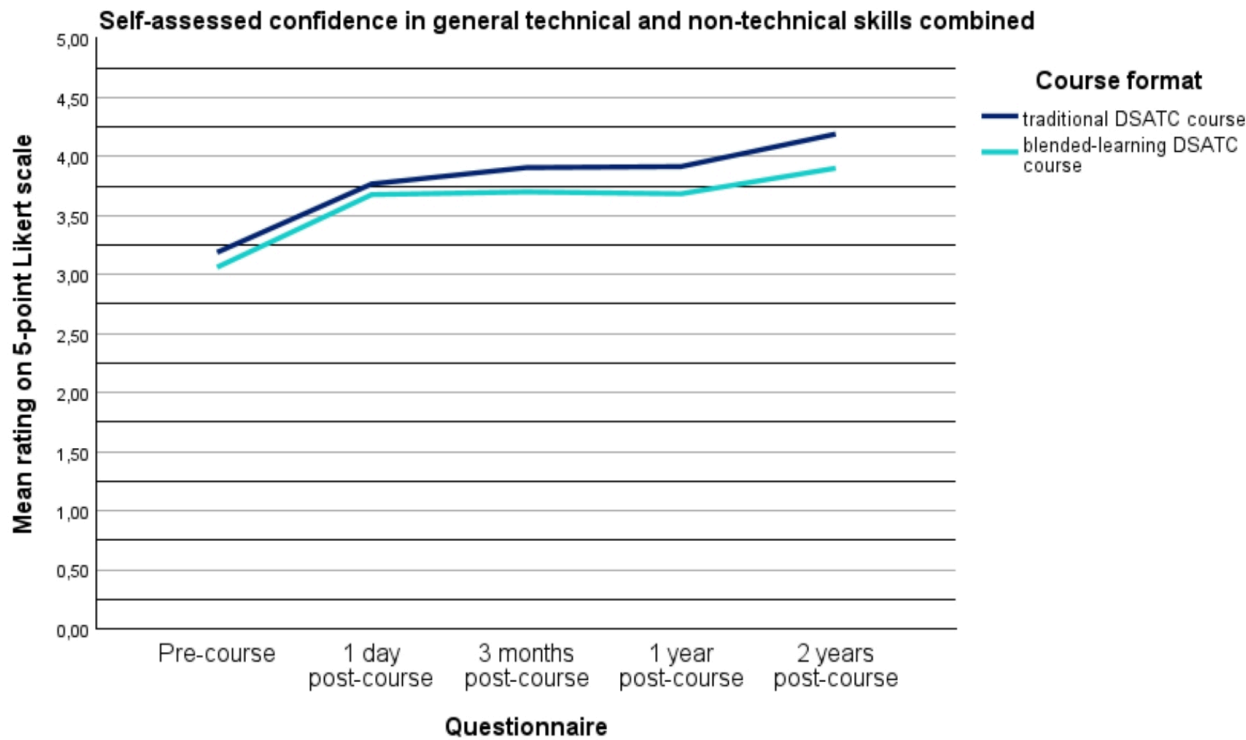


Figure 2

Longitudinal self-assessed confidence in general skills in the traditional versus blended-learning DSATC course

Supplementary Files

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