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Non-technical skills learning in healthcare through simulation education: integrating the SECTORS learning model and complexity theory

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ABSTRACT

Recent works have reported the SECTORS model for non-technical skills learning in healthcare. The TINSELS programme applied this model, together with complexity theory, to guide the design and piloting of a non-technical skills based simulation training programme in the context of medicines safety. The SECTORS model defined learning outcomes. Complexity Theory led to a simulation intervention that employed authentic multi-professional learner teams, included planned and unplanned disturbances from the norm and used a staged debrief to encourage peer observation and learning. Assessment videos of non-technical skills in each learning outcome were produced and viewed as part of a Non-Technical Skills Observation Test (NOTSOT) both preintervention and postintervention. Learner observations were assessed by two researchers and statistical difference investigated using a student's t test. The resultant intervention is described and available from the authors. Eighteen participants were recruited from a range of inter-professional groups and were split into two cohorts. There was a statistically significant improvement ($p=0.0314$) between the Mean (SD) scores for the NOTSOT pre course 13.9 (2.32) and postcourse 16.42 (3.45). An original, theoretically underpinned, multiprofessional, simulation based training programme has been produced by the integration of the SECTORS model for non-technical skills learning the complexity theory. This pilot work suggests the resultant intervention can enhance non-technical skills.

BACKGROUND

An area of human factors that has attracted much interest from educators is that of non-technical skills; the social (communication and team work) and cognitive (analytical and personal behaviour) skills that play a vital role in the support of high quality, safe and effective care.[1] Training in non-technical skills has been enabled over the last decade through the deployment of increasingly sophisticated simulation training; but while the majority of publications focus on 'whether' such education can be successful, they ostensibly overlook the question of 'how' certain educational tools are effective and lack clearly defined learning outcomes, a conceptually underpinned pedagogy and replicable educational materials.[2] Additionally, while many programmes highlight the key role of team working to non-technical skills safety, the education offered is often paradoxically within homogenous teams of learners.[3] From an educational perspective, it is inappropriate to simply transpose training from one discipline to another, as has often been the case when adopting human factors and non-technical skills training in healthcare.[4] Given the complexity of health systems, and given that that most human factors changes are retrofitted, it is unsurprising that effective improvements are limited.[5]

Work has been completed investigating the non-technical skill elements that regulate the behaviour of recent medical graduates' prescribing. It has identified non-technical skills as central[4] and situational error experience-based ways of learning as core, suggesting the role for a simulation-based programme. Recently, a more complete and generic theoretically grounded model of non-technical skills learning has been developed through consideration of key safety issues such as handover of care and prescribing: the SECTORS model[6] (figure 1). Although SECTORS describes how non-technical skill learning occurs within healthcare practice, further work is needed to investigate how this can be applied to design learning interventions. Given the key central role of error awareness impacting risk assessment and general situated cognition described by the SECTORS learning model, simulation is an elegant and often deployed method to achieve these goals while not risking harm to patients. The field of simulation based medical education has been increasingly accused of lacking theoretical underpinning or deployment of robust pedagogies.[7] Many theories that have been deployed focus on individualist models of learning,[8] as would be the case if SECTORS was deployed in isolation.

We undertook to design and pilot an original teaching package that addresses non-technical skills in the context of medicines safety through simulation-based inter professional learning. This programme was underpinned by the SECTORS model of learning and innovated by the employment of Complexity Theory[9] as a model to support the simulation deployment. In this manuscript, how these theories shaped the pedagogical choices of the programme will be described, as well as presentation of outcomes that support the effectiveness of the simulation programme created using this innovative approach.

METHODS

The Training in Non-technical skills to enhance levels of medicines safety (TINSELS) programme was developed and piloted in Blackpool Victoria Hospital Simulation unit, UK. Details of the process used to define the curriculum outcomes, key content and the structure of the course have

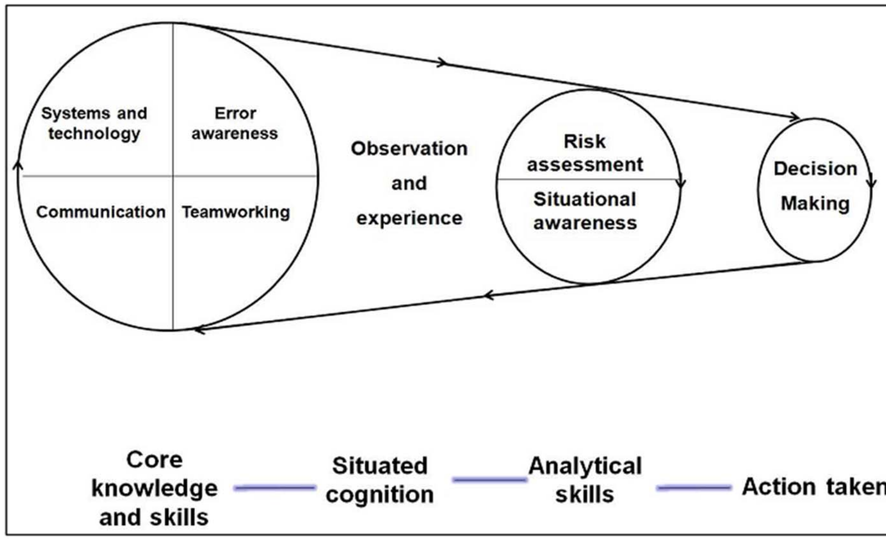

Figure 1 The SECTORS Model for training on non-technical skills.

been previously been described.[10] In this manuscript we will present the relevant underpinning theory that justify why these choices were made in the context of simulation-based education and how this also informed the production of a novel form of assessment.

In brief, a three-session simulation based intervention was produced: session one was a simulated ward encounter with multiple medicine related activities, with immediate debrief; session two was an extended debrief and facilitated discussion with selected video extracts from the first scenario; and session three a 'chamber of horrors' where inter-professional teams identified potential sources of error on a simulated ward. Each session was completed in the simulation suite with six to nine participants and lasted approximately 90 min.

The SECTORS model[6] was initially used to define the process of learning that had to occur, but as this model was derived from authentic experiences within the workplace, the faculty believed a further model was needed to support the form of simulation education that was to be constructed, namely Complexity Theory.[11] This theory examines how living phenomena (learning, for example) emerge in a web of relations that form among things, including both social and material things, such as bodies, instruments, desires, politics, settings and protocols.[11] This was considered an appropriate model for learning in this context and indeed has recently been discussed as a method of interest within simulation-based education.[10] Key aspects of Complexity Theory and their relevance to the curriculum choices made are presented in table 1 in a manner that also supports wider application to other simulation education design.

As well as guiding the interventional design, as highlighted in table 1, the principles of SECTORS[6] and Complexity Theory[9] were applied to outcome measures. It was decided that an objective measure of skill and knowledge acquisition was needed and in line with these models, it would have to be based on disturbance (error) awareness and based on actual interactions, rather than theory or facts.

To achieve this, the team developed a series of assessment videos that displayed either positive or negative examples of non-technical skills within this context in each of the 10 learning outcomes (four examples of each outcome, two negative and two positive). Scripts were prepared and peer reviewed by the faculty to reduce ambiguity of the skill being displayed, with videos completed in the simulation suite with wherever possible professionals taking on their own authentic role (example available to view at LINK TO BE POPULATED, full video resource available on request from authors). Participants viewed ten videos online as part of a Non-Technical Skills Observation Test (NOTSOT) and were asked to record the primary non-technical skill displayed and whether it was a positive or negative example, with explanation. They completed the assessment pre-intervention and postintervention. Each test had an example in each of the 10 core learning outcomes of the course, with a mix of positive and negative examples. No video was used in both assessments.

The learner observations were assessed by two researchers and scored as either 0 (no salient comments or incorrect interpretation), 1 (salient, but basic or without further intervention) or 2 (full and detailed appropriate observation) independently. In cases of disagreement, the comments were discussed with the faculty and a decision made as to whether the interpretations were appropriate and the score required (this occurred in only 4% of responses). The statistical difference between preintervention and postintervention scores was investigated using a student's t test.

RESULTS

The TINSELS programme was delivered to 18 participants were recruited from a range of interprofessional groups and were split into two cohorts. The full programme, course materials, learning outcomes, assessment videos and resource requirements are available on request from the authors.

There was a statistically significant improvement ($p=0.0314$) between the Mean (SD) scores for the NOTSOT precourse 13.9 (2.32) and postcourse 16.42 (3.45). Likert learner satisfaction scores were positive, as well as changes in safety attitudes observed and these have previously been reported in detail.[10]

DISCUSSION

The TINSELS programme has sought to innovate and address gaps in the current literature. While human factors learning (often a misappropriated term for non-technical skills learning[5]) is widely discussed within the context of healthcare simulation education, only recently have evidence based and healthcare grounded methods of understanding learning[6] and appropriate outcomes been defined.[1] TINSELS has sought to use these to

Table 1 The use of Complexity theory to support simulation deployment

Complexity theory element	Description[9]	Application to design (outcome to simulation intervention highlighted in bold)
Emergence	Emergence relies on non-linear dynamics of internal interactions among a quantity of diverse elements, such as diverse ways of thinking and acting, or diverse information	▶ Learner groups needed both differentiation and integration—It was decided that 'authentic' teams of multidisciplinary learners must be employed. ▶ Coaching to support outcome based process planning—in the context of SECTORS allowing integrated team based situational awareness and shared mental models.[12] This was fostered through a dedicated session for more in depth debrief.
Attunement	Both close listening and observing, as well as touching, intuiting and affective sensing of what is unfolding in the webs of relations in which one is acting with their colleagues	▶ Involve real multidisciplinary teams with members of different specialities and levels of expertise, including undergraduate and postgraduate trainees) in ratios that are 'authentic' to the workplace. ▶ Through the use of debrief, support individual learner to observe peers as well as their own behaviours, gain insight into their own performance and to model behaviour and knowledge to inform self-efficacy[13] and team situational awareness (SECTORS[6])—therefore it was decided to have a two stage debrief, with an initial immediate session to allow learners to consider their own actions and an extended debrief in a separate section with faculty edited led debrief to support learners considering their peers ▶ In designing assessment, it was decided that observation of actual interaction was key in judging learning
Disturbance and nested systems	Systems are nested rather than distinct, with learning occurring through disturbance of these nested systems	▶ Scenarios were designed to lend themselves to disturbance through commotion and complexity of the scenarios ▶ Planned disturbances and error triggers were integrated into the scenarios to ensure disturbance occurred and enhance error awareness (SECTORS[6]) ▶ Assessment was to be based on consideration of disturbance in the context of non-technical skills.
Experimentation	A complex system learns because elements in such a system experiment with the alternatives that are continuously generated	▶ Multiple sources of authentic feedback were integrated into the scenarios. The led to the building of a second scenario that was described as a 'chamber of horrors' allowing a number of the items experimented within in the first scenario to be revisited and considered. Multidisciplinary teams discussed each item, allowing a positive feedback loop to occur to consolidate learning.

produce an intervention that was pedagogically appropriate and theoretically underpinned and describe this in a manner that supports reader replication and dissemination. This is the first non-technical skills focused simulation-based training programme described in the literature[3] and the first non-technical skills intervention underpinned by the recently described SECTORS model[6] of learning to present outcomes demonstrating change in knowledge and skills. This suggests the utility of the SECTORS model within the field to support non-technical skills learning.

Additionally, by applying the well-studied Complexity Theory[11] in the relatively novel setting of simulation education, salient simulation training decisions are presented, discussed and justified. While this has guided the specific and contextual course design described, this again offers insight for readers who may consider the potential to apply Complexity Theory as a model to support their own interventional innovations. The decisions made using this theory are in themselves intriguing in the field of simulation learning. These have led to a focus on increasing authenticity or fidelity. Rather than doing so in terms of equipment or environmental fidelity, the intervention has instead focused on learner team and disturbance/error fidelity. While in many ways an intuitive issue, this work suggests that considering this different dimension of fidelity is vital to foster non-technical skills learning alongside technical skills learning within simulation education.

Additionally, the design and application of a novel non-technical skills assessment method is described and this is once again underpinned in this context by the use of the SECTORS model and Complexity Theory and is presented for replication and dissemination (this resource is available on request from the authors). It is worth noting that while the underpinning of this assessment and methods of production are described, its validity and reliability have currently not been assessed and this must be considered when interpreting the results.

Further work is needed to apply the SECTORS model in other contexts of simulation-based education to refine, amend or reject the model. Additionally, works are required to further investigate the importance of Complexity Theory within simulation-based education. Works are also needed to identify whether changes in non-technical skills can impact behaviour in the workplace. Finally, work to apply the NOTSOT assessment tool and to asses its reliability and validity as a non-technical skills assessment method is required.

The TINSELS project is replicable and adaptable across different clinical contexts. It is available as a teaching resource package and can be requested from one the corresponding author.

CONCLUSIONS

An original, theoretically underpinned, multiprofessional, simulation-based training programme has been produced by the integration of the SECTORS model for non-technical skills learning and Complexity Theory. This pilot work suggests the resultant intervention can enhance non-technical skills. Follow-up research is now required to implement this course in other clinical contexts and to consider learning resilience, impact on behaviour within the workplace and positive outcomes for patients.

Contributors MG conceived, planned and led the study, as well as the write up and is the guarantor. HB supported the design, aided analysis and co-drafted the manuscript, approving the final version. AS and MF led the delivery of the intervention and cowrote the manuscript, approving the final version.

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Competing interests MG has received various travel grants and honoraria to support the dissemination of various works from companies including Danone, Abbott, Vifor, Ferring, Nutricia, Warner Chilcott, Cassen Fleet and Norgine. At no point have these companies had any involvement in this work.

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Notes