Journal of Contemporary Medical Education

available at www.scopemed.org

Hypothesis

Building a theoretically grounded model to support the design of effective non-technical skills training in healthcare: The SECTORS model

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Received: November 21, 2012

Accepted: December 17, 2012

Published Online: January 09 2012

DOI: 10.5455/jcme.20121217125557

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Keywords: *Patient safety, non-technical skills, human factors, adverse events*

ABSTRACT

Patient safety is an increasingly prominent issue in healthcare. Despite much work investigating human factors system based approaches to reduce avoidable errors, there has been minimal work investigating education in this area. Education to enhance non-technical skills and support behaviour that reduces human factor sources of error is in its infancy. Published works describing interventions are heterogeneous in content and teaching methods, as well as limited in their underpinning or pedagogy. There is no well-recognised model or framework to guide educators in designing such interventions, which further compounds the problem. In this manuscript, the SECTORS model is proposed, a theoretically-grounded framework to aid understanding of how learning in non-technical skills occurs within healthcare. SECTORS combines three key elements: - The generic Knowledge and skills in core areas that contribute to and support learning in non-technical skills (**S**ystems and technology use, **E**rror awareness, **C**ommunication, **T**eamworking), a situated cognition approach to formal and experiential learning that develops these skills (**O**bservation and simulation) and developments in analytical skills that can integrate these and support decision making (**R**isk assessment and **S**ituational awareness). Further work is now needed to investigate the appropriateness of this model and its utility and effectiveness in supporting design of such education.

INTRODUCTION

Attitudes to errors in health care began to change towards the later end of the 20th century with a string of high profile incidents reported in the media. The Institute of Medicine's (IOM's) 1999 report *To Err is Human: Building a Safer Health System* in the US [1] was pivotal in organising this movement. This report shocked the public and galvanised politicians by suggesting that medical errors were causing up to 98,000 deaths per year in the US alone. The infamous comparison to a 'Jumbo Jet of patients dying every single day from medical errors' caused a furore that prompted immediate action across the globe.

In 2000, the UK Department of Health published a report outlining strategies to reduce risk from preventable errors in healthcare [2], mirroring similar international moves. Guidance on how to achieve this goal was mostly focussed on system based human factor improvement strategies, in line with thinking from Reason, who proposed the now ubiquitous Swiss cheese model of error [3]. This model proposes that as human error is inevitable, organisational or system based strategies are the best ways to enhance safety and deal with the human factors causing errors. Despite resulting programmes of risk assessment, incident analysis, national quality improvement campaigns,

audit and clinical governance, errors still occur with alarming frequency [4].

Extensive work in high stakes industries as early as the 1970s demonstrated that reducing error is not just about the right technical skills or system based human factor risk reduction strategies, but addressing the non-technical skills of staff that may lead to error [5]. These two areas are related, with human factors concerned with everything in the working environment that can impact patient care, such as guidelines, equipment, systems and an understanding of how human behaviour affects these. Non-technical skills are the cognitive and interpersonal skills that individual must possess to effectively deliver safe care within this environment.

The local and national improvement programmes already described have mainly focussed on human factor system based risk reduction, with education to enhance non-technical skills less common. Clearly these are not mutually exclusive and such forms of education would not replace other methods of error reduction, but support improvement as part of a package of measures. There have been successful attempts to design education to improve non-technical skills within other sectors [6]. This work was spearheaded by the National Aeronautics and Space Administration (NASA), commissioned by and in response to major disasters in aviation. They determined that many crashes were due to failures of interpersonal communication, decision making and leadership [5]. Programs were designed to modify behaviour, such as crew resource management (CRM) training to address these issues.

There have also been numerous attempts in the last decade to mimic such design within healthcare. However, despite a growing body of published work in the area, there is still a major flaw in the accumulated literature [7]. As is often the case in any education issue in healthcare, the focus of published research has been on 'whether' such interventions work, rather 'how', 'why', 'what' and for 'who' such interventions work. As such, the published body of work amounts to a heterogeneous collection of reports that at best offer a modest guide for design and present little in the way of convincing evidence of effectiveness. Additionally, there is not a single report that offers any form of theoretical underpinning [7] or conceptual framework for their work [8] and therefore, this body of work is collectively flawed.

The author has conducted a programme of research that has been unified by a single underlying question: how can effective non-technical skills training be produced to enhance patient safety? To answer that question, it has become clear that an understanding of how non-technical skills learning can occur within healthcare is needed. This paper will propose a model to aid such understanding and suggest its application within medical education.

METHODS

A programme of works has supported the answering of the authors overriding research question, all of which have been independent with their own specific research aims. These have included evidence synthesis using systematic review [7,9], qualitative research to understand the issues in further depth and test candidate elements [10,11] and piloting of educational interventions produced using this theory [12,13]. A number of these works have involved collaboration with other researchers and together with the existing literature on the topic, have been used to support synthesis of the final model by the author.

Throughout the development of the model, conceptual frameworks have been used. Conceptual frameworks play an essential role in identifying the nature of education problems and in formulating solutions or designing studies [8]. Even if they do not describe them, educators and researchers employ conceptual frameworks, in the form of models, theories or best practices, to guide educational research. Conceptual frameworks help to shed illuminate and magnify the issues at hand [14]. The use of frameworks has allowed the author to be mindful of assumptions and foundations of this development, as well as allowing this process to be transparent for the reader.

RESULTS

SECTORS describes the three areas that facilitate learning of non-technical skills in healthcare. The first sector describes the generic Knowledge and skills in core areas that contribute to and support learning in non-technical skills, the second sector the approach to formal and experiential learning that develops these skills and the final sector the developments in analytical skills that can integrate these elements and support decision making. Most importantly, SECTORS shows how these elements are linked in a cyclical manner, with the outcomes of practice further enforcing non-technical skills education and education informing practice, all underpinned by experience of adverse events. The model is shown in figure 1.

Systems and technology

Systems and technology based programmes are the most reported method of patient safety improvement [15,16] and form the cornerstone of much education in the area [7,9], supported by an economic theory, known as "coordination costs". This describes how in increasingly complex systems, the cost (either financial

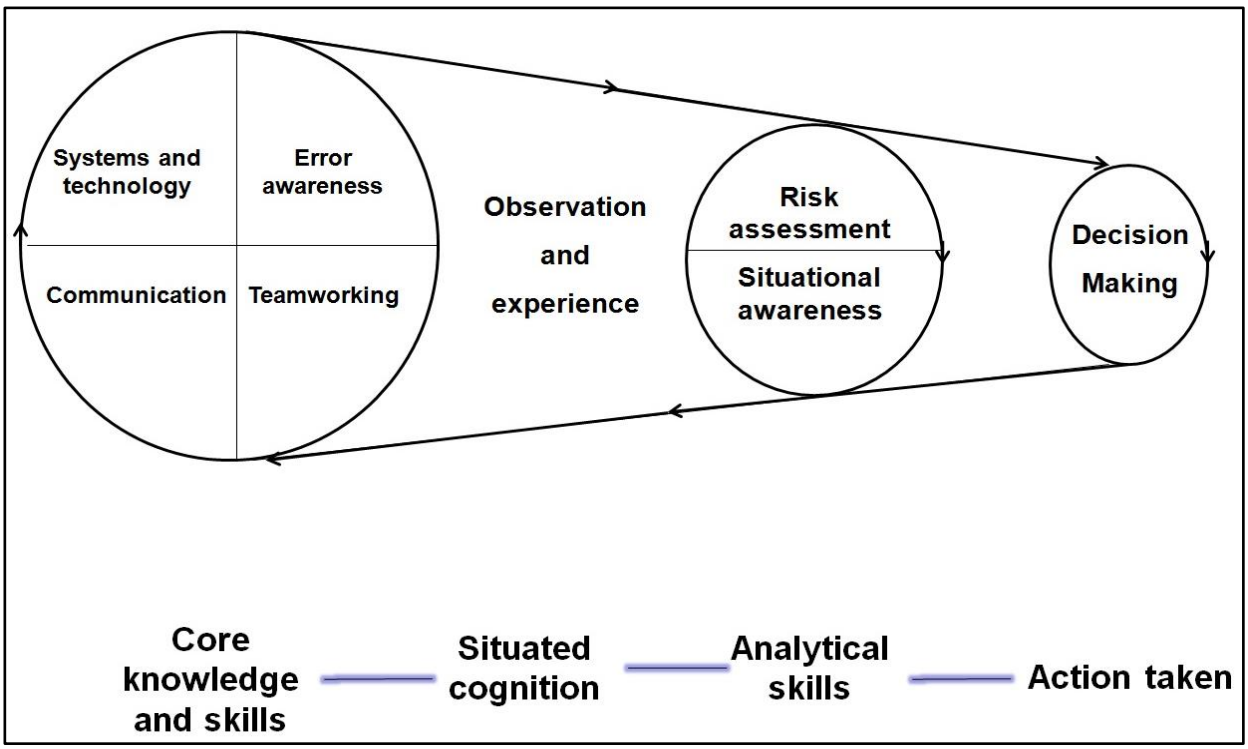

Figure 1. The SECTORS model for patient safety education

or time related) of coordination, including information management and communication, increases. Systems are therefore needed to safely manage this potentially increasing cost. A System can also act as a schema, a concept from psychology and cognitive science that describe an organized pattern of thought or behavior. They offer a framework representing some aspect of the world, or a system of organizing and perceiving new information. As a person's own schemata may be unwavering in the sight of new contradictory information (disconfirmation bias), an external shcemata offered by guidelines or protocols may reinforce more complete and safe way of working and reduce risk of error. From the learner's perspective, systems are seen in two ways. Experienced and senior members of staff may see systems as stifling innovation and eroding trust, so instead often choose to adhere to unwritten rules rigidly [17]. In recent graduates, the reverse is true and the use of systems to support safe practice is rapidly adopted, with an understanding that such procedures are necessary and helpful adjuncts to practice that is developed through experience in the clinical environment [18]. From either perspective, systems are viewed as the foundation to safety and as such are a key element of learning within non-technical skills. They offer schemata to organize thinking and manage the 'coordination costs' of increasingly complex healthcare systems.

Error awareness

Awareness of error, both within and outside healthcare is another cornerstone of existing educational interventions [7,9]. Poor awareness of error can lead to risk taking behaviour and in effect an erosion of professionalism, with tasks completed without consideration of the patient themselves. This sort of 'shift-work mentality' is supported by agency theory. Under this theory, patients do not have access to the information needed to make an accurate judgement regarding if a doctor is behaving in their best interest. The 'agency problem' is the potential for doctors to shirk their professional responsibility in such a setting. This is a problem that has been brought to the forefront in recent years as doctors across the globe are increasingly working in shift patterns that are similar to their nursing colleagues. In response to this, handover of care has become a more prominent issue for educators [19]. As well as the erosion of professionalism that can occur with shift working, there is reduced error wisdom caused by a lack of awareness of one's own errors as a result of discontinuous working. Error wisdom can lead to mental preparedness, independent of practical skills [20] and this has been shown to improve performance in healthcare [21].

For the learner, awareness of error is key to direct non-technical skills learning and is the primary element in almost all existing published healthcare interventions, as well as those outside healthcare [7]. Error awareness directs behaviour, informs analytical skills and supports decision making. The author has demonstrated that error awareness, independent of any other educational intervention, can enhance practice [10]. Within healthcare, generic understanding of broad error categories can be mixed with specific analysis of more relevant and local error issues [12], a development from the relatively constricted cockpit environment in which such education was born.

Communication and Teamworking

These elements are described together as they are symbiotically linked. A number of theories underpin a conceptual framework of understanding in these areas. Using psychological sciences can explain sub-optimal health care communication, with an egocentric heuristic identified [22]. This describes how professionals greatly overestimate the effectiveness of their communication, perceiving they have been clearly understood the majority of the time. Information richness theory [23] describes how different modes of communication are likely to be effective based on the information being transferred, again highlighting potential weaknesses in health care where communication methods are often dictated by resources available and not the nature of the task at hand.

Bystander apathy has been reported as early as the 1950s as occurring in groups, described in social science theories concerning diffusion of responsibility [24]. This can lead to dysfunctional collaborative working. Finally, the use of a pyramid power structure in healthcare can lead to problems with hierarchal communication. Political and business researchers have considered biological models suggesting systems of lateral communication to combat this phenomenon and facilitate effective and efficient transfer. Crew resource management designed with the aviation industry combat such hierarchal communication problems by the use of several tools, techniques and systems to facilitate lateral communication.

For the learner, communication and teamworking are perceived as being often at the core of error, particularly barriers to hierarchal or multidisciplinary teamworking. Education to enhance teamworking can improve the recognition of the role of such skills within safe practice [11]. This author has reported new educational interventions to enhance communication that have been underpinned by several elements of the SECTORS model [13], as well as their use as part of a generic non-technical skills training programme [12] in which they effectively enhanced safety attitudes.

Observation and simulation

In the aerospace industry there is an invariable focus on teaching methods that situate concepts in practice, drawing on real life models and learning through observation or simulation. This would suggest that non-technical skills training must be built on the principles of situated cognition, where learning is seen in terms of student's increasingly effective ability in different scenarios rather than in terms of an accumulation of knowledge [25]. Since situated cognition views knowing as an action within specific contexts and views Direct Instruction models of knowledge transmission as impoverished, there are significant implications for pedagogical practices. Firstly, instructional design should draw on apprenticeship models common in real life [26]. Secondly, design should rely on contextual narratives that situate concepts in practice. When the first elements of the SECTORS model are considered, learning in each area clearly aligns with this theory through applications such as the cognitive apprenticeship or anchored instruction [27].

Despite the clarity of this underpinning outside of healthcare, when educators began to transfer non-technical skills training into healthcare didactic teaching methods or non-interactive technology enhanced learning were often employed [7,9]. The duplicity in such pedagogical choices was compounded by the quite clear parallels that the majority of educators tended to draw to such aviation methods [28]. It is proposed that non-technical skills learning must align with such a situated cognition view of education.

Risk assessment and situational awareness

The final element of non-technical skills training outside of healthcare is the importance of harbouring and enhancing situational awareness [28]. Whilst learning in each of the elements already described will clearly support situational awareness within the clinical setting, integration of these skills to allow analysis in a specific situation is key. Previously, it has been demonstrated that learning within the workplace supports development of this skill, although this is often through experience of adverse events that may harm patients.

Within healthcare, the role of risk assessment as a related skill is also well reported. Situational awareness facilitates informed risk assessment, which in turn drives safe decision making. An example of this that has been well reported is Reason's three bucket model [29]. This theory views the risk in any situation from the professional's perspective and asks them to

consider how full each of their buckets. The buckets describe the risks associated with the 'task', the 'context' and the 'self'. Situational awareness allows the 'buckets' to be accurately filled and therefore the risk assessment to be complete and appropriate.

The SECTORS model

Non-technical skills learning is grounded in an understanding and awareness of error and supported through developing expertise in communication and teamworking, as well as an appreciation for and proficiency in the use of human factor based systems and technology to reduce the risk of adverse events. Learning in these areas is facilitated by observation of others and experience within the workplace, following a situated cognition model of learning. The core elements of non-technical skill learning described inform and facilitate a constant process of improving situational awareness that feeds into enhancements in risk assessment skills and ultimately decision making. Key to the understanding of learning in this context that the SECTORS model describes is the cyclical and self perpetuating nature of learning in this context. Similar to our understanding of how children develop skills using error correction strategies, the results of actions is shown to enhance learning in each of the key areas and thus enhance analytical skills.

Learning in non-technical skills within healthcare has always and continues to take place in this way, but unfortunately this model indicates that adverse events and potential harm to patients drives learning. The current trends in patient safety culture will help this issue by increasing awareness of errors and ensuring such learning is facilitated at each and every opportunity. The potential application of the SECTORS model is to inform instructional design that can enhance and drive learning in non-technical skills without any need for errors to occur within the clinical environment. Whilst the author has completed pilot work designing interventions that pay attention to the SECTORS model [12] that have shown improved safety attitudes, it is hoped that researchers will apply and report their findings using SECTORS and in particular consider investigating if the use of education designed using this model can enhance outcomes for patients.

CONCLUSION

A theoretically grounded model has been developed to understand how non-technical skills learning occurs within healthcare. This model has been used to support instructional design, but much more work is needed. Medical educators need to assess the appropriateness of this model for understanding learning in this context. The utility and effectiveness of this model for designing non-technical skills training must also be investigated. Although difficult, the ultimate aim of such research should be confirmation of improved outcomes for patients through appropriately underpinned and reported educational developments.

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