Authentic Moulage: Exploring participant engagement in simulation

Jessica B Parish BN, MN, GCC (ICU)

University of Newcastle

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CANDIDATES DECLARATIONS

Statement of Originality

I hereby certify that the work embodied in the thesis is my own work, conducted under normal supervision. The thesis contains no material which has been accepted, or is being examined, for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made. I give consent to the final version of my thesis being made available worldwide when deposited in the University's Digital Repository, subject to the provisions of the Copyright Act 1968 and any approved embargo.

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I hereby certify that this thesis is in the form of a series of papers. I have included as part of the thesis a written declaration from each co-author, endorsed in writing by the Faculty Assistant Dean (Research Training), attesting to my contribution to any jointly authored papers.

By signing below I confirm that Jessica Parish lead the research project conception and design, the full data collection and the majority of the statistical analysis. I wrote the full paper. Co-authors contributed by way of review and some contribution to the design and editing of the final manuscript to the paper/publication entitled: ***Does appearance matter? Current issues and formulation of a research agenda for moulage in simulation****.*

Brian Jolly

Robbert Duvivier

Dr Lesley MacDonald-Wicks *31/10/19*

Assistant Dean Research Training, FHEAM

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Brian Jolly

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Brian Jolly

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Carmel Loughland

Dr Lesley MacDonald-Wicks *31/10/19*

Assistant Dean Research Training, FHEAM

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To my family:

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To all those who were told they can't – you can.

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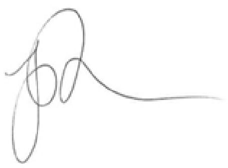
PUBLICATIONS INCLUDED IN THESIS

Peer Reviewed Journal Articles

By signing below, I confirm that Jessica Parish contributed more than 50% to the study design, data analysis and manuscript preparation of the publication below. Professor Brian Jolly, Dr. Robbert Duvivier and Associate Professor Carmel Loughland contributed to the manuscript preparation in their role as PhD supervisors.



Submitted Manuscripts included in this thesis

Title	Output type	Citations	DOI
Does Appearance Matter? Current Issues and Formulation of a Research Agenda for Moulage in Simulation. Simulation in Healthcare, 21(1), 47-50. 2017	Paper	5	10.1097/SIH.0000000000000211
Does authenticity in moulage matter? Results of a systematic review. Nurse Education Today, 64(1), 49-55. 2018	Paper	7	10.1016/j.nedt.2018.01.003
Expert opinions on the authenticity of moulage in simulation: a Delphi study. Advances in Simulation, 4(16). 2019	Paper		10.1186/s41077-019-0103-z
How does moulage contribute to participant perceived engagement in simulation? A mixed-methods pilot study in medical students	Paper		Submitted for Review
Measuring the engagement of medical students in simulation	Paper		Submitted for Review

using eye-tracking methodology: a randomised comparison study		

Peer Reviewed Conference Presentations and Posters

Title	Output type	Event
Does authenticity in moulage matter? Exploring Participant Engagement in Simulation	Conference Paper	Presented at SimHealth August 2015 in Adelaide, South Australia, Australia
SimART ™: Adding RealiTy to Simulation I	Conference Workshop	ANZAHPE-AMEA in Newcastle, New South Wales in March 2015.
SimART ™: Adding Reality to Simulation II	Conference Workshop	Presented at SimHealth August 2015 in Adelaide, South Australia, Australia
SimART™ - Rapidly applicable simulation on a budget.	Conference Workshop	Presented at the Australasian Simulation Congress 2016 in Melbourne in September 2016.
Does authenticity in moulage matter? Results of a systematic review.	Conference Paper	Presented at the Australasian Simulation Congress 2016 in Melbourne in September 2016.
Designing a scale for validation of moulage authenticity using the Delphi Method.	Conference Paper	Presented at the Australasian Simulation Congress 2017 in September 2017, Sydney.
SimArt: Matching moulage to your learning objectives	Conference Workshop	Presented at the Australasian Simulation Congress 2017 in September 2017, Sydney.
Moulage, more than just a Movie set trick…or is it?	Conference Plenary	Presented at the Australasian Simulation Congress 2019, on the Gold Coast, QLD.
What do the experts think? Development of the Moulage Authenticity Rating Scale (MARS)	Conference Poster	Accepted at IMSH 2020

Invited Presentations

Event	Venues	Summary	Output
Scholars visit Canada 2016	Wilson Centre and the University of British Columbia.	The research trip to Canada involved 7 days of meetings with researchers, scientists and simulation experts. During this time, I discussed my proposed topic, hypothesis and methodology with various individuals. As a result of this trip, I was able to consolidate my research and add to the methodology. I presented multiple times, developing my presentation skills and arguing the case for the research	Presentation - *Does authenticity in moulage matter? Results of a systematic review.*
Invited Scholar University of Bern 2019	University of Bern, Moulagen Museum	During this visit I met with moulage users from Europe and presented a summary of my PhD work in its entirety. In addition, I was able to meet with academics in nursing and medicine from Germany and Switzerland to develop potential projects. Finally, I was able to tour the Moulagen Museum, a museum that houses historic moulages.	Presentation - *Authentic Moulage: Exploring Participant Engagement in Simulation*
Hunter Medical Research Institute Open Day 2019	Hunter Medical Research Institute (HMRI)	I presented a summary of how simulation and moulage prepare health professionals for work, and hosted a science expo tent featuring moulage.	Presentation - *Science Meets Fiction Talk: The Weird & Wonderful World of Wounds*

Event	Venues	Summary	Output
ASSH Simulated Patients Special Interest Group	Australasian Simulation Congress 2016	Update on work	Presentation
ASSH Simulated Patients Special Interest Group	Australasian Simulation Congress 2017	Update on work	Presentation
ASSH Simulated Patients Special Interest Group	Australasian Simulation Congress 2019	Update on work	Presentation

Other Media

Title	Output	Link
Moulage and Making Stuff Podcast	Podcast - Simulcast Podcast	http://simulationpodcast.com/ep-7-moulage-making-stuff/
HMRI's open day to be held on Friday, featuring blood and guts and the mysteries of the brain	News	https://www.newcastleherald.com.au/story/6427944/do-you-carry-the-anti-squeamish-gene-find-out-at-hmris-open-day/
H.M.R.I THROWS OPEN ITS DOORS TO HUNTER KIDS	News	https://www.nbnnews.com.au/2019/10/11/h-m-r-i-throws-open-its-doors-to-hunter-kids/
Authentic Moulage Journal Club	Podcast – Simulcast Podcast	http://simulationpodcast.com

ABSTRACT

Moulage in the traditional sense is the art of replicating illnesses and wounds through casting wax moulds. Origins are traced to Ancient Egypt and forbidden practices of 17th century Europe. While traditional moulage is now housed in musea across the world, modern moulage is used to replicate illness and effects in simulation using special effects makeup techniques. Simulation is a well-established technique to prepare health professionals for clinical practice, and is grounded in a strong evidence base. Despite the strong evidence for the use of simulation, the conditions of moulage is an underexplored topic within the context of simulation research, and we know very little regarding how it works, under what conditions and what the effect is on participants of simulation.

In order to better understand how and why moulage impacts on participants of simulation, a series of complementary studies were completed. Initially a Systematic Review of authentic moulage in simulation was undertaken to understand the current research on moulage. This provided a useful baseline for the current use and evidence for moulage in simulation. Subsequently, a further study was undertaken to define authentic moulage in simulation via an electronic Delphi consensus method. This study recruited international experts on moulage and resulted in the development of the Moulage Authenticity Rating Scale (MARS) to measure moulage authenticity. Finally, a third study was conducted to explore how the authenticity of moulage effects participant engagement in simulation using a randomized control experiment design. This study utilized the MARS tool developed from the previous study to design moulage that was low-authenticity and high-authenticity, and compared levels of engagement using measures of self-report, eye tracking and interview methods. The results of this work presents previously unrecognized information on how medical students perceive the authenticity of moulage and how it contributes to their

performance and engagement in simulation. In summary, I present a number of suggestions as to how simulation users and designers might consider moulage in their everyday practice.

This thesis presents a series of philosophical research questions and findings that collectively make an original contribution to the future of moulage in simulation and undergraduate Medical Education using simulation-based curriculum, teaching and learning.

CHAPTER 1: INTRODUCTION

This dissertation outlines the theoretical underpinnings for simulation-based education in the health professions. In the ongoing/coming chapters, I outline the foremost theories that inform simulation and detail the design principles to achieve success in simulation. It explores the literature on fidelity, realism and authenticity across domains of simulation and creative arts, critically examining these concepts against the evidence for the use of moulage in simulation.

This chapter will provide the background to the work presented in the thesis. First, I will discuss the value of experiential learning in undergraduate medical education, and will provide a rationale for simulation-based education. Second, the theoretical underpinnings of simulation will be discussed, and I will argue that the impact of simulation goes beyond technical skills. Third, I will examine the concepts of fidelity, authenticity and realism, and argue that these have been used interchangeably in existing literature, with little regard for their respective merits. This chapter will set the groundwork for presenting the history of moulage, a technique to replicate realism in simulation.

A note on definitions, I use the term medical education to refer to undergraduate tertiary education for students training to be physicians. At times I will explore broader concepts that pertain to simulation and use the words health care professionals to describe all individuals that are trained and work in a health care setting. I utilise the Simulation Dictionary as my guide for definitions [1].

Introduction to Simulation

Learning through experience is identified as key for the development of an excellent physician [2]. Historically, this experience occurs in the real world with traditional means of mentored or supervised clinical placements. Decreasing clinical placement hours, increasing numbers of students, shorter hospital stays, and increasingly unwell patients can cause training clinicians to miss out on meaningful and diverse experiences essential to their learning [3, 4]. These circumstances have become a driver for experiential learning opportunities, such as Simulation Based Education (SBE) [3, 5, 6]. A Health Workforce Australia report identified the capability of simulation to enable students to “fruitfully engage with clinical placements in the early stage of their course” [6, 7]. Other drivers for SBE include the ethical imperatives of patient safety, the need for optimal treatment, and increasing expectations of quality in both practice and assessment. SBE provides the opportunity to train individuals in best practice, with no risk of harm to patients in the course of learning these skills [8]. For example, a student firstly learns how to take bloods on a purpose-designed arm so that mastery of skill is achieved before using this skill in actual practice. Due to the likeness of the Simulated Learning Environment (SLE) to the real world, this controlled setting allows learners to be assessed objectively at a standardised level. Namely, all cases can be replicated in the exact same way, and environmental characteristics can be altered to obtain different experiences [8].

Heavily prevalent in other professions such as aviation, defence and mining, SBE in healthcare is identified as a technique that creates real life experiences in a controlled environment [5]. These opportunities continue to increase with the development of technology in the means of simulation delivery [3, 5, 8-10]. Simulation delivery varies in approach, with the choice of modality driven by learning objectives.

These modalities include high- and low-tech simulators (manikins or other), simple and complex task-trainers, virtual environments and augmented realities, simulated patients, hybrid simulations (combining multiple modalities) and gaming solutions. Within healthcare, most of these modalities are used. Studies have demonstrated the positive relationship between SBE and learning outcomes [3, 5, 8-11]. For example, in a study where clinical placement was replaced with simulated clinical placement, there was no negative impact on the learning outcomes; in some instances the students who were in the simulation group had better exam results [12]. In medical education, SBE is unequivocally better than traditional models of learning when learning Central Venous Catheter (CVC) insertion, cardiac auscultation and many others [10, 13-15]. The positive impact of SBE extends to the clinical environment, where research shows clear links between simulation and improved patient outcomes [16]. For example, in a large study by Barsuk et al. (2009) intensive care trainees participated in simulation-based mastery training for the insertion of CVC which lead to improved technical performance of the skill on patients and a significant reduction on bloodstream infections [14].

Figure 1 - Simulation (c) Creative Commons

Now that the case for simulation-based education has been made, let us turn to the theoretical underpinnings. In particular I will discuss the value of experiential learning, and several contributing aspects, namely reflection, deliberate practice and scaffolded instruction with a particular emphasis on engagement of learners.

Simulation and Learning Theories

In this paragraph I will firstly discuss experiential learning, before moving on to explore other theories such as constructivism, reflective practice and deliberate practice. The primary theory referenced when discussing simulation is experiential learning and it is crucial to understand before further discussing learning theories applicable to simulation. Experiential learning theory heavily underpins SBE. This learning theory is best demonstrated by Kolb’s experiential learning cycle (Figure 2), in which the learner participates in an experience (concrete experience), reflects (reflective observation) and develops strategies (abstract conceptualisation) to deal with the same situation again (active experimentation) [17]. Experiential learning is derived from the work of Lewin, Dewey and Piaget, whereby they identified that “learning is best achieved in an environment that considers both concrete experiences and conceptual models” [18]. Kolb expanded this by identifying four environments to situate learning: feeling, thinking, watching and doing [19]. Concrete experiences refer to the opportunity for learners to learn a prescribed area – such as a practical skill or history taking. SBE’s power is in the *direct* experience of the participant. This provides opportunity for concrete experiences and reflection. It also allows the participant to identify the gaps in their learning and adjust their practise accordingly. Simulation provides the opportunity for the participant to practise, and repeat practise, in a dedicated environment. Thus allowing him/her to develop experimental mental models and strategies for the real world with the guidance of an experienced facilitator [17].

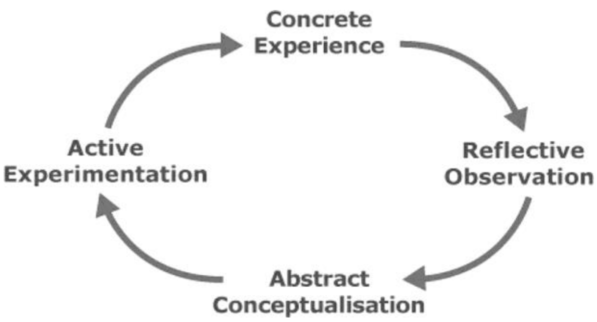


Figure 2 - Kolb's Learning Cycle

In addition to experiential learning theory, simulation draws from other theoretical perspectives. In this introduction I will focus on constructivism, cognitivism, behaviourism and deliberate practice. I will briefly introduce each of these theories, before showing their relevance for simulation-based education.

Constructivism, like most learning theories, has roots in the work of Piaget [20]. It draws on behaviourist and cognitive learning principles (which I discuss), and posits that learning is a combination of constructing meaning and making sense of experience [18]. Constructivism has two main arms, the cognitive and socio-cultural constructivist. The cognitive arm is all about individual meaning-making of new learning; the major theme is that learning is significantly influenced by the individual's prior knowledge. The personal meaning of, or connection with, a learning activity (in this case simulated activity) is influenced by personal and peer knowledge [20]. These prior experiences form the basis for how they interact with the activity, exploring and transforming their knowledge. The activity may be situated in a personal (individual) or social setting. Socio-cultural constructivism, although more technically an epistemology, highlights that knowledge is subjective and never "starts from scratch" [18]. Significantly, this perspective identifies that learning is never separate from social interaction, and that multiple realities exist.

SBE enlists constructivist theory by inviting the participant to use existing knowledge, be active in learning and to create extended personal meaning for the experience by allowing for reflective practice. For example, the learner moves from reading about intravenous cannula insertion to actually doing the task, simultaneously building on prior knowledge and making sense of the knowledge to real life. Within this process learners have the opportunity to reflect and critically analyse, utilising reflective practice.

Reflective practice is identified as an opportunity to critically analyse problems, not merely as a descriptive process, but a critical reflexivity – that is, deeply understand how individual and collective meanings are constructed [2]. In this section I discuss what reflective practice is and why it is relevant for simulation. The opportunities that are presented in reflective practice are grounded in positivism, interpretive theory and critical theory. These epistemologies are important when considering simulation. Positivism grounds itself in reality – what is scientifically observed, what actually occurs, as opposed to opinion and feelings. Interpretive theory references understanding how individuals and groups create meaning. It is socially constructed and there are no absolutes [18]. In contrast to positivism, critical theory posits that the research and researcher are linked. In combination, these philosophical standpoints are powerful in simulation; positivism allows for observation and critical appraisal, whilst interpretivism and critical theory allow for understanding *how* things occur and the conditions in which they occur.

Reflection and actual practice are strongly linked to the competent health practitioner [18] . Theory alone is not useful to create a competent practitioner, opportunity to practice and form links *between* theory and practice is the clincher to achieve competence. Schon (1986) describes two types of reflection that professionals demonstrate in competence: 1) reflection *in* action and 2) reflection *on* action [21]. Reflection-in-action occurs when the practitioner reworks the problem from different perspectives, establishes where the knowledge fits and how these interplay with the problem at hand. Reflection-on-action is a later task that takes into account the elements described in reflection-in-action, this might be writing a reflection or simply thinking through what did occur [18, 21]. Simulation provides the opportunity to develop reflective practice in-action and on-action, allowing a practitioner to try solving the same problem from different perspectives, establishing knowledge and solutions with reduced risk to a real person. The on-action reflection is actioned during debriefing, where the individual can think back and consider what contributed to the challenges or success. Beyond this, the individual continues this think back process, over weeks, and sometimes months, reflecting on their thoughts, actions and decisions [18]. The reflection-on-action process can be self-driven, however, experts identify that self-assessment can be a limitation [22]. Structuring reflective questions or activities at a later date might reinforce this perspective change. This process is vital to cement the cognitive change [23].

Another aspect that facilitates reflexivity in simulation is the use of **deliberate practice**. Here I will outline what deliberate practice entails with examples of its use in simulation. Deliberate practice refers to the concept of practicing a skill repetitively with the specific goal of achieving mastery in said skill [24]. The key to the success of deliberate practice is the engagement of the participant and motivation to improve. Deliberate practice theory is best demonstrated by the example of learning an instrument; to achieve mastery, one must practice in small units, over time, with repetition and feedback to reach a pre-determined improvement goal [24, 25]. An example of the success of deliberate practice is demonstrated by the work of Barsuk and colleagues [13]. To improve central venous catheter insertion performance, nephrology fellows participated in a deliberate practice simulation session. The fellows' performance improved significantly using the deliberate practice technique as compared to the traditional learning group [13]. This success of mastery-based deliberate practice is not a one-off. More recent work shows the positive impact on clinical practice in nursing care of central line maintenance; nurses showed high levels of variability in clinical practice prior to deliberate-practice simulation based training

[26]. Kneebone (2005) highlights that to avoid arrested development (where a learner plateaus in their performance), deliberate practice activities should be interwoven with other contextual activities, i.e. scaffolded [25, 27].

Moving to **Behaviourism**, or behavioural learning, I briefly outline what behaviourism is and how it applies to simulation. Behaviourism theorises that all learning should result in behavior change, and that behaviour change occurs as a result of external stimuli [28]. Here we see similar thoughts to experiential learning, where learners learn by doing, and apply deliberate practice techniques to stimulate a particular, pre-specified, behavioural change. So, for example, a medical student might practice the same venipuncture training activity with a concurrent objective to be able to respond to a frustrated relative. In the first instance, the participant may be flustered, lose their train of thought; however, over time, they would develop skills to manage their behaviour in response to the external stimuli. Behaviourism is distinctly different from the previous theories such as constructivism. Whilst they do appear similar, constructivism is characterised by a search for meaning and an individual perspective, whilst behaviourism describes learning as a result of an environment or stimulus. Simulation is a complex combination of both of these; the learner develops their own expertise and perspectives through experience, while the simulation designer considers the environment and how that influences their learning.

Finally, I raise cognitive learning theory. **Cognitive learning** theory is a learner-centred theory that is focused on what the activity may mean to the individual, and how they process information; the learners pre-conceived thoughts and expectations play a large role in their interaction with the environment [18, 20, 23]. Knowledge is not 'ready-made' and though it might be developed through social interactions and external stimuli, cognitivism posits that the individual is the one who controls the learning. The stages of attention, processing, memory storage and action can be stimulated using simulation and the active engagement that occurs in SBE. For example, if designed well, simulation can promote such a level of engagement that attention to information is high and the individual deems it worthy of remembering. In addition to this, this type of learning facilitates the same mental modelling development that experiential learning theory provides – the individual learns how to learn, as opposed to being taught [23].

Each of these theoretical perspectives views simulation from the perspective of the learner. However, the learning process is shaped by the way simulation-based education is designed and implemented. In short, the simulation needs to accommodate a variety of considerations to maximise the benefit of a resource-intensive instruction method. One way of ensuring learners have ample opportunity to benefit from their experiences, and reflect on them, is by scaffolded instruction. I will now turn my attention away from the learner (the 'consumer' of the simulation) to the provider of the simulation – the instructor.

Scaffolded instruction or scaffolded learning refers to the idea that a learner is assisted by the tutor to achieve a skill, gradually decreasing the amount of support provided [29]. A good example of scaffolding is to compare the approach of the learning activity for a first year student to a final year student. More supports are put in place for the first year participant to focus on one task, for example, administering an intramuscular injection – the student would focus on this one activity with a tutor directly supervising and delivering feedback. For a final year student, you would embed this activity of delivering an intramuscular injection in a larger simulated activity, say a trauma presentation, whilst the tutor observes in a separate room and allows the student to reflect in a peer group. This concept of scaffolding is very closely aligned to that of cognitive load theory, as the level of difficulty of a task and the mental load of a task are closely linked. Cognitive load theory proposes that learners can become overloaded if the learning activity entails a degree of cognitive load, or processing effort, that exceeds the capacity of the learner [30]. Working memory is limited and dealing with excessive cognitive load can impede long term information storing. In simple terms, working memory might be impacted by the complexity of the task (intrinsic load), the way it is presented (extraneous load), and the nature of the learning process that occurs (germane load) [31]. Using the same example of intramuscular injection, the cognitive load of the activity is significantly lower in the first year activity, because the scaffolding helps reduce intrinsic load (the procedure is carried out on a piece of plastic and not with a real person) and reduces extraneous load (ward-based distractions such as noise and people passing by) as opposed to the final year activity where the student must deal with competing priorities, noise, peers and family members [30]. Leppink et al. (2015) highlight the importance of understanding working memory by linking the level of complexity in the task at hand with the way the information will be presented in the design of medical education [32].

The learning theories outlined above describe the concepts that underpin simulation and its design. Simulation is an inherently active learning process in which the structure, design and presentation of the environment can both increase the difficulty of the activity and presumably influence the engagement of the participant in the simulation. The question is, how does engagement play a part in simulation? The following section critiques engagement in the context of simulation by exploring literature and relevant instructional design aspects of simulation.

Engagement and Simulation

Ranging from simple skills to complex, team-based scenarios, the success of simulation is dependent largely upon the degree of participant engagement and effective debrief/feedback strategies [11, 12, 33-35]. I will focus only on participant engagement in my discussion, as debrief/feedback strategies are beyond the scope of the project. I will answer two questions: what is engagement and why is it important for simulation?

Firstly, what is engagement? The notion of engagement is presumably grounded in the learning theories above, but is a state of being, as opposed to a philosophical standpoint; engaged learners "construct knowledge from experience, meaning interpretation and having interactions with peers" [36]. In gaming, engagement is described as being associated with qualities that "pull people in" [37]. Hung et al. (2006) describe engaged learning as "authentic", whereby learners are able to problem-solve, make choices and interact with peers and instructors [36]. Simulation demonstrates these aspects in the very nature of its delivery – participants are given a case they must solve, often in a group. Despite the implied discussion of engagement in simulation, there seems to be no theoretical literature that directly addresses engagement in simulation. This paucity of literature is addressed by Padgett et al. (2018) in their work exploring simulation engagement. Notably, they do not consider the serious gaming field to contribute to their discussion. They highlight "despite its purported importance, our understanding of what engagement is… it is limited" [38]. Our discussion on engagement and the interpretation of engagement is discussed in greater detail in Chapters 7, 8 and 9.

Secondly, why does engagement matter? Learner engagement is essential for deepening the learning experience [20, 39-41]. Deep learning refers to the instance where the learner demonstrates an understanding of a situation, as opposed to surface learning, where an individual may repeat back information *verbatim* – indicating they do not have a genuine understanding [42]. Simulation facilitates this process (engagement) by drawing participants into a learning environment in which they must process, analyse, problem-solve and reflect. In addition to this, the high level of emotion that can be stimulated in simulation facilitates can enhance memory processing [43, 44].

Recommended strategies to facilitate participant engagement in simulation include:

- Simulation pre-briefing, and
- Participant-centred facilitation, and
- Psychologically safe environment (confidentiality agreement), and
- Realistic replication of the environment, and
- Fiction contract [45-48].

Although each of these items have their own importance, I will focus on the fourth point: realistic replication of the environment. Although each of these points are worth addressing in the context of simulation design, I limit my discussion to the realistic replication due to its relevance to the thesis topic (moulage). In addition, I will briefly touch on the fiction contract due to the relationship it has with the concepts of engagement and suspension of disbelief.

Participant engagement and the transferability of the activity to real life is enhanced by fidelity, realism, authenticity and the presence of 'cues' in the simulation setting [46, 49]. These concepts can enable a participant's ability to suspend disbelief in simulation. The term 'suspension of disbelief' was coined in the early 1800s in creative writing, whereby a reader could suspend doubt and accept the unbelievable if the work appeared to resemble reality. Suspension of disbelief is now widely accepted as key in participants engagement in simulation regardless of the environment [47].

Simulation environments are varied across institutions, health facilities and the world. A brief overview of the variance of simulation environments helps to understand the need for clarity in the use of definitions and concepts. Some simulation environments are situated in purpose-built simulation centres where rooms are designed to mimic exact clinical settings – such as emergency departments or wards. These centres have ‘control rooms’ which house technology such as simulator computers and recording equipment. In most cases a one-way mirror is present so that an instructor can unobtrusively view participants throughout the simulation. The simulated hospital room is likely to have cameras and microphones to record or live stream participants’ activities. Unlike a simulation centre, some simulations are delivered on a real ward, amongst patients – also known as ‘in situ’ or translational simulations. *In situ* simulation (ISS) (See Figure 3) is an emerging form of simulation in which participants are actual, on-duty staff members [50]. In this case, the simulator may be the only foreign object in the simulation.

However, fabricated cues may still be used to contribute to facilitate participants’ suspension of disbelief in the scenario. Before discussing the detail of the cues, I will explore the concepts of fidelity, authenticity and realism below.

Figure 3 – in situ simulation (Image: Victoria Brazil)

Fidelity, Realism and Authenticity: Definitions, Interchangeability and Differences

In this section, I discuss the concepts of fidelity, realism and authenticity. Firstly, I highlight the interchangeable use of the words in the simulation literature. I also discuss the challenges and limitations with the nomenclature, including the definitions for the purpose of this thesis.

- *Fidelity*

The definition of fidelity is varied across simulation literature. Early definitions refer to fidelity as being the degree of simulator likeness to reality – that is, how closely does a manikin appear, feel and sound like a real person [51]. In an effort to clarify definitions, fidelity was further divided into five categories [51-53]:

- functional (or behavioural), how closely the simulators actions and responses represent a realistic response;
- physical, likeness of equipment in appearance and feel;
- environmental, similarity of environment to real life;
- equipment, how closely the equipment matches that of real life; and,
- psychological, the level to which the simulator is perceived as real.

At some point after this early literature, Ker and Bradley (2010) identified that fidelity is multidimensional and encompassed simulation as a whole – the learning objectives, environment, equipment, manikin and learner combined construct simulation, as opposed to only the simulator. Despite this, most research on fidelity focuses on simulator technology only [54, 55]. Despite the variances in categories and definitions, researchers agree that the level of fidelity required is directly related to the level of learning required [54]; high-tech does not necessarily equate high fidelity [39]. For example, teaching a first-year student how to obtain bloods from a square block with piping in it, for initial skill acquisition, is high fidelity but not high-technology [49, 56]. Ker and Bradley (2010) discuss that fidelity is more than high-level technology and should encompass simulation authenticity, with a focus on transfer of learning [49]. De Giovanni et al. (2009) explored the concept of fidelity (without defining fidelity) in transfer of learning by comparing a small number of students learning heart sounds on a high-tech simulator or computer – there was no difference in outcome, however one might conclude that they were really making a comparison of technology, as opposed to fidelity. Norman et al. (2013) explored the application of fidelity to healthcare simulation in a literature review – concluding that fidelity is complex and multidimensional (the functionality, physicality, environmental and psychological aspects all interrelate) [39, 57]. However, in the Norman et al (2013) paper the terms authenticity and realism were used interchangeably with fidelity, echoing the confusion that Bland et al. (2014) identified [58, 59]. This lack of clarity in nomenclature can lead one to pursue 'high fidelity at all costs' without the evidence, leading to unnecessary expenditure and ineffective use of high-technology equipment . A classic example in healthcare simulation is purchasing a high-technology simulator (at around $100,000 AUD) that replicates human movements and features (such as breathing, blinking and talking) to teach first year nursing students how to move a patient safely. To effectively teach moving a patient safely an instructor only needs a simple, low-technology manikin or a volunteer student and it would still be referred to as 'high-fidelity' – at a significantly lower cost (around $5,000 AUD for a manikin). Another aspect of the fidelity conundrum is the thought that high-fidelity simulations cause an increased cognitive burden due to the increased stimuli and decreased situational awareness. For example, familiarising yourself with the functions of a simulator that fully replicates real world (e.g. breath sounds, heart sounds) in combination with being challenged with an alarming monitor and simulated staff members might lead to cognitive overload. A study on low versus high fidelity simulations with paramedicine students found that those in the high-fidelity group experienced both greater psychological fidelity and cognitive burden, however their performance did not worsen [60]. Another study with nursing students found that the performance of participants improved with the use of high-fidelity simulations – participants were put in a low- or high-fidelity life support simulations as a part of an Advanced Life Support course. The participants of the high-fidelity group had better memory retention, managed complex situations better and were more confident in their practice [61]. Conversely, in a study comparing low- and high-fidelity neonatal training, there was no difference between the two groups post intervention or over time [62].

A challenge with exploring these comparison studies, is that there is no formal definition of fidelity – we may not be comparing like with like. Even when Hays (1980) explored flight simulation fidelity in early literature, he identified confusion with the term and recommended limitation of the term fidelity to the actual equipment. More recent dialogue reveals the term fidelity is still used variably and is interchangeable with other terms, such as authenticity and realism, amongst simulation educators and users – in which Hamstra et al. (2014) urged the term fidelity be abandoned in healthcare in favour of physical resemblance (how closely the simulator physically resembles real life) and functional task alignment (matching of simulator to task) due to the confusion [56]. I explore these ideas here further and also in the publication included at the end of this chapter (Chapter 1).

- *Authenticity*

Authenticity is defined as having the “quality of being real or genuine, not fake” or “quality of accurately recording or reflecting something”, demonstrating the two aspects of authenticity commonly discussed [63]. It is established that simulation is not real, in fact, common briefing for simulations identify that whilst the situations mirror or ‘reflect’ real-life events they are not ‘real’. Further exploration of the term authenticity or authentic, identifies two core characteristics: context and the process of learning. Context refers to how closely the ‘whole experience’ mimics real life – describing authenticity in simulation. Spector et al. (2014) acknowledge that authentic learning in education is complex, describing it as “a pedagogical approach… situates learning… in the context of real-world situations”[64, 65]; whilst Herrington et al. states that learning activities “should match as nearly as possible the real world tasks of professionals in practice” [64]. Gulikers et al. (2007) also argued that each activity should be “judged by its resemblance to the […] situation it aims to reflect,“ describing authenticity as subjective and that it is student perceptions that influence learning [66].

Authenticity in simulation is noted as increasingly important by Rystedt and Sjoblom (2012) and is largely impacted by learner interaction. However, it is often dismissed by simulation facilitators, with an expectation of sorts that “authenticity is often treated as unproblematic and thought to follow automatically from designs…” [67-69].

For learners, however, their “perceptions of authenticity are critical because learning is embedded in our everyday experience of the world […] Information and problems perceived to be authentic entail social contextualization […] which influence all subsequent mental processing” [70]. Petraglia (2009) identified that the lack of perceived authenticity in health education facilitates the KAP-gap (the Knowledge Attitude and Practice gap). Also known as the theory-practice gap, the concept of the KAP-gap describes the situation when what happens in actual health practice is different to that of formal learning [71]. For example, formal teaching of a subcutaneous injection stipulates the use of 45-degree insertion angle, whilst the administration product description of subcutaneous enoxaparin mandates that the injection should be administered at 90 degrees. This gap can facilitate knowledge wastage due to a lack of contextual authenticity, inhibiting a transfer of knowledge.

Whilst contextual authenticity in simulation and authentic learning process are separate concepts, they are intertwined [64, 65, 72]. Authenticity is not simply limited to the physical representation of a manikin, but to the persuasiveness of a narrative, the learning context and the relevance of the activity and the dynamic interactions between them – thus, a clear delineation from the term fidelity [64, 67]. However, the first step to the perception of authenticity, is the ability to suspend disbelief – which we discussed earlier with reference to being able to be convincingly real to actively engage [73].

Bland et al. (2014) suggest that the authenticity of simulation is dependent on multiple, combined factors, again repeating this idea that authenticity is complex and multidimensional. They also point out that the characteristics contributing to authenticity are under-researched – that is, what contributes to defining authenticity [69]? Participants in a qualitative study on authenticity felt that the physical representation of the learning environment did not matter as much as the participant's engagement. Participants commented "there is so much suspension of disbelief required […] there just had to be enough to get them engaged" and "the data was real enough so that you would think it was real, and it becomes real" [64]. What is enough to facilitate this 'suspension of disbelief'? To what level must the activity match the real world? Rystedt and Sjoblom further discuss the concept of authentic simulation, concluding that even small disruptions to authenticity (relative to the real life task) can cause the participant to dismiss the authenticity and clinical relevance of simulation [67]. These findings further confirm that authenticity is relative to the activity it mimics and subjective to the learners' perception. This reinforces the importance of suspending disbelief and the strong link to perceptual authenticity, which brings me to realism.

- *Realism*

In this section I discuss the definitions of realism, its importance in simulation and how it relates to fidelity and authenticity. Encompassed in this concept of authenticity is realism, a multidimensional aspect of instructional design. The Oxford Dictionary defines realism as “the quality or fact of representing a person or thing in a way that is accurate and true to life” [74]. To unpack realism, I will make comparisons to literature on realism in media (such as film), as there are parallels – the suspension of disbelief required, the portrayal required to evoke emotion – that are relevant and link well with simulation. Then I go on to explore how participants of simulation perceive realism.

The first example I draw from is realism in the film industry. Key elements that contribute to the construction of realism in film are plausibility (the ability for it to occur in real life); typicality (the event could readily happen to the participant/observer); factuality (the event actually happened); involvement (how well the observer/participant can relate to the event and feel emotional involvement); narrative consistency (no contradictions); and perceptual persuasiveness (how well items or events are presented, persuading the individual it could be real) [75]. The apparent reality (how authentic or real something appears to an individual) of film is directly associated with increased emotional arousal [41, 76, 77]. I propose these sub-categories can also apply to the context of simulation in healthcare and instructional design in portraying authenticity. This idea that likeness of simulated space contributes to engagement in simulation is not new [35, 57, 58, 78]; simulation literature on realism highlights multidimensional aspects already considered in Hall’s (2003) hypothesis – engagement is more than physical (perceptual persuasiveness), it is also semantic (conceptual – plausibility, typicality and involvement) and phenomenal (emotional – involvement and perceptual persuasiveness) [46, 75, 79]. Research on a scale for assessing realism identified a significant difference in perceived realism on various simulators [80]. A ‘flat uterus model’ was rated the lowest, whilst a pelvic model and desktop uterus model had very little difference in scores. The results also revealed that the importance of realism extended to the function of the simulator – perhaps comparable to the 'flow' of a simulation and whether its progression reflects real life (semantic realism) [80]. The evidence at this point is limited, however, as there is no assessment of the models in a contextual situation or other simulation. It would be useful to know how the different simulators influence engagement in the context of physical, semantic, and phenomenal realism; what is it that facilitates a 'suspension of disbelief'? Dieckmann's [79] work explores how realism might be interpreted for simulation at a conceptual level and is widely accepted in the simulation community. I discuss this in more detail in Chapter 5 and 9.

Moving on to simulation participants' views on realism, I discuss some examples of work exploring this and describe the confusion associated with realism. A study exploring the perception of realism during resuscitation training, found that high-fidelity simulation resulted in greater realism. Participants were put through various paediatric simulations with either full function Laerdal SimBaby™ manikin (experimental group) or limited function Laerdal SimBaby™ manikin (control group) [81]. However, there appeared to be confusion regarding the definitions of both realism and fidelity, with no discussion regarding the theory underpinning these concepts – thereby limiting the application of the findings. It is unclear how the perception of realism influences success of simulation.

Other research on participants' perceptions of realism has shown that, like fidelity and authenticity, the level of realism and its impact on learning is directly related to the learning objectives; the simulator and environments level of realism must be contextual to the learning objectives and learner level [57, 64, 72, 79, 82]. However, it is important to note the distinction between transfer of learning and engagement; here we are exploring the impact of realism (and/or authenticity) on engagement.

Exploration of other simulation literature confuses realism with fidelity, and *vice versa* [83]. Francis (2003) discussed the concept of realism originating in a psychological context; realism is subject to the judgement of the viewer/participant [46, 79, 84]. For this thesis, the term fidelity will hold to the original definitions; fidelity refers to amount of likeness a simulator holds to the real world (whether in sound, appearance or behaviour) and is directly related to the technology (as opposed to the whole environment). Authenticity refers to how an activity reflects real life, in narrative, context and physical likeness. And finally, realism relates to the contextual elements of the simulation; it defines perceived reality of simulation – physically, semantically (conceptually) and phenomenally (emotionally).

While the concept of realism is widely discussed in simulation, there are perhaps broader perspectives to be considered. Simulation users debate the necessity of absolute representation, as I have outlined, versus a conceptual representation. In the next section, I discuss alternate perspectives of realism that the world of arts might bring.

Authenticity, Engagement and Visual Arts Literature: Another Perspective?

Building on the concepts of realism having perceptual elements, reality is perhaps in the eye of the beholder. Moving now to visual arts, the idea of perceived reality is discussed with reference to the psychological concept of dual awareness [76]. Here I will introduce dual awareness, how it applies to simulation and link it back to the work on realism I have already outlined. In addition, I will briefly discuss how visual intake influences emotion.

Dual awareness proposes that the individual's ability to move from the executive space (comparing constructed imagery with reality) to the entertainment space (engaging with fiction as if it were real), enables the learner to feel they are directing their own learning – allowing the individual to safely participate in make-believe situations, with the option of 'opting-out' at any point [41]. It is hypothesised by Tan (2008) that this dual awareness enables the individual to 'buy-in', essentially experiencing the situation as more realistic. The concept of dual awareness and the individual's ability to engage in the entertainment space relies heavily on the perceived reality – i.e. the scenario must have emotional believability. Tan (2008) further suggests that distracting, or unnatural, elements of an environment can disengage the buy-in, causing individuals to rationalise the situation and thereby inhibiting emotional arousal. Here, I will briefly digress to discuss the visual intake pathways and their relationship to emotion – this is of relevance due to the visual nature of moulage and the methods utilised in the later study.

It is hypothesised that emotional cues engage neural circuits, directing attention to the area of interest and invoking sensory systems. This theory posits that when the sensory systems are engaged they increase attention and trigger processing of perceptual cues, and initiate reflex responses, whether the individual is aware of this or not [85, 86]. The eyes act as a gateway to processing, with more emotional pictures or scenes enhance information seeking and attention – as demonstrated by eye movements such as scanning the room or settling on one area of focus (I discuss this in more detail in Chapter 8). Indeed, eye movements are influenced by sensory features of visual cues (such as edges, complexity); emotional experiences are linked to heightened learning and memory [85, 87, 88]. The explanation for why this occurs is linked to brain regions that regulate attentional focus (such as the amygdala, ventromedial prefrontal cortex), however further discussion on this neuropsychology is beyond the scope of this thesis. Emotional arousal and enhancement of memory is correlated with recall, thus the relevance of facilitating engagement, and subsequently emotional arousal, in simulation [88].

In an example of how this might all be linked, Rystedt and Sjoblom (2012) identified disengagements in their case study of an anaesthesia, finding that any ‘glitches’ in the representation of reality in simulation caused a disruption in the learner’s engagement [67]. This connects well to Dieckmann et al.’s (2007) realism hypothesis – the narrative and setting must be logical and believable[79]. For example, despite the SLE appearing as a highly realistic hospital ward, one-way glass and Perspex-mounted microphone (often used in simulations to facilitate observation) could serve as reminders (ergo, ‘glitches’) of the reality, disrupting engagement in the simulation. In learning, the concept of emotional engagement and engagement of learners is discussed by Norman (2013) and many others [39, 40, 76, 89]. They identify that emotional impact of the experience is directly related to engagement, which is linked to impact on learning. The presence of emotions, as discussed earlier, allows active engagement in the activity and can enhance the process memory retention.

Comparing the results of watching graphic movies to documentary-style movies, study participants’ memory was enhanced by the graphic movies due to the visual representation of cues, stimulating an emotional response [44]. When applied to simulation, I would hypothesise that just as the apparent reality/believability/perceptual persuasiveness of artistic media directly impacts engagement, the apparent reality of visual cues is vital to the engagement of learners in simulation [39, 40, 76]. In this thesis, I explore this hypothesis within the context of moulage; the believability of moulage contributes to engaging with the fiction contract and therefore the simulation.

Before introducing you to moulage, I will discuss a counter perspective to authentic portrayal of authenticity.

The Argument Against Highly Authentic Portrayal? A Counter Perspective.

There are arguments against a highly authentic portrayal. Research in film and media discusses the elements of authenticity and proposes that complete authenticity is not required, and only first impressions contribute to engagement of the viewer [90]. Viewers mentally construct beliefs and theories from initial impression; Kubicka (2013) hypothesises that high levels of authenticity are not required for emotional engagement. Goodman (1976) and Wells (2002) suggest that no similarity at all is required to establish a relationship of resemblance, that “being likened to reality is not essential for creating meaning” [90], Goodman (1976) quotes “I seldom suppose that I can literally reach into the distance, slice the tomato...[…]… I recognize the images as signs for the objects… signs that work … without being confused with what they denote” [90-92]. As identified by multiple authors in simulation, authenticity and the portrayal of reality have become a sort of *desideratum*, as opposed to a multidimensional element characterised by participants’ perceptions [69]. Dieckmann et al. (2007) outline the need for the simulation to have logic and believability, which is not reliant on highly accurate replication of reality[79].

Another theory worth considering in the quest for authenticity is the theory of the Uncanny Valley. The SLE in most cases is ‘uncanny’ in that it is a fabricated environment (perhaps with the exception of *in situ* simulations); it looks familiar, yet at the same time it is strange [93]. Masahiro Mori proposed this effect in 1970, attributing this ‘uncanny’ feeling to the perceived reality of replicas having both human and nonhuman features – it was better to have outright nonhuman than a mix of human and nonhuman features [94, 95]. The problematic features were typically the eye shape and texture, the skin texture and facial abnormalities such as oversized lips. The problem was that there seemed to be inconsistency in the realism portrayed, causing individuals to have conflicting opinions about perceptual persuasiveness (Figure 4) [94].

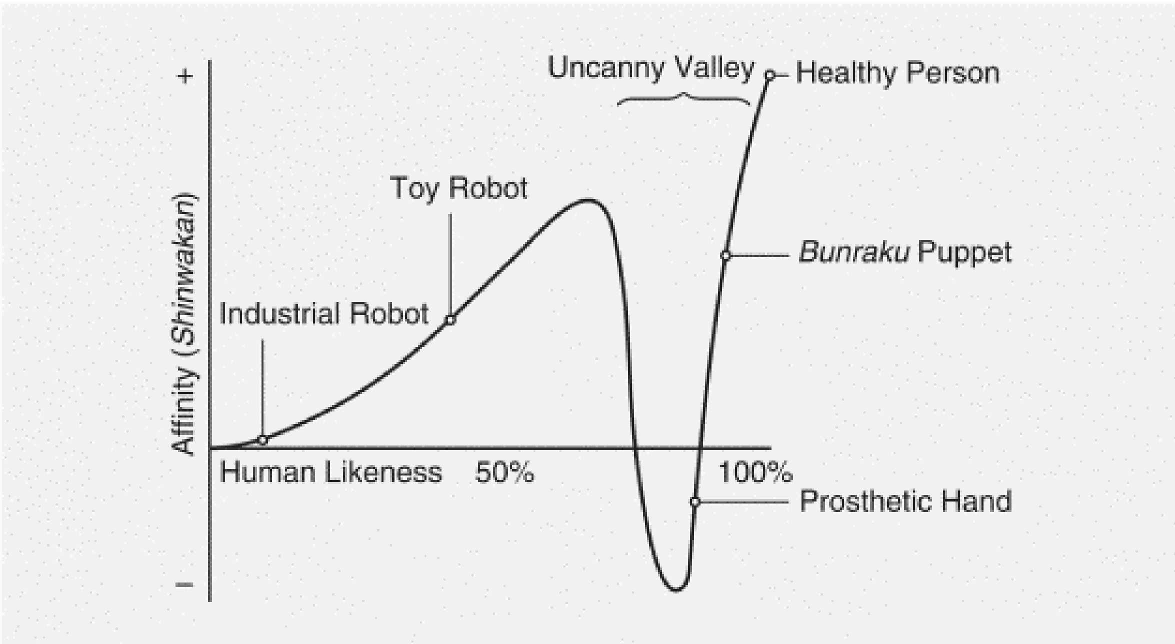


Figure 4 - The Uncanny Valley [95]

Whilst the Uncanny Valley has typically been used in robotics or avatar research, the case could be made that simulations could cause the same disengagement due to the conflicting human and nonhumanness. For example, perhaps it is better to have a low level of authenticity in environment, manikin and surrounding props as opposed to a highly-authentic environment with obviously fake manikin? That is, it is best to acknowledge simulation’s lack of reality and engage with simulation in this representative way, suspending disbelief in a simulation that sufficiently reflects the activity it intends to replicate. Whether this is the case, simulation literature does not sufficiently describe; yes, simulation is a successful method for education, however most simulation research has not explored what works, for whom and under what circumstances [96]. A good example of research not exploring all aspects of simulation is the use of moulage, a technique commonly used to replicate reality in simulation [97]. Moulage is the use of special effects makeup techniques to create the appearance of illness, trauma or other effects, such as smells and sounds [98]. Common examples of this include creating a diabetic ulcer, skin tear, the appearance of ageing or bruises [35, 49, 99]. In order to understand the work described in this thesis, I will set current innovations in moulage against its historical development. This will be described in detail in the subsequent chapter.

The complexities of designing high-quality simulation is not to be understated. It is grounded in well-established theories of learning and has a long history in health education, with proven results for success. Many aspects, such as debriefing, have been investigated with defined recommendations for practice. That said, many aspects of simulation are unknown, including how the perceptual persuasiveness influences participant buy-in and engagement in simulation.

CHAPTER 2: MOULAGE IN SIMULATION

Paper associated with this chapter

Paper 1: Does appearance matter? Current issues and formulation of a research agenda for moulage in simulation [100]

Publications relevance to thesis

I significantly contributed to the research in this paper, which forms the following chapter. I contributed, in the majority, to the conception and design of the project. I performed the entirety of data collection and analysis. I wrote the paper and performed the edits and revisions for publication, with some assistance from co-authors with editing.

Citations to date: 6

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The full paper can be read at the end of this chapter.

Now that I have laid the groundwork for simulation in medical education and the complexities of effective design, I now move on to a more detailed account of moulage. In this chapter, I will discuss the first use of moulage and how it came to be a teaching aide in medical education, before addressing the relevance of moulage in simulation. I will conclude this chapter with a critical review of the literature on the use of moulage in simulation, which leads to the research questions and empirical work presented in this thesis.

History of Moulage

Figure 4 - Moulage Origins (C) Creative Commons

Moulage dates to the ancient Egyptians, when embalming and preservation of the dead was reserved for the Pharaohs of the time. Although historical accounts are vague, this mummification was linked to the traditional moulage process used for building models for anatomical and medical teaching in the late 16th century [101, 102]. Using the process of casting, artists created anatomical negative moulds from cadavers and then used wax to fill the moulds. After completing the moulding and casting process, the models were painted to enhance the realism of the replicas [103, 104]. This form of modelling was surpassed by the use of manikins and plastic models more recently, however, there continues to be some work with wax-type products to create authenticity [102, 104]. In fact, according to European moulage curators, moulage has continued to be used in medical education due to the limitations of two-dimensional images for teaching dermatological conditions. For example, at the

University of Bern and a Zurich Teaching Hospital in Switzerland, teachers utilise moulages of syphilis and measles due to the resurgence in clinical presentations.

The preservation of this moulage is an art form in itself. Moulage conservationists are trained in techniques to restore and repair damaged moulages, preserving them for further teaching and history. In my research on the history, I discovered that moulage was used as part of documenting research outcomes. For example, the Zurich Moulagen Museum houses moulages documenting the effects of varied doses of electromagnetic waves for x-radiation. Other examples of moulage at the Zurich museum included surgical moulages demonstrating vein stripping or surgical incisions.

With the old moulage models mostly housed in musea across the world, the term moulage in modern use refers to the application of special effects or makeup techniques to manikins and simulated or standardised patients [98, 105, 106]. These techniques vary from casting and moulding wounds to apply to the manikin; painting bruises, lacerations or rashes on the skin of a simulated patient; or creating an illusion of blood loss, illness or any other idea imaginable. Simulation staff rely on training resources such as books, home recipes, web-based instructions (e.g. YouTube) and their attendance at special training courses. Training workshops begin at $300.00 USD for basic techniques, with costs for comprehensive training (including basics plus special techniques such as prosthetics) reaching up to $1,600 USD per person [107-110]. Training does not include basic equipment to utilise moulage techniques. A basic kit includes tools such as palette knives, palettes, brushes of various types, sponges, safety and hygiene equipment. The makeup itself typically includes specialty and

Figure 5 - Modern Moulage

theatrical makeup supplies such as greasepaint, crème foundations, fake blood, effects powders, latex, non-latex equivalents and waxes.

Scoping the literature on moulage and authenticity, there is a lack of clarity on authenticity's importance in moulage [69]. Articles on moulage in general are few, with most focusing on recipes and 'how-to' directions [100].

Moulage Today: A Critical Review of the Literature

With this history in mind, I now look to the literature exploring current use of moulage in simulation and the evidence for its use.

The Evidence for Moulage in Simulation

Despite the assumption that moulage contributes to realism, there seems to be no clear evidence of moulage inclusion being essential in simulation practice [100, 111-119]. Some authors refer to Wikipedia for evidence of its inclusion [120], and others list passing comments from participants about 'how real it was' [97, 120]. Citing anecdotal feedback from participants in the paper and no further empirical research, the author concludes that moulage is an "educational tool in its own right" [120]. Hogg and Miller (2016) designed a simulated course to train 3rd year undergraduate medical students in recognising the deteriorating patient, where moulage was used to complement the realism of a burns trauma scenario. The author concluded that realism contributed to participant confidence established through a post-course questionnaire. Of course, this might be true, however perhaps it may have been the act of practicing and participating in a real-time activity that required intervention – there is no way of knowing this unless a comparison study of some kind was undertaken [121].

Moulage and Retention of Knowledge

The few papers that do explore moulage beyond mere description provide some suggestion that moulage could increase the retention of knowledge. In an example of this, 2D images of melanoma were pitted against 3D pre-prepared moulages in undergraduate dermatology education – over time, the knowledge of those in the 3D group remained unchanged, whilst those in the 2D group performance deteriorated [122]. However, perhaps the reason for knowledge retention in this instance was that the moulage was used in an active learning activity – the students interacted with the 3D examples, as opposed to passive learning in a lecture-based setting. Smith-Stoner (2010) evaluated the effectiveness of moulage on teaching by observing student engagement. She noted that following the activity, the participants recalled content in the weeks ahead – however, there was no comparison or measurement completed [97]. In newer work, the use of moulage is associated with improved performance in paramedic students and is now implemented as a workforce preparation technique in undergraduate radiography training [123, 124].

Clinical Specialties and Moulage

Most papers that explore moulage at greater depth are in the field of dermatology [122, 125-128]. Moulage may provide a unique opportunity to educate individuals on various skin ailments that would be difficult to achieve in short clinical placements. In the example of melanomas, there would be a requirement for authenticity due to the opportunity for accidental misdiagnosis and the significance of observing its height, texture and abnormality in shape and colour. In one paper, the authenticity of moulage was assumed to be high – the learners dismissed the moulage item as being the patient’s own skin ailment [125]! One could question whether this is due to lack of prior experience on the part of the students or due to the highly authentic portrayal, and in this circumstance authenticity might have unforeseen consequences, such as misdiagnosis. Other areas that moulage papers seem to focus on is trauma, gynaecology or emergency burns scenarios – in which the participants might need to estimate blood loss [129] or treat a major trauma (such as burn) [113].

On the Authenticity of Moulage

Moulage is most commonly associated with realism in simulation by simulation technicians and users alike [97, 99, 120]. However, authenticity of moulage is rarely explored – or at least not discussed in the literature [97, 120]. In a study on the use of temporary tattoos as a moulage technique, measuring the validity of moulage was the main purpose of the study [127]. The tattoo was rated as highly realistic by study participants. In a study on the use of simulation as a teaching technique for dermatology, Hernandez et al. (2013) noted briefly that the moulage was deemed authentic by an individual dermatologist – however this was not validated in any formal way, so there was no way of knowing the level of authenticity provided, limiting conclusions on its necessity. In a similar study, Garg et al. (2010) and Goulart et al. (2012) noted that the limitation to their study was a lack of validation of the authenticity of the moulaged prosthesis [122, 130, 131]. Jain et al. (2013) assessed validity of the moulaged skin artefact by comparison to images of actual melanomas and independent review by dermatologists [125]. Another paper compared the validity of moulage when applied by a professional makeup artist, versus a simulation staff member with no training [119]. The moulage applied by the makeup artist scored higher in the analysis of face and content validity. No verification of authenticity was undertaken in this research, therefore one could not truly say that the moulage was authentic. Verification of authenticity could be expert consensus on accurate replication or the use of a rating tool to assess levels of authenticity. Indeed, on personal observation of the images shared in the paper, the authenticity of moulage appeared quite low, despite the use of a professional makeup artist.

Moulage and the Level of Learner

One paper suggested that the perceived authenticity in moulage differed between the levels of learner. In their construct evaluation of a peritonsillar abscess task trainer, the less experienced physicians rated the authenticity of moulage lower than the experienced physicians [132]. Perhaps this is an example where the cues may not be sufficiently authentic enough for the participant to move on – physical realism was not achieved, so therefore semantic realism could not be.

The Expense of Training, Equipment and Time Associated with Moulage

Moulage is a highly popular topic at simulation conferences around the world [117, 118, 133-138]. Workshops on moulage techniques provide delegates an opportunity to learn special effects makeup techniques to apply to their simulation practice. Outside of conferences, there are a few organisations which provide moulage training courses. These vary from beginner to advanced, at varied levels of cost [139]. In addition to this, these businesses contract to large organisations to provide realistic injuries that “evoke a sense of urgency and impact in trainees which is unsurpassed” [108].

This pursuit of achieving highly realistic scenarios comes at significant cost. High technology manikins can cost up to $100,000 AUD (such as the Laerdal SimMan™ or Harvey® heart sounds manikin), let alone the cost of purchasing moulage equipment and other supporting props, such as hospital beds. Many authors identify simulation as being expensive, even more so to maximise realism, and that efforts should be taken to minimise cost due to the expense of such interventions being a barrier to its use [119, 140-144]. Literature on the justification of cost in simulation are scarce, thereby limiting the ability of simulation education to demonstrate its worth [145, 146]. The efforts to facilitate realism should be guided by the level of realism required to facilitate participant engagement in the simulation [47, 119]. However, strategies for matching the realism to engagement and identifying the level required are not addressed [147].

With consideration of moulage within this context, perhaps we should consider it within the frame of a barrier. Time spent on simulation is well-identified as a barrier to implementing simulations [143, 147, 148]. Nurse academics identify time as a single most common barrier to using simulation. Examples of nurse academic's views on the barriers and facilitators for integrating simulation into nursing curricula include "not enough time to prep" and "it is very time-consuming…" – in particular for so-called 'high-fidelity simulation' [143, 148]. This perpetuates the idea that efforts must be made to minimise both time and expenses spent on simulation, without diminishing the effectiveness of the simulation itself.

Conclusion

There is a paucity of literature available on the use of moulage in simulation. Despite this, there is an assumption from the community that it is necessary to facilitate realism. To use moulage effectively and appropriately in simulation further research is required. Such research should include exploring the impact of moulage on engagement, how moulage authenticity facilitates engagement and the suspension of disbelief, and how moulage authenticity contributes to diagnostic training. The influence/importance/impact of moulage may differ depending on the level of learner and the clinical specialty (e.g. burns or trauma).

Does Appearance Matter? Current Issues and Formulation of a Research Agenda for Moulage in Simulation

Jessica B. Stokes-Parish, M. Nurs (Adv Prac);

Robbert Duvivier, MD, PhD;

Brian Jolly, PhD

Summary Statement: The use of moulage is assumed to add realism and authentic context in simulation. Despite the expense required to utilize moulage effectively, there is little exploration in the literature as to both its necessity and its accuracy of portrayal. We explore engagement, authenticity, and realism theories in the context of moulage and highlight the need for more evidence on moulage in simulation-based education, including suggestions for future research. In particular, we urge the simulation community to move beyond descriptive papers to investigate moulage in terms of justification and clarification.

(*Sim Healthcare* 12:47–50, 2017)

Key Words: Moulage, Realism, Engagement, Authenticity, Fidelity, Simulation-based education, Instructional design.

Simulation-based education (SBE) is commonly used in both undergraduate and postgraduate education. Often used as a primer before clinical placement or when clinical activity is infrequent, the level of realism required in SBE is frequently questioned in the literature.[1–3] Typically, in SBE staff "set the scene" using equipment that matches the clinical environment to increase the illusion of "the real thing," using techniques such as moulage to simulate wounds and other effects.[4–6]

Moulage dates back to the ancient Egyptians, when embalming and preservation of the dead were reserved for the Pharaohs of the time. Although historical accounts are sketchy, this mummification was linked to the traditional moulage process used for building models for anatomical and medical teaching in the late 16th century.[7–9] Using the process of casting, artists created anatomical moulds from cadavers and then used wax to fill the moulds. After completing the moulding and casting process, the models were painted to enhance the realism of the replicas.[7,10] With these models now housed in musea across the world, the term moulage currently refers to the application of special effects or makeup techniques to manikins and simulated or standardized patients.[11,12] Common examples of moulage include bruises, wounds, burns and other signs of trauma, and illness effects such as sepsis, jaundice, and rashes. Simulation staff rely on training resources such as books, home recipes, web-based instructions (eg, YouTube), and their attendance at special training courses. Such training courses can be expensive, with costings for a basic course US $450.00 to 600.00. In addition to this, the outlay for using moulage in every day simulation practice is estimated to be at least US $300.00.[13] This figure covers tools, specialty, and theatrical makeup supplies.

Considering the significant cost to simulation that moulage requires, we need to reflect on the necessity of moulage in simulation. With the theoretical concepts of engagement, realism, and authenticity in mind, we sought to identify the place of moulage in simulation. This Concepts and Commentary will explore the evidence base, with a view to developing a research agenda that will allow the field to move beyond "show&tell" or descriptive research toward clarification studies.[14] We will identify areas of investigation that are currently underdeveloped, which would benefit from studies seeking to answer "how and why does it work?" rather than "what did we do?" We argue that our collective effort should focus on deepening our understanding to advance the science of simulation. We hope that this C&C will stimulate the simulation community to reflect on the purpose of moulage in their teaching and to strive to ask more appropriate research questions.

How do Moulage, Engagement, Realism, and Authenticity Relate?

Learner engagement is essential for deepening the learning experience.[15–17] Components of engagement critical to the success of simulation involve the learners' perception of the activity, including how realistically it is portrayed.[18–21] If you were to reflect on a film you watched recently, think on the scenes portrayed. How realistic did it appear to you? If it was an action or horror film, did the makeup portrayed look real or artificial? Did the surrounding scene props fit the picture, or were they out of place—that is, did it feel authentic?

Authenticity, "quality of being real or genuine, not fake" or "quality of accurately recording or reflecting something" is dependent on participant interaction and perception.[22–24] Further exploration of the term authenticity or authentic identifies two core characteristics: context and the process in learning. Context refers to how closely the "whole experience" mimics real life. Authentic learning in education is complex, and it has been described as "a pedagogical approach [...that]

From the School of Medicine and Public Health (J.B.S.P., R.D., B.J.), Chameleon Simulation Centre School of Medicine and Public Health (J.B.S.P.), University of Newcastle, Callaghan, New South Wales, Australia.

Reprints: Jessica B. Stokes-Parish, M. Nurs (Adv Prac), Chameleon Simulation Centre Level 1, Clinical Skills Training Centre, Hunter Region Mail Centre, NSW, 2300, Australia (e-mail: Jessica.stokes-parish@newcastle.edu.au).

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situates learning [...] in the context of real-world situations."[25] Authenticity in simulation is noted as increasingly important[24]; however, it is sometimes dismissed by simulation facilitators as unimportant.[24,26,27] For learners, however, their "perceptions of authenticity are critical because learning is embedded in our everyday experience of the world [...] Information and problems perceived to be authentic entail social contextualization [...] which influence all subsequent mental processing."[28] Although contextual authenticity in simulation and authentic learning process are separate concepts, they are intertwined.[22,23,25] A literature review discovered the following four key themes of authentic learning experiences: "real worldness," open-ended inquiry, discourse among learners, and choice.[29] When this framework of authenticity was applied to a pilot simulation, it was found that the gap widens between real world and simulation when there is a lack of real worldness.[23] Furthermore, authenticity of simulation is dependent on multiple, combined factors, with the detail contributing to authenticity under-researched[27]; to what level is real worldness (perhaps this is realism) and elements of authenticity required? Even small disruptions to authenticity can cause the participant to dismiss it and subsequently the clinical relevance of simulation.

If you consider authenticity of a bruise painted on a manikin or simulated patient, ask yourself, is the bruise portrayed authentically? As simulation professionals,[30,31] we often dismiss the authenticity of small details as unimportant.[24] An example might clarify how authenticity can derail the purposed learning set for the participant. Consider a bruise, perhaps applied with too much makeup, making the appearance of the bruise too blotchy, which the learner incorrectly identifies as being external, thinking about active bleeding and seeking to stem the bleed, while in actual fact, it was meant to reflect an internal splenic bleed requiring urgent surgical attention. Although key factors of engagement in learning include participant briefing (inclusion of confidentiality agreements, acknowledgement of participant requirements, limitations of simulation and suspension of disbelief, and open discourse in simulation), can we underestimate the impact of the accuracy of visual cues portrayed?[2,18,32] As educators and simulation designers, it is imperative that we question the authenticity of delivery and the presence of real worldness.[22,23,29]

Encompassed in this concept of authenticity is realism, a multidimensional aspect of instructional design. Key elements that contribute to the construction of realism in media are plausibility (the ability for it to occur in real life), typicality (the event could readily happen to the participant/observer), factuality (the event actually happened), involvement (how well the observer/participant can relate to the event and feel emotional involvement), narrative consistency (no contradictions), and perceptual persuasiveness (how well items or events are presented, persuading the individual that it could be real).[33] The apparent reality (how authentic or real something appears to an individual) of film is directly associated with increased emotional arousal.[17,34,35] We propose that these subcategories can also apply to the context of simulation and instructional design in portraying authenticity. This idea of identifying that the likeness of the setting and context contributes to engagement in simulation is not new.[15,18,36,37] Based on the theoretical principles of reality in simulation, research on perceptions of participants has shown that the level of realism and its impact on learning is directly related to the learning objectives of the activity.[19,23,36,38] However, it is important to note the distinction between transfer of learning and engagement; here, we are exploring authenticity and its impact on engagement. Unpacking the simulation literature on realism highlights multidimensional aspects already considered in Hall's (2003) hypothesis—engagement is more than physical (perceptual persuasiveness), and it is also semantic (conceptual—plausibility, typicality, and involvement) and phenomenal (emotional—involvement and perceptual persuasiveness).[19,20,33]

Scoping the literature on moulage and authenticity, there is a lack of clarity on its importance in moulage.[27] Articles on moulage in general are few, with most focusing on recipes and "how-to" directions. The few articles that do explore moulage further provide some suggestion that moulage could increase the retention of knowledge (as opposed to using images). In an example of this, two-dimension (2D) images of melanoma were pitted against 3D-preprepared moulages in undergraduate dermatology education—over time, the knowledge of those in the 3D group remained unchanged, whereas those in the 2D group performance deteriorated.[39] Moulage is most commonly associated, in the literature, with authenticity and its contribution to this.[4,6,11] Despite this assumption, there seems to be no clear evidence of moulage inclusion being essential in simulation practice.[40–47] Some authors refer to Wikipedia for the evidence,[4] and others list passing comments from participants about "how real it was"; however, authenticity of moulage was not explored or at least not discussed in the literature.[4,11] Most articles that explore moulage at greater depth are in the field of dermatology.[39,48–51] Probably because of the niche it fits, moulage may provide a unique opportunity to educate individuals on various skin ailments that would be difficult to achieve in short clinical placements. In the example of melanomas, there would be a requirement for authenticity because of the opportunity for accidental misdiagnosis and the significance of observing its height, texture, and abnormality in shape and color. In one article, the authenticity of moulage was assumed to be high—the learners dismissed the moulage item as being the patient's own skin ailment.[48] One could question whether this is due to the lack of previous experience on the part of the students or due to the highly authentic portrayal, and in this circumstance, authenticity might have unforeseen consequences. Frijda (1988)[34] and Tan (2008)[35] explored the psychology of authenticity and engagement in media, identifying the need to allow "dual awareness"—that is, clearly identify what is real and what is not to allow the observer to engage. Perhaps the boundaries of play were not set before engagement in the simulation. In any case, the authenticity of moulage seems to be largely ignored in the literature and commonly taken for granted.

If we drill down further to apply the theory of authenticity and realism to moulage, do we consider authenticity and realism in detail? Perhaps moulage is ignored as being only an abstract representation of reality; moulage is a physical element of realism, yet it crosses into the semantic and phenomenal spaces in various situations. Applied to moulage, the subcategories of realism[33] suggest that moulage should be believable, relatable, and not contradictory. Imagine a wound that is applied to a manikin. Was the wound plausible—that is, is there a possibility it would occur in real life. Was it consistent with the scenario (narrative)? Were there aspects of the wound that could have "jarred" the participant—was it colored incorrectly or misshapen/inappropriately located, interrupting their engagement. This concept of jarring is supported in the literature, where episodes of disengagement occurred in simulations when the narrative or setting was not plausible or factual.[24] This response, however, could change on the basis of the participants' level of expertise—that is, a novice learner may not pick up these anomalies because of their low level of knowledge in the area (although perhaps the authenticity replication is required for teaching purposes). To an expert in the field, the inaccuracies may be too distracting (conversely, perhaps they do not require the physical level of realism to engage). This jarring can significantly impact the purpose of the learning; instructional design of simulation is critical to its success.[2,32] Applying the framework by Rule[29] to moulage, one can hypothesize that it must have real worldness to facilitate authentic learning. What is not clear in literature is the level of authenticity in moulage required to achieve this within the design process. The issues discussed highlight the need to understand how the authenticity of moulage impacts on learner engagement at any level.

You will note that we (the authors) have not included the term "fidelity" in our discussion. This is due to the continued confusion and lack of clarity regarding its definitions and appropriate use. We agree with Hamstra et al's (2014)[52] position of abandoning the term and as such have limited our discussion to the terms engagement, moulage, realism, and authenticity.

Directions for Future Research

With these caveats in mind, we ask the reader to consider the application of moulage in simulation. Do we dismiss moulage as being so unimportant that we do not see the cause for exploration? There seems to be some mismatch in our thinking—we are willing to outlay thousands of dollars in expense to add this skill to our simulation expertise, and it is regularly included in the discussion of instructional design; however, there seem to be no goalposts in the literature with regard to its use and the accuracy of portrayal required. We questioned why this is the case. Is moulage actually not essential to the success of simulation or maximal learning outcomes? The theories outlined previously suggest that the accuracy of portrayal would be essential (in part), with each generation expecting better portrayal of authenticity than the previous.[53] However, some research argues that complete authenticity is not required.[54,55] Instead, they argue that the participant engages from the initial impression only. Some even go so far as to suggest that no similarity at all is required to establish a relationship of resemblance.[55,56] Perhaps moulage is essential to some disciplines but not others (eg, dermatology but not obstetrics). Is the concept of authenticity too complex to fathom in any meaningful studies—that is, there are too many variables to explore? After a thorough search of the literature regarding moulage in simulation, there is little discussion on any of these concepts. Do they not apply?

We would argue the case that the relationship between moulage, authenticity, and engagement should be explored in future research to shape the design of simulation and maximize learner engagement. To achieve this, a framework for authenticity in visual cues should be developed. Moving beyond descriptive research,[14] a framework would allow for benchmarking and comparison between modalities and authenticity of portrayal. A comparison study might look like Garg's (2010)[39] design, rating the authenticity of moulage versus digital images and its impact on engagement (using a measure for engagement) or a study exploring a poorly represented (in-authentic) moulage versus a well-represented (authentic) moulage. Studies such as these would provide information such as quality of products used, level of training required, accuracy, and real worldness of portrayal required. Further research that might benefit the simulation community in understanding whether participants are influenced by authenticity of portrayal. Interviewing participants using a model of open-ended inquiry could provide insights as to how they value the accuracy of portrayal and its influence on their buy-in or engagement (ie, is the participants' value of simulation influenced by the authenticity of portrayal or how "well presented" the simulation is?). Furthermore, it would be useful to understand the impact of engagement in a novice versus expert learner. Such a study might compare the novice with expert's response to varied levels of authenticity. Referring to the instances where an expert may identify anomalies in design, would their engagement be "jarred" or do they engage beyond the physical level of realism? This could be explored through measuring their engagement via a number of methods. Information from these studies would inform practice at both an instructional design and delivery level.

CONCLUSIONS

It seems that the validity and authenticity of moulage should be explored for use in simulation to provide clarity for future practice. We suggest moving on from the description of what is done to studies focusing on justification and clarification of why and how the approach worked.[14] We call upon the simulation community to begin a discussion on moulage and commence exploring the potential for robust research to define whether authenticity in moulage really does matter.

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CHAPTER 3: METHODS

Aims of the Thesis

As described in the previous chapter, there is a paucity of evidence related to the use of moulage in simulation, particularly with regard to authentic applications of moulage. This thesis builds on literature surrounding authenticity, student engagement in simulation, and moulage.

The aim of this thesis is to explore to what extent the authenticity of moulage impacts on the engagement of participants in simulation.

Hypotheses

I have generated two hypotheses for this study to explore the aims of the thesis. They are:

1. Highly-authentic moulage facilitates increased medical student engagement in simulation;
2. Highly-authentic moulage is more acceptable to medical students than the low-authentic counterparts.

The questions generated from these hypotheses are:

1. To what extent does the authenticity of moulage impact on the engagement of participants in simulation?
2. What impact does the apparent reality (how authentic it appears) of moulage have on participants in simulation (in learning and engagement)?

These hypotheses and research questions led to the development of research objectives, which form both the individual research studies and chapters of this thesis. These objectives are:

1. To examine the published literature regarding the:
    1.1. Current use of moulage in simulation;
    1.2. Impact of moulage on the participants’ engagement in simulation;
    1.3. Importance of authentic moulage in simulation design.
2. To develop a theoretical system of classification in moulage to depict or reflect ‘authenticity’.
3. To determine how the use of authentic moulage impacts on engagement of participants in a healthcare simulation.

Thesis Structure Overview

Following the objectives outlined, this thesis will firstly explore the current use of moulage in simulation internationally. This is a crucial starting point; the understanding of the current use of moulage is essential to assess the degree to which moulage is currently being used and to identify the expected standard for simulation-based education. These issues are discussed in both Chapters 2 and 4.

Firstly, the definition of authentic moulage was developed by classical Delphi study (Chapter 5), resulting in the development of a tool to assess authenticity. The tool was tested via reliability and validity measures in Chapter 6. Following this development, the impact of authentic moulage was tested in a series of experiments, exploring how students perceived the authenticity of moulage and how it contributed to engagement in simulation (Chapters 7 and 8). In the final chapter, Chapter 9, I discuss the implications of the results of research and highlight future research opportunities.

Research Design

To test the hypotheses of this research, that highly-authentic moulage leads to higher participant engagement in simulation, a mixed-method approach was used.

All research is based on the premise of investigating or considering a subject of inquiry [149]. The underlying theoretical perspectives that inform this work are situated in post-positivist and constructivist approaches.

As a way of background, positivism has been the dominant course of theoretical perspectives in social and physical sciences for centuries [149]. Empirical evidence, scientific laws and methods are examples of research situated in positivism. Key aspects of positivism include aims, hypotheses and research rigour; the overall aim is to contribute to the greater body of knowledge and be able to generalise to the broader population [149]. Post-positivism, on the other hand, purports that not all observed phenomena can be considered fact; the complexity of knowing and knowledge confounds this and is impacted by the fallibility of man and research methods. It is grounded in critical realism, where the emphasis is placed on collecting multiple types of data to prove that a hypothesis might be wrong (as opposed to right, as in the case of positivism). This type of research aims to provide an explanation, with a focus on predicting and controlling phenomena – the researcher remains independent.

Constructivism, as previously discussed in Chapter 1, acknowledges that knowledge and meaning is socially constructed and, at times, there can be multiple (and conflicting) realities [149]. The aim of this research is to understand phenomena, with a partnership-type approach including the researcher and participants views, to co-construct evidence.

In this research, I have used a mixed-methods approach to answer different research questions. Research aims to discover or generate new knowledge and there are a variety of ways to approach this task [149]. Mixed-methods allows a researcher to combine techniques and theories to have a better understanding of the field which they are studying. Due to the nature of the questions (e.g. to explore, develop and determine how authentic moulage impacts on engagement), mixed-methods research is a suitable approach. Doing this allows for triangulation of results, exploration and explanation of relationships and provides hypotheses for future work. You can see the tangibility of this in later chapters; for example, the qualitative nature of the Delphi Survey 1 (Chapter 5) allowed me to inform the subsequent quantitative survey rounds. In addition to this, the complex nature of engagement and moulage would not sufficiently be explored using only one method.

- *Systematic Review*

When conducting the systematic review, I adopted a post-positivist approach. This allowed me to survey the current evidence supporting the use of moulage in simulation and to gather information regarding its use. The methods applied followed the PRISMA reporting guidelines; the full methods used can be read in Chapter 4.

- *Moulage Authenticity Rating Scale – Delphi Study*

With regard to the development of the authenticity rating scale, I took a constructivist approach – the research method is built in the sharing of perspectives and thereby influences the theory constructed, a byproduct of the relationship between researcher and participants. By using this approach, I was able to acknowledge that differences of views and alternate realities might exist depending on the setting. The method I deemed appropriate for this was to use the traditional Delphi technique a consensus technique used to explore expert views on a particular topic [150-152]. The details of methods used can be read in Chapter 5.

- *Engagement Study*

In the final experiment, an empirical study, I adopted both a post-positivist and a constructivist approach. The structure of the design allowed me to objectively identify the performance of the participants and to also make meaning of engagement in the SLE. But the research required qualitative approaches to understand the deeper experiences and behaviours of the student.

I separate the results into two categories: i) Student views on moulage, and ii) the impact of moulage on engagement.

To measure the student views on moulage, I used three measures to explore their perspectives. Using surveys, I asked for self-reporting of engagement and how involved they were in the simulation. Secondly, I asked them to rate the authenticity of moulage (using the tool described in Chapter 5). In addition to this, I interviewed them using Stimulated Recall Technique to elicit information regarding their views on their engagement, the moulage and their interaction with the scenario itself. I also explored the time it took to make treatment decisions and the clinical decision pathway they chose through means of video observation. The full methods and results are detailed in Chapter 7. To understand the impact of moulage on engagement, I utilised eye-tracking methodologies to observe their areas of focus and scanpaths. The methods and results of this study are presented in Chapter 8.

- *Participants*

For the Delphi study, I recruited participants who were experts in the application of moulage in simulation or the use of Special Effects makeup techniques (SPFX). Their experiences were relevant for contributing to the information regarding current practices around moulage and their views on how it should be used. The participant numbers were considered appropriate for the Delphi study and further discussion on this can be read in Chapter 5.

For the experiment, I selected undergraduate medical students in their 4th or 5th year of the undergraduate medical degree. These students participate in a 5-year degree, and in their 4th and 5th years are situated in clinical practice alongside their lectures and tutorials, i.e. there is a heavy clinical component. In their earlier years of study they spend their time learning procedural skills and history taking, and in their 4th year of the degree they begin participating in complex, immersive simulations. At the point in which they participated in the experiment, they had participated in paediatric and adult Advanced Life Support (ALS), and other assessment studies. A single centre was chosen to provide consistency for the implementation of the study. At the time of PhD enrolment, I was working with a simulation centre for undergraduate medical students. By the time I commenced the experiment, I was no longer working with the centre and had no conflict to contend with in terms of delivering the experiment (I had no prior relationship with the participants).

The participant numbers recruited for this study were insufficient for generalisabilty, due to the difficulties of recruitment associated with the students. Student schedules and availability of the simulation centre were inflexible (and associated costs), thereby limiting the ability of researcher to continue the study *ad nauseam*.

Ethical Approvals

Ethics approval was obtained for all studies that involved human participants. Each chapter provides a summary statement regarding this, including the approval reference.

This chapter provided a summary of the philosophical approaches to the research design and outlined considerations and rationale throughout the process. I will now present the studies completed that contribute to the body of work that comprise this thesis.

CHAPTER 4: MOULAGE IN HEALTH PROFESSIONS SIMULATION AND MEDICAL EDUCATION – A SYSTEMATIC REVIEW

1. The purpose of this work was to examine the published literature regarding the:
    1.1. Current use of moulage in simulation;
    1.2. Impact of moulage on the participants' engagement in simulation; and
    1.3. Importance of authentic moulage in simulation design

Paper: Investigating the impact of moulage on simulation engagement—A systematic review [153]

Publication Relevance to Thesis

I significantly contributed to the research in this paper, which forms the following chapter. I contributed, in the majority, to the conception and design of the project. I performed the entirety of data collection and analysis, consulting with the co-authors for their input when required. I wrote the paper and performed the edits and revisions for publication, with some assistance from co-authors with editing.

Citations to date - 8

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Review

Investigating the impact of moulage on simulation engagement — A systematic review

Jessica B. Stokes-Parish[a,b,*], Robbert Duvivier[b], Brian Jolly[b]

[a] *Department of Rural Health, University of Newcastle, 114-140 Johnson Street, Tamworth, NSW 2340, Australia*
[b] *School of Medicine and Public Health, University of Newcastle, Bowman Building, University Drive, Callaghan, NSW 2300, Australia*

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ABSTRACT

Background: Simulation Based Education (SBE) is used as a primer for clinical education in nursing and other health professions. Participant engagement strategies and good debriefing have been identified as key for effective simulations. The environment in which the simulation is situated also plays a large role in the degree of participant engagement. Various cues are staged within simulations to enhance this engagement process. Moulage techniques are used in current-day simulation to mimic illnesses and wounds, acting as visual and tactile cues for the learner. To effectively utilise moulage in simulation, significant expense is required to train simulation staff and to purchase relevant equipment.

Objective: Explore the use of moulage in simulation practice today and its influence on participant engagement.

Design: Using a systematic process to extract papers, we reviewed the literature with a critical-realist lens.

Data Sources: CINAHL Complete, ERIC, Embase, Medline, PsycINFO, SCOPUS, Web of Science, Proquest, Science Direct and SAGE.

Review Methods: 10 databases were systematically reviewed using the keyword “moulage” to answer the question “How does the authenticity of moulage impact on participant engagement?”. 1318 records were identified prior to exclusion criterion were applied. 10 articles were targeted for review, following exclusion for English language and publication between 2005 and 2015.

Results: The resulting 10 papers were assessed for quality using the Medical Education Research Study Quality Instrument (MERSQI). The majority of papers were situated in dermatology teaching, with only one nursing paper. Study participants were both undergraduate and postgraduate. Most of the studies were undertaken at a university setting. No papers comprehensively addressed whether the authenticity of moulage influences learner engagement.

Conclusions: Results were limited, yet clearly outline a widely held assumption that moulage is essential in simulation-based education for improved realism and subsequent learner engagement. Despite this, there is no clear evidence from the literature that this is the case, suggesting that further research to explore the impact of moulage on participant engagement is warranted. A number of recommendations are made for future research.

1. Introduction

Simulation-based education (SBE) is used increasingly in health professions education due to its close resemblance to the real world, the safe environment it provides and the opportunity for guided learning (Hotchkiss and Mendoza, 2001). Simulation has been identified potentially as a substitute experience where clinical practicum is unavailable, offering the opportunity to practice situations of high-acuity, low-incidence without risk of patient harm (Ziv et al., 2006; Hayden et al., 2014). Examples of simulations include simple, skills-based activities, such as hand hygiene or taking a blood pressure. SBE can be designed with increasing complexity to engage learners in a whole scenario, rather than just task training. For example, a scene where a patient collapses and the learner must respond to the situation as they would in the real world could be targeted at a final year undergraduate medical or nursing student. The delivery varies in approach, with the choice of modality driven by learning objectives (Ker and Bradley, 2010). These modalities include high- and low-tech simulators (manikins), simplistic and complex task trainers, virtual environments and augmented realities, simulated patients, hybrid simulations (combining multiple modalities) and gaming solutions. Within nursing, the majority of these modalities are used. Studies are increasingly revealing the

* Corresponding author.
E-mail addresses: Jessica.stokes-parish@newcastle.edu.au (J.B. Stokes-Parish), Robbert.duvivier@newcastle.edu.au (R. Duvivier), Brian.jolly@newcastle.edu.au (B. Jolly).

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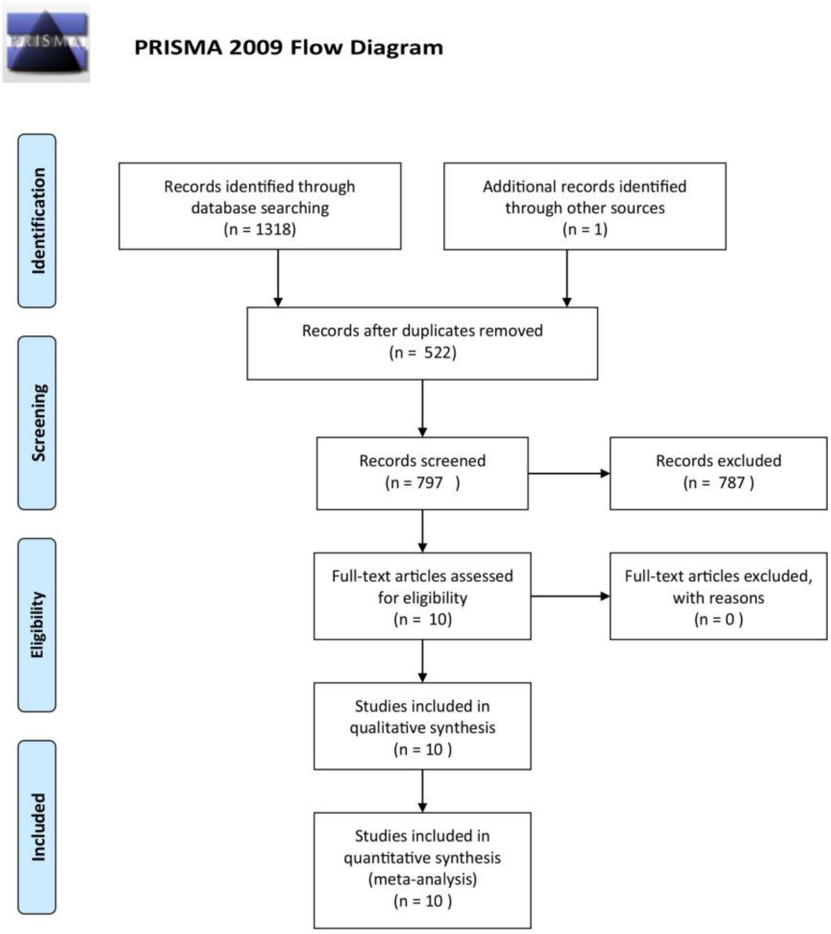

Fig. 1. PRISMA 2009 flow diagram.

positive relationship between SBE and learning outcomes (Hayden et al., 2014), however the success of simulation depends largely on the degree of participant engagement and effective debrief/feedback strategies (Hotchkiss and Mendoza, 2001; Seropian et al., 2004; Jeffries, 2005; Rodgers, 2007; Roberts and Greene, 2011; Hayden et al., 2014). This paper will explore one feature of participant engagement — moulage. Moulage is defined as the use of special effects makeup techniques to simulate illnesses, bruises, bleeding wounds or other effects to a manikin or simulated (Standardized) patient, acting as visual and tactile cues for the learner (Foot et al., 2008; Smith-Stoner, 2011; Merica, 2013).

2. Background

The environment in which the simulation is situated plays a large role in the degree of participant engagement. Engagement is derived from the French “engager”, which describes the process of “involving oneself in an activity” or to “establish a meaningful contact or connection with” (Engage, 2017). The concept of engagement is discussed in visual arts literature, with reference to the psychological concept of dual awareness (Frijda, 1988). Dual awareness refers to an individual's ability to move from the executive space (comparing constructed imagery with reality) to the entertainment space (engaging with fiction as if it were real). Engaging with both spaces enables the learner to feel they are directing their own learning — allowing the individual to safely participate in a make-believe situation (such as a simulation), with the option of ‘opting-out’ at any point (Rooney et al., 2012). Tan (2008) also hypothesises that this dual awareness enables the individual to buy in, experiencing the situation as more realistic (Tan, 2008). However, both of these concepts rely heavily on perceived reality — i.e. the scenario must have emotional believability. Tan (2008) further suggests that distracting, or unnatural, elements of an environment can disengage participant buy-in, causing individuals to rationalise the situation and thereby inhibiting emotional arousal. Rystedt and Sjöblom (2012) identified disengagements in their case study of an anaesthesia simulation, finding that any “glitches” in the representation of reality caused a disruption in participant engagement (Rystedt and Sjöblom, 2012). This connects well to Dieckmann et al.'s realism hypothesis: narrative and setting must be logical and believable. Dieckmann et al. (2007a, 2007b) posit that realism is composed of three parts: physical

Table 1
MERSQI breakdown.

Scale item		Subscale	No. (%) present (n = 7)[a]
MERSQI (maximum, 18)	Study design (maximum, 3)	Single-group cross sectional or single group posttest only (1)	57 (n = 4)
		Single group pretest and posttest (1.5)	14 (n = 1)
		Nonrandomized, 2 group (2)	14 (n = 1)
		Randomized controlled trial (3)	14 (n = 1)
	Sampling: institutions	1 institution (0.5)	86 (n = 6)
		2 institutions (1)	14 (n = 1)
		3 or more institutions (1.5)	0 (n = 0)
	Sampling: response rate	Not applicable	0 (n = 0)
		< 50% or not reported (0.5)	72 (n = 5)
		50–74% (1)	14 (n = 1)
		> 75% (1.5)	14 (n = 1)
	Type of data	Assessment by study participant (1)	14 (n = 1)
		Objective (3)	57 (n = 4)
	Validity evidence for evaluation instrument scores	Not applicable	
		Content (1)	72 (n = 5)
		Internal structure (1)	0 (n = 0)
		Relationships to other variables (1)	0 (n = 0)
	Data analysis: sophistication	Descriptive analysis only (1)	43(n = 3)
		Beyond descriptive analysis (2)	43 (n = 3)
	Data analysis: appropriate	Data analysis appropriate for study design of data (1)	71 (n = 5)
	Outcome	Satisfaction, attitudes, perceptions, opinions, general facts (1)	14 (n = 1)
		Knowledge, skills (1.5)	57 (n = 4)
		Behaviours (2)	0 (n = 0)
		Patient/health care outcome (3)	0 (n = 0)

[a] Only 7 of the 9 papers included in the study were suitable for MERSQI to be applied to.

(physically believable), semantic (conceptually believable) and phenomenal (emotionally believable) (Dieckmann et al., 2007a, 2007b). Realism in learning mandates that the reality of the environment and simulator must be contextual to learning objectives and learners, and is subject to the judgement of the participant (Ross, 1988; Ker et al., 2006; Dieckmann et al., 2007a, 2007b; Herrington et al., 2007; Rodgers, 2007; Rudolph et al., 2007a, 2007b). Realism is often substituted with fidelity (in both the literature and practice), the degree of simulator likeness to reality (Hays, 1980). More recently, fidelity has been divided into subcategories: equipment fidelity (degree to which simulator duplicates reality), environmental fidelity (degree to which simulator duplicates sensory clues) and psychological fidelity (the degree to which the participant perceives simulator reality) (Ker and Bradley, 2010). Considering fidelity and realism applied to the simulated space, could the environment itself cause a "glitch" in the engagement? For example, despite the SLE appearing as a highly realistic hospital ward, two-way glass and Perspex microphone (often used in simulations to facilitate unobtrusive observation) could serve as reminders (ergo, "glitches") of the reality, disrupting engagement in the simulation. That is, how emotionally believable it is. In learning, the concept of emotional engagement and engagement of learners is discussed by Norman (2013) and many others (Frijda, 1988; Valkenburg and Peter, 2006). They identify that the emotional impact of the experience directly relates to engagement, which in turn links to the impact on learning. The presence of emotions, as discussed earlier, allows active engagement in the activity and can enhance the process memory retention. Comparing the results of watching graphic movies to documentary-style movies, study participants memory was enhanced by the graphic movies due to the visual representation of cues, stimulating an emotional response (Cahill et al., 1996).

With these concepts in mind, one could then hypothesise that just as the apparent reality (level of authenticity) of artistic media directly impacts engagement, the apparent reality of visual cues could be vital to the engagement of learners in simulation (Frijda, 1988; Valkenburg and Peter, 2006; Grodal, 2009).

Participant engagement in simulation is enhanced by fidelity, realism, authenticity and the presence of 'cues' in the simulation setting — such as moulage techniques (Diamond et al., 2011). Recommended strategies to facilitate participant engagement in simulation include: simulation pre-briefing, participant-centred facilitation, a psychologically safe environment, use of a fiction contract and the realistic replication of the environment (Jeffries, 2005; Rudolph et al., 2007a, 2007b). Moulage techniques are used in current-day simulation to mimic illnesses and wounds, acting as visual and tactile cues for the learner (Foot et al., 2008; Smith-Stoner, 2011; Merica, 2013). Various 'special effects' makeup techniques, similar to those used in theatre or movie production, are used to add reality to the environment. Examples of these techniques include casting and moulding wounds, painting bruises or other illness effects (such as the appearance of jaundice or sepsis) onto a manikin or simulated patient (Foot et al., 2008; Smith-Stoner, 2011; Merica, 2013).

First records of moulage can be traced through written accounts and artefacts to ancient Egypt, where the appearance of the deceased was preserved (Schnalke, 1995). Initially these casts were buried with the deceased, but increasingly moulds of the face were preserved and displayed for viewing (Schnalke, 1995). At some point in the early Renaissance era, probably the 15th or 16th century, the practice of moulage in museums commenced to aid training physicians knowledge of animal and human anatomy (Schnalke, 1995; Arnold, 1999; Mattatall and Rustige, 2001). Beyond the initial accounts of moulage in Egypt, literature is sparse on it's progression, however, moulage is identified as resurfacing in French medical teaching in the 17th century. Moulage was used to depict diseases, often post-mortem to investigate cause of death and to expand anatomical knowledge. More specifically, three-dimensional objects were created using a mould of wax to develop anatomical replicas that were later painted to create closer likeness to the real anatomy (Cooke, 2010). Moulage, considered a form of art as much as a teaching aid, lost its popularity in the mid to late 20th century due to the cost of development, the closely guarded secrets of artists and the advancing development of photography (Schnalke, 1995; Mattatall and Rustige, 2001).What is left of the wax moulds is now held in various museum collections across the world (Schnalke, 1995; Mattatall and Rustige, 2001; Cooke, 2010). Nowadays, simulation facilitators attend special effects makeup training to learn complex techniques for application on manikins and simulated patients. In addition to the time and cost spent on training (2 day basic special effects make-up training course costs $500.00USD (minimum)), there is significant expenditure (roughly $400.00USD) on application

Table 2
Summary of papers.

Reference	Study design	Article type	Outcomes (test method)	Comparison intervention	Participant number	Participant type	Level of training	Clinical topic	Location
Atlas, et al.	Post test, convenience sample, single-group design	Supplement	Satisfaction survey	nil	Not reported	Healthcare providers	Post graduate	Biothreat diseases/ health management	Not specified
Foot et al.	No study design reported	Technical report	nil	nil	na	Unspecified	Post graduate	Trauma	Hospital-based
Garg et al. (2010)	Randomized group allocation, pre-test, post-test 2 group-design.	Empirical research	Knowledge, satisfaction	3D moulage	90	Medical students	Undergraduate	Dermatology	University-based
Goulart, J. M., et al.	Single group, convenience sample or randomized? Pre and post test	Empirical research	Skill: process, knowledge	Moulaged lesion	59	Medical students	Undergraduate	Dermatology	University-based
Hernandez, C., et al.	Single group, sample? Post test	Empirical research	Skill: process, knowledge	Moulaged lesion	190	Medical students	Undergraduate	Dermatology	University-based
Jain, N. M. P. H., et al.	Convenience sample, two group post-test	Empirical research	Skill: process, knowledge	Melanoma moulage models	75	Medical students	Undergraduate	Dermatology	University-based
Langley et al.	Single group, convenience sample, post test	Construct Validity study of moulaged tattoo	na	nil	95	Dermatology staff	Post graduate	Dermatology	Conference
Pywell, M.J., et al.	Convenience sample single–group, post test	Empirical research	Satisfaction survey - Validity & construct comparison	Professional moulage v unprofessional moulage	20	Unspecified	Unspecified	Burns	Unspecified
Smith-stoner	No study design	Report	na	nil	Not reported	Unspecified	Unspecified	Nursing	Not specified
Taylor et al.	Single group, post test	Commentary (construct validity)	na	nil	12	Medical professionals	Mixed	Otolaryngology	Not specified

tools and makeup to apply moulage in simulation (Rodgers, 2007; Ker and Bradley, 2010; Merica, 2013). Application of moulage amongst simulation educators and facilitators is varied in detail and accuracy of portrayal.

Against this background of the use of moulage in simulation, we investigated how the authenticity (how closely something reflects the original, or how genuine something appears) of moulage has an impact on participant engagement using a systematic review.

3. Methods

The aim of this systematic review is to explore the current use of moulage in simulation, including its impact on participant engagement and the levels of authenticity required. We hypothesise that the authenticity (how closely something reflects the original, or how genuine something appears) of moulage has an impact on participant engagement, and therefore seek to have the following question answered as a result of this review:

- How does authenticity of moulage impact on participant engagement?

3.1. Search Strategy

We used a librarian-guided search strategy to conduct the literature review. Using the PRISMA Checklist for Systematic reviews (Moher et al., 2010) as a guide, we searched ten databases (CINAHL Complete, ERIC, Embase, Medline, PsycINFO, SCOPUS, Web of Science, Proquest, Science Direct and SAGE) using Boolean combinations AND and OR for 'moulage' "simulation" "authenticity" "realism" and "fidelity", which yielded zero (0) results. Revised search terms of 'moulage' and 'simulation' still returned low (< 500 total articles) numbers of results. In consultation with the librarian, we explored other search terms, such as "makeup", "art", "special effects", with no relevant documents found. To ensure all potential fields were explored, we broadened the search strategy again (in accordance with PRISMA guidelines) to use the single term 'moulage' in abstract, title and keywords, resulting in a total of 1318 articles at 1 March 2015. The systematic review was unable to be registered with PROSPERO due to it not having at least one outcome of direct patient relevance (Moher et al., 2010).

3.2. Inclusion and Exclusion Criteria

The Inclusion criteria was set to include papers of English language, published within the last 10 years, peer-reviewed journal articles and moulage-related empirical studies. With this set of criteria applied and duplications removed, two independent reviewers (JSP, RD) undertook an initial hand search of the abstracts found in the automated search, resulting in a total of 2 articles eligible for inclusion. This number was deemed insufficient to provide a comprehensive review of current views on moulage. In an effort to capture themes regarding moulage, we (JSP, RD) revised the inclusion criteria to include moulage related studies, not limited to peer-reviewed journal articles and empirical studies. We did a snowball search of article reference lists for relevant articles to include in the study that might have been missed by the database search. A final number of 10 articles were deemed appropriate for the purpose of this study as depicted in the PRISMA flowchart (Fig. 1).

3.3. Quality & Nature of Papers

Table 2 summarises the methodological quality of included studies. To objectively measure the quality of the papers we used the Medical Education Research Study Quality Instrument (MERSQI) tool. The MERSQI was developed in 2007 to assess the quality of studies using its rating categories — study design, sampling, data type, validity of evidence, data analysis and outcome (Cook, 1964). Its validity is supported by good interrater reliability, high correlation with global quality ratings and high impact factor of journal publication. Two reviewers (RD and JSP) independently measured the quality of included articles, discussed the scores for each category and reached consensus on a score by an iterative process. Two of the included publications were unable to be scored using the MERSQI tool due to the nature of their report (technical and other reports). Only 1 of the studies was a randomized controlled trial. Some studies reported content validity (44%), however none described internal structure or relationships to other variables. All studies were single-site, with varied types of reporting (see Table 1). It was difficult to generalise results due to the varied quality and nature.

3.4. Study Characteristics

The number of enrolled participants in studies varied from 12 to 190, two (2) studies did not report on participant numbers. Participant discipline types ranged from specialist and general medical to generic healthcare providers, four (4) of which were medical students, two (2) unspecified, one (1) mixed medical professionals, one (1) healthcare provider & one (1) dermatology specialists. The level of learners were identified as mixed — four (4) of the studies were on undergraduate level trainees, four (4) were of postgraduate-focused, one (1) was mixed and one (1) unspecified the level of training. The clinical areas of the research also varied; five (5) of the studies had a clinical topic of dermatology, one (1) on trauma, one (1) on biothreat diseases, one (1) on otolaryngology, and one (1) on nursing. The location of studies was mainly university-based (4), with one (1) hospital based, one (1) at a conference and the remaining three (3) unspecified. The study characteristics are detailed in Table 2.

4. Results & Discussion

None of the studies directly set out to investigate student engagement as a result of the authenticity of moulage. Despite this, some themes can be drawn from the papers. Research by Garg et al. (2010) could be interpreted as moulage having an impact on student engagement due to the higher level of memory retention in learners (Garg et al., 2010). Garg et al. compared the use of three dimensional (3D) moulages versus two dimensional (2D) images in second year medical student teaching. Although there was no immediate statistical difference, a difference was evident at the three-month test. Further analysis of these results indicated that the 3D-group was better able to recognise lesions than the 2D-group at three months compared to baseline — "using silicone-based 3D prosthetic mimics…resulted in significantly improved immediate clinical skills acquisition…and overall performance" (Chang, 2010; Garg et al., 2010), suggesting that 3D-group was able to better retain their knowledge. In the paper, authors suggest that attitudes toward moulage was favourable, stating "the 3D method was thought to be enjoyable, effective, and authentic" (Garg et al., 2010). What could be the reason for this? Perhaps it is a result of increased realism, decreasing the participants cognitive load, allowing the participant to engage better. Or, as Norman (2013) and others suggested, if more effective learning is a direct result of engagement, perhaps the 3D-models decreased the risk of glitches in the representation of reality. (Rystedt and Sjöblom, 2012; Norman, 2013).

Hernandez et al.'s (2013) research on medical student's ability to detect melanomas in patient reviews came to similar conclusions as Garg et al. Following lecture-based education, students then had the opportunity to interview simulated patients with a moulaged melanoma. However, only 29% ($n = 56$) of students noticed the moulage — could a more engaging 3D-moulage prior to the interview lead to an improved performance? (Hernandez et al., 2013).

Similarly, along this trail of thought, both Goulart et al. (2012) and Jain et al. (2013) used 3D silicone moulages applied to simulated patients for student interviews (Goulart et al., 2012; Jain et al., 2013). The results of their research indicated an improvement in student performance when using moulage compared to lectures. Again, one might believe that the participant perception of reality was increased, and therefore engagement, leading to improved learning outcomes. The authors went as far as to say that "the clinical implication is that these are potential lives lost to melanoma that could have been prevented" (Goulart et al., 2012). Interestingly, students in Jain et al.'s (2013) study commented on the moulage being so authentic that they dismissed it as the simulated patient's own melanoma (Jain et al., 2013). This begs the question can moulage be *too* real? Perhaps the moulage was so authentic that participants were unable to differentiate between the executive and entertainment spaces, thereby restricting learning (Frijda, 1988; Tan, 2008). Perhaps the participants are accustomed to the highly unrealistic appearance of manikins and task trainers and this caused a glitch in their learning (Rystedt and Sjöblom, 2012)? However, given the lack of detail in instructional design, it is unclear from the paper what type of briefing and orientation the learner had prior to engaging in simulation. Was there instruction on the boundaries of the 'game'? Maybe the dismissal of the moulage was a result of lack of briefing for simulation, that is, the proper steps were not taken so that participants could engage — as opposed to directly related to the physical representation of engagement.

The research discussed varied levels of authenticity pertaining to moulage, with only Langley et al. (2009) deliberately setting out to assess the validity of moulage as the purpose of the research (see Table 2 for summary of construct validity) (Langley et al., 2009). Though there was no specific reference to the term authenticity, the word realism could have been used to indicate levels of authenticity. The results indicated that the moulage designed was highly realistic — as rated by dermatology specialists. Based on the assumptions about engagement and learning, one would assume that the transfer of learning would be increased as a result of increased realism and authenticity. Langley has yet to validate the transfer of learning relative to this realism, however rates the opportunity highly, stating "the learner will be engaged a realistic clinical situation"(Langley et al., 2009). Other research into moulage in simulation-based education discusses how moulage is a key element that is under-investigated in research (Foot et al., 2008; Smith-Stoner, 2011). Referencing Wikipedia for the definition, Foot et al. (2008) identifies a technique to design a wound and suggests that adding visual basics to an environment creates additional realism (Foot et al., 2008). Foot et al. (2008), however, does not discuss authenticity or its impact on the learner. Citing anecdotal feedback from participants (undergraduate nursing students) in the paper and no further empirical research, the author concludes that moulage is an "educational tool in its own right" (Foot et al., 2008). Hernandez et al. (2013) noted briefly that the moulage was deemed authentic by an individual dermatologist, though the authenticity was not the focus of the study (Hernandez et al., 2013).

In the research by Garg et al. (2010), they noted their limitation to the study was a lack of validation of the authenticity of the moulaged prosthesis — "prosthetic lesions were of higher fidelity than were eruptions, and this may, in part, account for why students performed better with prosthetic lesions" (Garg et al., 2010). Similarly, Goulart et al. (2012) commented that the lack of authenticity was a limitation of the study, with no validation of the moulage included in the methods (Goulart et al., 2012). Jain et al. (2013) assessed validity of the moulage by comparison to images of actual melanomas and independent review by dermatologists (Jain et al., 2013). Foot et al. (2008), Atlas et al. (2005), Taylor and Chang (2014) and Smith-Stoner (2011) did not discuss the authenticity of moulage (Atlas et al., 2005; Foot et al., 2008; Smith-Stoner, 2011; Taylor and Chang, 2014).

5. Conclusion & Recommendations

In review of the included literature, we found it difficult to extract clear evidence. We were unable to clearly answer the question of how the authenticity of moulage impacts on participant engagement. There are several reasons for this.

Firstly, there was very little literature. With only nine papers to review, it was difficult to generalise results and provide clear recommendations for the future design of simulations including moulage. As outlined in the methods, a broad range of databases were searched, including non-health disciplines, such as military and other industry-based simulation users. Given the small number of results, one must ask, why have we, educators, not yet considered the authenticity of moulage within simulation? Why are we yet to explore moulage in instructional design and the level of authenticity required to produce optimal learner outcomes? The research mainly focused on medical education, with only one identified as nursing specific — yet, the assumption in this paper was that moulage was important for student engagement.

Secondly, most of the research was poorly constructed. As summarised in the discussion on quality and nature (Table 2), the relevant studies were small and mostly limited to single-site, often with very little comparison or quality data (e.g. Limited to post experiment surveys of participant). We also noted that the majority of research was limited to dermatology teaching. Is this due to moulage only being critically relevant in dermatology? Perhaps the return on investment in dermatology is higher than other areas of clinical practice?

Finally, in addition to the research designs being poorly constructed, the studies were not replicable. Approaches appeared incomplete at times, creating confusion for the reviewers. It was not clear how the studies could be replicated in larger format, nor was there link to theoretical frameworks. Key elements regarding the delivery of simulations were left out, without enough information to clearly repeat studies for generalisation across broader fields.

We were unable to confidently answer the research question "how does authenticity of moulage impact on participant engagement?", thereby unable to provide recommendations for the use of moulage in simulation. Future directions for research in this area might include mixed-method studies exploring if and how moulage influences participant engagement and assessing what level of authenticity is required in the replication of moulage to achieve optimal engagement. Methodology such as eye-tracking might reveal 'glitches' or areas of disengagement for participants. A rating scale for realism or authenticity could be useful to objectively measure the authenticity of moulage, therefore enabling researches to examine the relationship between moulage and engagement. It would also be interesting to assess the differences (if any) between types of participants — such as discipline (e.g. nursing versus medicine), level of learning (e.g. first year student versus New Graduate) and types of specialties (e.g. wound nursing versus oncology nursing).

In summary, although difficult to obtain, the resulting papers clearly outline an assumption that moulage is essential in simulation-based education for improved realism and subsequent learner engagement. Despite this, there is no clear evidence from the literature that this is the case. As a result of this review it is apparent that further research is warranted in regards to the authenticity of moulage and the impact on learner engagement and subsequent transfer of learning.

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Glossary

Moulage: A technique applied in simulation that mimics illnesses, wounds and other ailments to enhance realism

Realism: A concept referring to the degree of likeness between simulation/simulator/environment and actual reality.

Fidelity: http://www.ssih.org/Portals/48/Docs/Dictionary/simdictionary.pdf

CHAPTER 5: EXPERT OPINIONS ON THE AUTHENTICITY OF MOULAGE IN SIMULATION

The purpose of this work was to explore expert opinions on moulage authenticity to:

2. To develop a theoretical system of classification in moulage to depict or reflect 'authenticity'

Paper: Expert opinions on the authenticity of moulage in simulation: a Delphi study [98]

Publication Relevance to Thesis

I significantly contributed to the research in this paper, which forms the following chapter. I contributed, in the majority, to the conception and design of the project. I performed the entirety of data collection and the significant majority of data analysis, consulting with co-authors on occasion when the data analysis need verification. I wrote the paper and performed the edits and revisions for publication, with some assistance from co-authors with editing.

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Advances in Simulation

RESEARCH Open Access

Expert opinions on the authenticity of moulage in simulation: a Delphi study

Jessica Stokes-Parish[1,2*], Robbert Duvivier[1,3] and Brian Jolly[1]

Abstract

Background: Moulage is a technique in which special effects makeup is used to create wounds and other effects in simulation to add context and create realism in an otherwise fabricated environment. The degree to which moulage is used in the simulated environment is varied; that is, there is no guide for how authentic it is required to be. To objectively assess whether a higher level of authenticity in moulage influences engagement and better outcomes, a common model to assess authenticity is required. The aim of this study was to explore expert opinions on moulage in simulation and develop an instrument for the classification of moulage in simulation.

Methods: The instrument was developed in 3 phases: expert panellist recruitment, domain identification, and consensus rounds. A Delphi technique was used to explore themes of authenticity using Dieckmann's Theory of Realism as a frame of reference. An initial list of elements was raised by a panel of international experts. The experts participated in a further four rounds of questioning, identifying and then ranking and/or rating elements of authenticity in moulage. A priori consensus threshold was set at 80%.

Results: In round 1, 18 of 31 invited panellists participated, and a total of 10 completed round 5 (attrition 44%). As a result of the Delphi, the Moulage Authenticity Rating Scale was developed. Under the three domains of realism, 60 elements were identified by experts. A total of 13 elements reached the consensus threshold, whilst tensions regarding the necessity for authentic moulage were identified throughout the rounds.

Conclusion: This study demonstrates the complexity of moulage in simulation, with particular challenges surrounding the experts' views on authenticity. A prototype instrument for measuring moulage authenticity is presented in the form of the Moulage Authenticity Rating Scale (MARS) to further aid progress in understanding the role of authentic moulage in simulation.

Keywords: Authenticity, Engagement, Instructional design, Instrument, Moulage, Simulation, Special effects makeup, SPFX

Background

Simulation is used in a wide range of disciplines, including healthcare, education, and other industry sectors (such as defence, mining, and engineering). It serves as an opportunity for practice where particular situations are not common or unsuitable/unsafe for practice [1, 2]. The success of simulation is largely dependent on instructional design and effective debrief techniques [3–5]. Key elements of instructional design include using appropriate fidelity to evoke realism [6]. Fidelity is thought to encompass physical, conceptual, and psychological components of simulation and is a topic of polarising discussion in the simulation community. Similarly, realism is suggested by Dieckmann (2007) as the degree to which a participant perceives reality in physical, semantical, and phenomenal aspects of reality [7]. Briefly, these modes of reality describe the actual physical components of reality such as the physical components of a manikin, and the semantical component of realism describes a conceptual kind of realism—for example, if bleeding occurs, a low blood pressure will result—and, finally, the phenomenal mode of realism. This kind of realism describes an emotional process, e.g. is the situation believable? [7]. The fiction contract is used to jump the hurdle of simulated realities, expecting that participants do the hard work of choosing to engage. The simulation

* Correspondence: Jessica.stokesparish@gmail.com
[1]School of Medicine & Public Health, University of Newcastle, Newcastle, NSW, Australia
[2]Department of Rural Health, University of Newcastle, Newcastle, NSW, Australia
Full list of author information is available at the end of the article

community places importance on creating a level of realism, as noted in various literature [8, 9]. Encompassed in these broad aspects of 'realism' in simulation, are cues and set-up—thought to be essential for participant engagement [10, 11]. One kind of cue that contributes to physical realism is moulage.

The term moulage is used to describe special effects makeup (SPFX) and casting or moulding techniques that replicate illnesses or wounds [12]. Moulage has a long history in health professions education and anatomical teaching [13, 14]. Today, the techniques of moulage can include using make-up for bruising, creating wounds with wax, painting latex to achieve burns, and adding smells to the simulated environment. It can be costly to use these techniques, with specific training and equipment potentially required to effectively use moulage. It could be argued that moulage is only a physical component of realism; however, it may be also semantic and phenomenal. For example, moulage would presumably be a cue that assists a participant to move from A to B (semantical realism) and could aid in believability or emotional buy-in (phenomenal realism).

What does the literature say about moulage?

Until recently there has been no attempt to explore the place of moulage in simulation other than accepting the status quo; evidence for moulage mainly focuses on instructional "how-to" guides and historical accounts in dermatology [14]. A recent systematic review explored the effectiveness of moulage on engagement in simulation, highlighting the paucity of credible research on moulage [12]. The research highlighted the disparities in use across disciplines, industries and simulation centres, identifying there was no evidence to support the need for moulage in simulation [12, 15]. Since the publication of this systematic review and after a moulage "call to arms" [14], Mills et al. (2018) demonstrated that the use of "highly realistic" moulage versus no moulage improved immersion in paramedicine students [16]. Novel research in the field of radiography identified students' preferences for realistic moulage, with students commenting "... couldn't tell it was makeup at first. Which I thnk [sic] is better as it looks more realistic ..." [17]. Other research suggests that moulage improved realism; however, the quality of moulage was purportedly challenged by the lack of time to apply moulage [18].

The term highly realistic, or realistic, is used frequently to create a distinction in simulation realism and in simulation manikin marketing [16, 19–21]. Despite this, there is no clear definition of what constitutes realistic. In fact, many educational outcomes papers that discuss the comparison of highly realistic or high-fidelity versus their low counterparts do not provide measures to define these classifications. For example, in Mills et al.'s (2018) study described earlier, there was no measurement to quantify "highly realistic"; however, in a study on burns training, Pywell et al. (2016) assessed the face validity of moulage in a comparison study for burns training [22]. In dermatology, authenticity of moulage rates highly due to the high-stakes conditions of diagnosing melanoma and other skin conditions [23–28]. In the field of gynaecology, researchers developed a rating tool to determine realistic simulator design [19, 22]. This is particularly interesting, given the inconsistency in industry approaches to designing simulators appearance—for example, Laerdal SimMan 3G versus LifeCast Adult Male Manikin versus CAE Healthcare Apollo (See Fig. 1). These manikins have varied levels of authenticity in their appearance—LifeCast, for example, employs SPFX teams to replicate the life-like appearance of manikins, including realistic skin and other details.

Some simulation designers and users argue that a high level of accuracy in the portrayal of moulage is necessary for the effectiveness of simulation; however, absolute authenticity is questioned in the current literature [9, 29, 30]. How does the use of moulage change the approach to instructional design of simulation? Before exploring its impact on instructional design, and then simulation participants, we posit that we must first understand what constitutes moulage authenticity. What is good moulage? And what, therefore, is bad moulage? How much time and money can one justify spending on moulage, when the cost-effectiveness of simulation is a priority for institutions and education [31]. We identified authenticity as a priority area for research in the use of moulage in health professions simulation [14], prior to exploring the many other possibilities in engagement, instructional design, and other areas of interest.

Aims

This study aimed to develop an expert-generated instrument that defines moulage's authenticity in simulation practice.

Methods

The study was approved by the University of Newcastle Human Research Ethics Board (H-2016-0326).

Regarding the application of moulage, there are many techniques and moulage is used across multiple disciplines (within health, military, and other industry-based activities) across the world. For this research, we focused on healthcare simulation. To mitigate these challenges, a group consensus technique such as the Delphi method is capable of distilling expert opinion on key elements constituting moulage authenticity. The Delphi method is particularly flexible with achieving consensus through the use of electronic surveys to participants across the world, whilst maintaining anonymity [32]. In this section, we will

Fig. 1 Comparison of manikin appearance

outline the methodology employed to deliver the Delphi consensus method.

Panellist selection

We sought to recruit a representative sample of experts with first-hand knowledge of moulage. An individual was classified as an expert if they worked with direct involvement in simulation instructional design and implementation (in particular, moulage), or as an experienced SPFX artist, involved in creating moulage or arts in anatomy. This wide-ranging sampling approach is supported by literature on Delphi technique to achieve high-quality outcomes [33, 34]—we chose to keep this broad due to the lack of evidence for moulage in the literature. Individuals were excluded from the study if they had no expertise in moulage/SPFX design or application, or, they had no expertise in the instructional design of simulation. The researchers screened participant responses for exclusion.

Panellists were identified via purposive sampling method to ensure adequate representation across geographic and educational variances (see Table 1). JSP approached simulation societies, journals and authors of papers that included moulage, and identified recommendations for expert participation, in addition to Google and LinkedIn searches, and via a snowballing technique informed by our previous Systematic Review [12] (Additional file 3). Literature does not provide clarity or consensus on the appropriate size of panels for a Delphi study; however, method experts recommend taking into account the number of experts in the subject area and the likelihood of completing the survey rounds [32]. In this study, nominees were individually contacted electronically, with requirements, study details and ethics approval outlined with a link participate in the first round. Each individual was allocated a unique identifier so they would remain anonymous to each other throughout the process, but identifiable to the researchers for administration purposes.

The listed societies, editors, and authors assisted in the recommendation of panellists, resulting in 31 individuals being invited to participate. Eighteen responded to the invitation to participate (58%), with a total of 10 panellists remaining at the closing round (an attrition rate of 44%) (Table 2). Efforts were made to minimise attrition by clearly outlining the expected timeframes, priori consensus, and simple technology use [35].

Element generation

We used the typical Delphi method whereby the authors presented a series of open-ended questions to the experts to generate the initial elements [33]. The authors developed the round 1 questions using Dieckmann's Theory of Realism as a conceptual framework [7]. In response to the need to understand moulage, we identified Dieckmann's theory as an appropriate fit for developing a theoretical framework for moulage. This is because realism is contextual to both the environment and learning objectives, yet is subject to the participants' judgement. Realism, in this theory, is composed of three domains—physical, semantic, and phenomenal. Physical realism refers to the actual physical representation, such as the characteristics of moulage, its textures, and colours; that is, how persuasive is the authenticity in your perception of reality [7, 14]. The semantical mode of realism refers to a conceptual type of realism, it is more about a participant's relationship with the activity or story. That is, can s/he relate to the story? Is the representation plausible, could it occur in real life? In this

Table 1 Participant location and expertise

Geographic location of panellist	Expert panel roles	Expertise level (self-rated)	Highest degree held by expert	Frequency of moulage use
USA [7]	Moulage	Beginner (0)	No degree [2]	Daily [7]
Australia/New Zealand [6]	Expert/technician [11]	Intermediate [10]	Certificate [2]	Weekly [8]
Canada [3] UK [2]	Instructional designer [8]	Advanced [8]	Diploma [3]	Fortnightly [1]
	Simulation instructor [4]		Bachelor [4]	Monthly (0)
	Special effects expert [1]		Masters [6] PhD [1]	Occasionally [2]

Table 2 Panellist participation

Activity	Number
Invited to participate	31
Round 1	18
Round 2	15
Round 3	13
Round 4	12
Round 5	10

instance, the moulage may not be authentic, but by way of the 'fictional contract' it is enough to help you regard it as authentic and predict what might happen next. For example, "if A occurred, B will happen"; Dieckmann et al. (2009) use the example of haemhorrhage—bleeding occurred; therefore, the blood pressure will decrease. *How* the information is shared is irrelevant, if interpretable information is shared. Finally, the phenomenal mode of realism is an emotional realism; engagement is reliant on your involvement in the situation and how persuasive it is to you, overall. Participants engage with the activity as if it were the real experience because they are emotionally engaged. For example, the moulage authenticity may be variable, but they engage with the narrative and situation because it makes sense to them.

This framework of realism creates the basis for starting our discussion on moulage in simulation, with attention to how moulage and engagement might interrelate. The use of Dieckmann's Theory of Realism presents a novel approach to exploring moulage, operationalising an otherwise theoretical approach to realism in a practical way. Throughout this research, we framed our questions, interpretations, and analysis on this theory.

Data collection tool

Data was collected using Survey Monkey, a secure, encrypted web-based electronic questionnaire system [36].

Delphi procedure

The survey was presented to the experts in multiple iterative rounds via the survey host (Survey Monkey) in late 2016. In the first round, designed to identify the basis for generating the elements of authentic moulage. Instructions for completing the Delphi and the surveys were shared with the panellists, followed by demographic questions regarding the participants, as well as a series of open-ended questions, and a request to list at least three elements that contribute to the appearance of moulage being real (Additional file 4). The questions were grouped into the three categories of Dieckmann's realism—physical, semantic, and phenomenal. Statements regarding physical, semantic, and phenomenal realism were continually presented to the panel in subsequent rounds. In round 2, the elements identified in round 1 were thematically analysed by the researchers together (JSP, BJ) to group common themes. The themes were presented in round 2 in question format, seeking agreement via 5-point Likert scale (strongly agree to strongly disagree) as to whether the elements contribute to the appearance of moulage being real (e.g. "Colour is an element that contributes to the appearance of moulage being real"). Participants were requested to rank their top 5 elements out of the 14 physical elements. In round 3, providing feedback from round 2, the questions were re-framed to seek a rating of importance. Once the consensus threshold was reached on an element, it was removed from further rounds of questioning. The same process was repeated in round 4 and round 5. Total consensus on every element was not reached; therefore, the Delphi closed after the fifth round as per the priori consensus. In all rounds, experts were given the opportunity to add additional background, suggest revisions or additions via the use of free text boxes in the survey instrument. A flowchart of the process followed can be seen in Fig. 2.

Priori consensus

In line with recommendations for Delphi technique methodology, a priori consensus was set at 80% or five rounds of surveys, whichever was sooner. The data was analysed using Microsoft Excel (Version 15.33). The results were shared in each round with the respective question.

Results

Initial elements generated

In round one, a total of 60 elements were raised as contributing to the authenticity of moulage (Additional file 1). Of the 60 elements presented by the experts in relation to the appearance of moulage, the most common element of physical authenticity was "colour" (n = 11). Coming in at second, was likeness to real world. The elements generated were grouped into common themes, resulting in the population of 17 elements generated in round 1 (see Table 3).

In round 2, panellists were asked to rate their agreement with the statements presented and rank their top five (5) elements of physical authenticity. To calculate the mean rank of items, the sum of answers was divided by the number of panellists, minus the missing data. Likeness to real world was overwhelmingly highest ranked, with 87.5% of respondents ranked this element in the top 5. It was followed closely by "anatomical correctness" (62.5% ranked in the top 5), "position" (50%), "colour" (62.5%), and "detail" (68.7%) (see Table 4). Some items scored very closely or within the mean ranking numbers listed below, such as "scale" and "texture". However, we analysed that these had significantly higher

Table 3 Common elements in round 1

Common elements generated in round 1 (n = number of times listed)
Colour (11)
Likeness to real world (7)
Texture (6)
Position (4)
Smell (4)
Blend (3)
Depth (3)
Feel (3)
In conjunction with setting (3)
Size (2)
Shape (2)
Relevant/logical (2)
Not over done (2)
Consistency (1)
Scale (1)
Detail (1)
Sound (1)

missed answers and therefore less votes, meaning that the weight of the response was lower.

In addition to the listing of elements contributing to physical authenticity, panellists were asked to comment on what level of authenticity is required for the moulage to be conceptually believable (semantic realism) and how moulage contributes to choices (phenomenal realism). Seventeen elements presented were in relation to semantic realism, and 16 elements were in relation to phenomenal realism. After combining common elements, there were 15 and 9 resulting elements, respectively.

Subsequent rounds

In round 3, we reframed the questions to rate the level of importance of each element to better understand the consensus view. The elements that reached consensus early were clear: "likeness to real world", "anatomically correct", "position", and "detail". Table 5 provides a full summary of the results of each element.

Throughout the rounds of questioning, the experts were invited to provide further comments to explain their answers or add to the discussion. With little theoretical underpinnings for moulage in simulation, the discussion amongst the experts contributed new ideas and concepts to the approach to the use of moulage. Early on the panellists identified the priority for realistic moulage. Examples of responses include

"the more realistic a situation or environment is, the more believable it will be for the learner and the easier it will be to engage". (Participant 15: Intermediate Moulage Expertise, USA).

"There definitely needs to be a relatively high level of authenticity so that the learners 'buy in' to the scenario. If the learners deem the scenario unrealistic, they will not engage fully, and get nearly as much out of it, as they would if it was more realistic." (Participant 2: Intermediate Moulage Expertise, Australia).

"... Obviously the higher the level of realism the more engagement of the learner ...." (Participant 3: Advanced Moulage Expertise, USA).

In describing the necessity for authenticity, experts identified that realism is learner dependent:

"... For example a red cloth could symbolise blood in a scenario if the learner is willing to believe that the red cloth is to be interpreted as blood. ..." (Participant 18: Advanced Moulage Expertise, USA).

"Some novice students can engage in low fidelity simulations as they are not yet equipped to process information under pressure. For the more experienced, scenarios resembling reality as closely as possible are advantageous." (Participant 16: Intermediate Moulage Expertise, Australia).

The thoughts from the experts regarding the necessity of authenticity presented some interesting tensions. Firstly, they felt that the accuracy of moulage directly relates to the relevance of the scenario, contributing to diagnoses and behaviours. Secondly, they felt that moulage that was not authentically portrayed can be confusing.

"the visual effect must be similar to the lived experience as this allows the student to connect the dots and transfer concepts and theory to practice", (Participant 4: Intermediate Moulage Expertise, Canada).

"Bad or excessive moulage can be worse than none as it can remove the focus away from learning to 'gazing' at the theatrical aspects as an independent entity. Can be used by some learners as an excuse for poor performance - 'it was naff and not anything like real life so I

Table 4 Top five elements by mean ranking

Element	Number of respondents who ranked item (%)	Mean ranking
Likeness to real world	14/16 (87.5%)	1.43
Anatomical correctness	10/16 (62.5%)	2.30
Position	8/16 (50%)	2.50
Detail	11/16 (68.7%)	3.09
Colour	10/16 (62.5%)	3.70

Table 5 Results of rounds 3–5

Element	R3 (%)	R4 (%)	R5 (%)
Colour	77	83 threshold met	–
Size	23	66	100 threshold met
Consistency	31	50	68
Position	85 threshold met	–	–
Depth	15	17	55
Shape	49	66	100 threshold met
The feel	62	67	44
Smell	46	41	33
Scale	54	59	67
Texture	31	59	55
Detail	85 threshold met	–	–
Sound	23	25	33
Likeness to real world	100 threshold met	–	–
Anatomically correct	93 threshold met	–	–
The moulage fits logically within the scenario	100 threshold met	–	–
The moulage is presented as a part of props/scene	84 threshold met	–	–
The moulage is at a sufficient level so as not to distract/confuse the participant	92 threshold met	–	–
Good facilitation can mitigate low realism	69	75	77
Simulation orientation can mitigate low realism	61	66	89 threshold met
The moulage is well-timed, where appropriate	92 threshold met	–	–
The moulage fits with the scenario	100 threshold met	–	–
The moulage makes use of all senses	76	66	78

couldn't apply myself like real life'", and (Participant 7: Intermediate Moulage Expertise, Australia).

"The more realistic looking and feeling the moulage allows trainees to become more invested" (Participant 13: Advanced Moulage Expertise, Australia). However, the issue of cost and time became a central point of discussion—some experts described the use of cue cards (with written cues) instead of moulage. The final instrument can be viewed as Additional file 2.

Discussion

We performed an international Delphi study that led to 13 indicators for moulage authenticity. To our knowledge, this is the first detailed expert identification of indicators of moulage authenticity.

Clear agreement on elements such as colour, likeness to real world was different to size and shape, for example. In these instances of meaning making with "size" and "shape", the element initially appeared to have no agreement and in later rounds reached agreement. The reason for this is not entirely clear, but could be due to the attrition in the rounds. That is, perhaps the experts who had a view of disagreement dropped out of the study; therefore, the resulting "consensus" may not be representative of the initial group. Another point of view might be that the areas of clear consensus (likeness to real world, colour, etc.) were identified very early on, and perhaps these other elements were areas of "emerging" consensus. That is, now that the clear winners were removed, the grey areas could be adequately considered by the experts. We argue that there is confidence in the answers due to the ranking process implemented in round 2. The top five (via mean ranking) clearly correlate with the items reaching consensus in the latter rounds.

On exploring the importance of the top five elements, we were unsurprised to see "likeness to real world" as the area of priority. The consensus on "appearance", "feel", and "anatomical accuracy" are consistent with research on simulator realism [19]. Interestingly, one might argue that likeness to real world is a proxy term for authenticity. If so, the implication is not insignificant. If likeness to real world is rated as the single most important element of moulage, does this then mean that authentic portrayal of moulage is necessary, hands down? Considering Dieckmann's realism, physical, semantic and phenomenal the element of authenticity directly relates to the physical aspect of realism [7].

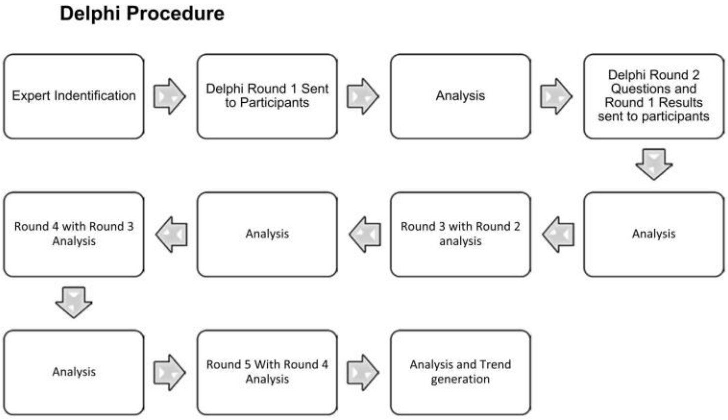

Fig. 2 Delphi procedure

However, it stands to reason that there is a direct relationship between authentic physical portrayal and the semantic and phenomenal aspects of realism. A more authentic portrayal of the semantical element might enable an easier leap from "A to B" and a more emotional "buy-in" for the phenomenal realism. Realistic moulage improves immersion (phenomenal realism), but may negatively affect clinical performance; however, in this research there is no measurement of the realistic portrayal of moulage [16]. Moulage rates higher in face validity when applied by a trained make-up artist versus a simulation technician, but did not appear to hinder performance [22]. In our conceptual work, we suggested that perhaps moulage could be a conceptual representation of reality; however, the use of the term likeness to real world and its rating of importance might suggest otherwise [14]. Hamstra et al. argue that simulators should be assessed on how closely they resemble real life (physical resemblance) and how closely the simulator functions like a real human would (functional task alignment) [30]. If applied to moulage authenticity, then the likeness to real-world aspect is relevant to the purpose at hand. For example, if a trauma scenario is presented with the purpose of training undergraduate medical students how to conduct primary and secondary assessments, whilst maintaining situational awareness, we would argue likeness to real world is relevant for the purpose of learning. If moulage is not authentic, the learner might dismiss the relevance or assume it is not important.

Another perspective when considering the authenticity of moulage is the Theory of the Uncanny Valley (Fig. 3), whereby the pursuit of authenticity in robotics and avatars created a sense of fear instead of engagement—it looks familiar, yet it is simultaneously strange [37, 38]. This theory proved that the inconsistency in the realism portrayed caused individuals to have internally conflicted opinions about perceptual persuasiveness. If applied to authentic moulage, perhaps authenticity is relative to the surrounding environment. For example, the moulage might be more "strange" when applied to a mannequin, as compared to a Simulated Patient (a real person trained to portray a particular illness or effect) [39].

A discussion regarding authentic moulage is timely. How would a framework for moulage authenticity apply to our practice? Firstly, we suggest that understanding moulage with a theoretical lens would add weight to the importance of its application in simulation. Sentinel work on simulation foundations either identifies moulage as a side note or does not included it in the discussion of realism at all [8]. Secondly, by using this instrument, simulation might be assessed in more measurable ways, enabling designers to make conclusive decisions about the application of moulage in their simulation design. An extension of this might include its use as a marker of authenticity when using simulation as a form of assessment, potentially improving the validity and transferability of the simulation-based assessment. Additionally, we suggest that the authenticity rating could be applied to the comparison of manikins and their appearance, or in comparison of manikins and simulated patients, further extending our understanding of the use of manikins and simulated patients.

Limitations

The research did not include experts from South America, Africa, or Asia. We are unsure if this was due to the

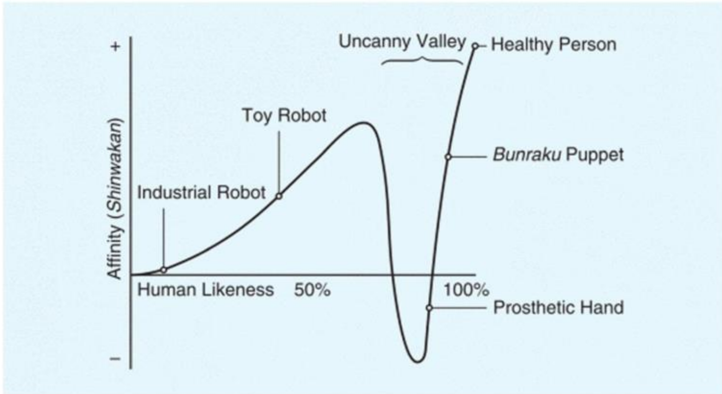

Fig. 3 The Uncanny Valley (Mori, 1970)

methods employed or the patterns of research in those continents. Purposive sampling was selected as the method due to the increased likelihood that panellists selected possessed the necessary expertise. Perhaps this reflects the level of maturity of simulation in these continents, whereby research centres, journals, and attendance is not as predominant as in western societies. Additionally, it is worth considering the bias that might be inadvertently demonstrated by publishing bodies—it is known that the majority of authors in high-ranking medical education journals, for example, are from 5% of the world [40, 41].

Despite planned administrative processes and clear objectives, the administration of this Delphi was time-consuming [42]. This led to a delay in some of the survey deployments, which may have contributed to the attrition rate. Despite this, the attrition rate is not too dissimilar to other Delphi work—the larger the panel, the greater the attrition [43]. Some of the attrition may be attributed to a lack of interest or expertise (for example, the SPFX artist dropped out after round 1).

Additionally, the lack of information regarding moulage may have contributed to the need for the full five rounds of questioning and the lack of consensus. Perhaps the paucity of research around moulage and the absence of a theoretical framework contribute to the contradictory views and the lack of consensus on some issues. We would argue that, similar to Mullen (2003), a multiple "correct" answers are better than a "unanimously agreed wrong answer" [43].

As for other limitations, we do not present findings of a content validity study in this paper. This work is not included as we felt it would detract from the discussions raised by the experts and falls outside the scope of this study.

Future directions and conclusion

The potential for authenticity and moulage remains largely unexplored. Experts on moulage present thoughtful ideas as to how moulage might contribute to realism in simulation and what authentic moulage might mean in this context. The development of this instrument presents an opportunity to measure the impact of authentic moulage on various aspects in simulation. To verify the instrument's representativeness, content validity should be assessed by means of an expert survey. Additionally, there is a need to assess the reliability could be verified in a series of trials, whereby moulage elements with a range of authentic and inauthentic features would be rated for authenticity by simulation experts, clinicians, and students. Additionally, the fit of this instrument across other domains, such as augmented, virtual, or mixed realities, could benefit the wider simulation community.

Further areas of exploration might include the comparison of junior versus senior learners, exploring how the approach to simulation context and cues differs. This could be done applying the moulage instrument to create clear distinction between high and low authentic moulage.

This paper presents novel work in the field of both authenticity and moulage. Tensions remain present in regard to the necessity of moulage, how it is applied and the level of authenticity required to be portrayed in a variety of settings. There is a clear imperative to explore authentic moulage further to benefit the simulation community.

Additional files

Additional file 1: Elements identified in round 1 of Delphi. (DOCX 99 kb)
Additional file 2: Moulage authenticity rating scale (MARS). (DOCX 64 kb)
Additional file 3 Round 1 Survey Content. (DOCX 22 kb)
Additional file 4: Recruitment. (DOCX 55 kb)

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Authors' contributions
JSP designed the initial study, carried out the full study, analysed the data, and wrote the majority portion of this paper. RD and BJ contributed to the study design, reviewed and contributed to the paper. Additionally, BJ assisted with the analysis of the data. All authors read and approved the final manuscript.

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Availability of data and materials
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request. Initial data generated or analysed during this study are included in this published article—"Additional file 1".

Ethics approval and consent to participate
Please see the manuscript for full details on ethical approval gained by the HREC body of the University of Newcastle.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Author details
[1]School of Medicine & Public Health, University of Newcastle, Newcastle, NSW, Australia. [2]Department of Rural Health, University of Newcastle, Newcastle, NSW, Australia. [3]Parnassia Psychiatric Institute, The Hague, The Netherlands.

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Additional File 1 – Elements identified in Round 1 of Delphi

1. My specialty is wounds so they must look like the wounds seen in practice,
2. they must mimic characteristics and
3. blend into the skin or manikin
4. Colour
5. Size
6. Consistency
7. Position
8. Appropriate relation to the regional anatomy and physiology. The correct size of bone for the injured area for example.
9. Depth and shape. A three dimensional wound or area of involvement presents a more realistic cue to the student especially if the objectives of the simulation involve analysis of diagnostics in order to develop a plan of care. A raised mole or an infected wound with tunneling for example.
10. The moulage is logical for the case.
11. In other words not moulage done just for the sake of doing it or a wow factor.
12. Looks like,
13. smells like and
14. feels like the real thing
15. scale,
16. colour,
17. texture
18. Texture/Depth,
19. Color and
20. Detail.
21. Likeness of bodily fluids to real fluids especially blood;
22. match of items to story presented;
23. presented as part of other props/scene setting
24. The dirt, blood, pus of any drainage adds to the realism There is always some redness to the areas involve from slight to more intense
25. Coloring of the wound, sore scare e.c.t needs to needs to be as close as possible
26. The application of a wound, scar, sore edges need to be flush with the surface in order to look like part of the skin
27. texture
28. colour
29. smell
30. Interactive training experience that mimics realism.
31. Sensory utilization
32. Simple to defined wound development
33. Knowing what you are creating on a mannequin or person looks like in real life. It is vital to visualize from pictures or an actual wound what it is you are trying to replicate.
34. Less is more. Starting small is a key element when creating any type of wound. Over doing your work takes it away from the realistic to a science fiction element.
35. Using the right materials. Matching skin color and what a real live wound looks like is majorly important to develop realism for the learning. Example, high shadow

(blue) can provide the depth to a bruise but if it is frosted and creates a glimmer in the light, that's not real. In the end it takes PRACTICE before using any material in a simulation.

36. Colour
37. Shape
38. Texture
39. Use of products that are realistic looking (ie skin colour and wound colour matching)
40. Use of products that are realistic feeling.
41. Design of moulage that is based on clinical fact (ie use clinical photographs).
42. Color,
43. texture, and
44. positioning all contribute to the realism of moulage and increase the fidelity of the simulation.
45. Environment,
46. texture, context,
47. sound,
48. smell,
49. feel
50. Matches the learners expectation of realism
51. Blends in seamlessly with the narrative/story
52. Not obviously make-up
53. Knowledge of real wounds then duplicate them.
54. The amount of blood
55. the textures colors and
56. thickness of wounds and
57. thickness of blood and smells
58. Appropriate color,
59. size and
60. placement

Supplementary File 2 - Moulage Authenticity Rating Scale (MARS)

Element	**Low Authenticity 0**	**Mid Authenticity 1**	**High Authenticity 1**
Colour			
Size			
Position			
Shape			
Detail			
Likeness to real world			
Anatomically correct			
*The moulage fits **logically** within the scenario*			
*The moulage is presented as a **part of props/scene***			
*The moulage is at a **sufficient level** so as not to distract/confuse the participant*			
***Simulation orientation** can mitigate low realism*			
*The moulage is **well-timed**, where appropriate*			
*The moulage **fits** with the scenario*			
COLUMN TOTAL			
		TOTAL SCORE	

Scoring Instructions: Rate each element according to the scale (0 – low, 1 – mid, 2 – high).

The higher the score, the higher the authenticity.

Authored by: Jessica Stokes-Parish, Robbert Duvivier, Brian Jolly

July 2016
Jessica Stokes-Parish

Additional file 3

Survey Content
Round 1

INFORMATION

Thank you for agreeing to participate in this Delphi survey on moulage authenticity.
This questionnaire round is the first of up to five rounds of the survey. You will have the opportunity to revise your answers with subsequent rounds of the survey.
In these surveys, you will be asked to develop priorities among the authenticity of moulage. Most of the questions can be answered with only a single selection. Where appropriate, a space is also provided for you to comment on the underlying reasons for your responses.
•
Once we have received responses from all panellists, we will collate and summarise the findings and formulate the second questionnaire. You should receive this in the next month.
We assure you that your participation in the survey and your individual responses will be strictly confidential to the research team and will not be divulged to any outside party, including other panellists.

QUESTIONS
Please complete the form below. Your details will be kept strictly confidential.

PAGE 1 – Sampling

1. I have read the explanatory statement and consent to participation in this research.
    a. Yes
    b. No
2. Please state your name
3. Phone number
4. Email address
5. Role title
6. Work address
7. Qualifications
    a. PhD

   b. Masters
   c. Bachelor
   d. Certificate
   e. No qualification
8. Please enter your country that you are currently living in:
9. What would you describe as your area of expertise in relation to simulation (Eg. Technician, special effects/moulage expert, instructional design)
10. Are you actively practicing moulage on a regular basis
   a. Yes
   b. No
11. How would you describe your level of expertise with moulage (or SPFX):
   a. Beginner
   b. Intermediate
   c. Advanced
12. Are you regarded as an expert in your field of practice
   a. yes
   b. no
13. Please provide detail on your response to question 12 (eg. Publications, workshops delivered, examples of moulage work):
14. Which continent do you live in:
   a. North America
   b. Australia
   c. Europe
   d. Asia
   e. Africa
   f. Other:

PAGE 2 – Domains of authenticity

Moulage is known in the simulation environment as the use of special effects makeup techniques or casting to add cues or elements of reality to a simulation. Examples of moulage might include applying bruises or illness effects through the use of makeup, or the use of pre-made wounds on a manikin or person.

The following questions are about what elements you feel contributes to realistic moulage. Please answer in as much detail as possible.

15. List at least 3 elements that contribute to the appearance of moulage being real (that is, what physical aspects of the moulage make it look real?)

July 2016
Jessica Stokes-Parish

16. Please list a brief explanation (2 or 3 sentences) of the importance of each factor that you listed in the previous question

Realism is a context discussed in simulation literature frequently. The level of realism to facilitate learning is relative to the learning objectives of the activity. What we are exploring here is how realism influences engagement in the scenario. Realism encompasses statements such as "The scenario was highly realistic" and refers to how the simulated situation reflects real life.

To explore realism and engagement further, we use the framework of realism presented by Dieckmann et al (2009) in which the authors discuss “physical”, “semantical” and “phenomenal” modes of realism.

Physical refers to the actual physical representation, such as the characteristics of the moulage, it’s textures and colours (eg. how persuasive is it in your perception of reality).

(Ref: Dieckmann, P., D. Gaba, and M. Rall, Deepening the theoretical foundations of patient simulation as social practice. Simulation In Healthcare: Journal Of The Society For Simulation In Healthcare, 2007. 2(3): p. 183-193.)

17. How can the physical appearance of moulage in a simulation influence (positive or negative) a learner’s engagement?
18. Is there anything more you wish to add?

The semantical mode refers to a conceptual type of realism. It is more about your relationship with the activity or story – can you involve yourself in the story? What would typically happen? Is it plausible that the narrative or story presented to you would occur? In this instance the moulage may not be authentic, but by way of the ‘fictional contract’ it is enough to help you theorise what might happen next. For example, if "A occurred, B will happen"; Dieckmann et al (2009) use the example of haemhorrhage - bleeding occurred, therefore the blood pressure will decrease. How the information is shared is irrelevant, as long as interpretable information is shared.

19. What level of realism (authenticity) is needed to engage with a scenario for it to be considered conceptually believable?
20. Is there anything more you wish to add?

The phenomenal mode is an emotional type of realism, where engagement is reliant on your involvement in the situation and how persuasive it is to you. You engage with the activity as if it were the real experience because you are emotionally engaged. For example, the moulage authenticity may be variable, but you engage with the narrative and situation because it makes sense to you.

21. How might the appearance of moulage influence (positive or negative) the clinical choices the learner makes about a scenario?
22. How might the appearance of moulage evoke an emotional response?
23. Is there anything more you wish to add?

Thank you for participating in Round 1 of the survey.

CHAPTER 6: CONTENT VALIDITY OF MOULAGE AUTHENTICITY RATING SCALE

The purpose of this chapter was to achieve the following research objective:

2. To develop a theoretical system of classification in moulage to depict or reflect 'authenticity'

This chapter describes the content validity and reliability of the Moulage Authenticity Rating Scale (MARS). Following the Delphi Consensus study, we sought to determine the ability of the Moulage Authenticity Rating Scale (MARS) to distinguish between moulage conditions.

Aim

The purpose of this study was to determine if the MARS was able to distinguish between levels of authenticity. We also wished to study whether there were latent dimensions within the MARS by performing a factor analysis on the 20 item scale. We hypothesised that the Physical, Semantic and Phenomenal items might group together in 2 orthogonal sub scales (Physical and Cognitive).

We hypothesised that the MARS would rank Group 3 images as the most authentic and the manikin moulage (Group 1) as the least authentic.

Method

An anonymous survey design was used to distribute a series of images depicting various moulages to assess the authenticity of the image using MARS. An A/B Survey was designed in Survey Monkey (www.surveymonkey.com) to randomly assign the image to be rated to the participants from a pool of images. Each participant was presented with 3 images and the Moulage Authenticity Rating Scale per image. The three images were at assumed levels: low, medium or high level authenticity.

Alongside each image was a brief description of the scenario that would accompany such an injury.

In line with best practice for developing questionnaires, participants were requested to make comment on whether other aspects of moulage authenticity were missing or should have been removed[154].

We used a 3- point Likert scale to score the physical elements (7) of authenticity due to the nature of how authenticity and realism are described in simulation - typically rated as Low, Medium or High. The physical elements of authenticity were: Position, detail, likeness to real world, anatomically correct, colour, size, shape. We used a 5-point Likert scale (Strongly Agree to Strongly Disagree) for the phenomenal and semantic elements 13 – 20. The phenomenal and semantic elements (6) of authenticity are defined as per the previous descriptions in Chapter 5:

- The moulage fits logically within the scenario/presenting complaint
- The moulage is presented as a part of props/scene
- The moulage is at a sufficient level so as not to distract the learner
- The moulage is consistent with the objectives
- The moulage is not overdone
- The moulage is well-timed, where appropriate

We determined that because the phenomenal and semantic modes of realism did have aspects of overlap, we would combine the two into a single “cognitive” category. That is, a non-physical category. The rationale for doing so was due to the low number of items identified as phenomenal and semantic, respectively, in the previous chapter (Chapter 5). From a practical sense, we hoped to achieve the ability to score the moulage using the Moulage Authenticity Rating Scale using a single, combined scale (you will see in the results that this was not sufficiently sensitive).

In addition to these questions, the participants were requested to comment on the usability of the tool and to provide observations on its use in real life.

Participant Group

To complete an effective analysis, our goal was to recruit 150 participants to complete the survey and utilise factor analysis testing. Reliability studies require a minimum of 50 participants [155], factor analysis studies recommend a 10:1 respondent to variable ratio which would mean recruitment of 130 samples [156, 157]. The survey was deployed via personal contacts, social media networks and via an invitation to simulation journals and communities to share amongst their networks. Participants completed the survey anonymously.

Analysis

To determine the internal reliability of the tool, I firstly utilised a scale analysis on the groupings. The grouping were as follows:

- Physical element groupings
- Combined phenomenal and semantic groupings.

Once this was completed, I then completed a factor analysis on the entire scale [154, 158].

The pool of images was constructed as follows:

Group 1: Moulage applied to a manikin

Group 2: Moulage applied to a Simulated Patient

Group 3: A real injury

Statistics

IBM Statistical Software Package for Social Science (SPSS v. 25) was used for all statistical comparisons. Statistical significance was defined at a value of 0.05.

Ethics

Ethics approval was obtained through the University of Newcastle Human Research Ethics Committee (H-2016-0326).

Results

Participants

59 participants completed the survey between May 2018 and February 2019. Each participant rated the authenticity of 3 randomly-allocated images (either low, medium or high authenticity) using the MARS tool. This resulted in a total of 177 Images rated.

Scale Analysis

Physical elements

A consistency analysis was carried out on the 7 physical elements of the MARS. Cronbach's alpha showed the scale to reach acceptable reliability, $\alpha = 0.93$. All items appeared to contribute to the reliability of the scale (see Table 1; a decrease in alpha resulted when any item was excluded) and hence no items were excluded from subsequent analyses.

Table 1 - Physical Items Scale Analysis

Item-Total and Scale Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Position	15.33	14.97	.71	.57	.92
Detail	15.53	14.18	.82	.75	.91
Likeness to Real World	15.60	13.62	.87	.81	.91
Anatomically Correct	15.45	14.85	.74	.62	.92
Colour	15.54	14.52	.74	.60	.92
Size	15.36	15.07	.80	.71	.92
Shape	15.46	14.82	.78	.70	.92
Scale Statistics					
Overall Scale Mean	18.05	Scale Variance	19.62	Cronbachα	0.93

Phenomenal and semantic elements

Further consistency analysis was conducted on the cognitive elements, comprising 6 items. Cronbach’s alpha demonstrated acceptable reliability, α = 0.85. The majority of the elements appeared worthy of inclusion (See Table 2), with the exception of the final element “The moulage was well-timed”. The internal consistency of this subscale, expressed as alpha increased to 0.89.

Table 2 - Cognitive Scale Analysis

Item-Total and Scale Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
The moulage fits logically within the scenario/presenting complaint	18.20	16.91	.71	.57	.86
The moulage is presented as a part of props/scene	18.10	17.42	.71	.55	.86

The moulage is at a sufficient level so as not to distract the learner	18.02	16.81	.81	.74	.84
The moulage is consistent with the objectives	18.03	17.18	.75	.59	.85
The moulage is not overdone	17.96	17.98	.71	.65	.86
The moulage is well-timed, where appropriate	18.19	19.50	.48	.32	.90
Scale Statistics					
Overall Scale Mean	21.70	Scale Variance	24.82	Cronbach's α	0.86

All items

The combined elements were tested for reliability, comprising of a total of 13 items. Cronbach's alpha again showed acceptable reliability, α = 0.90. All items appeared to warrant retention, with any items excluded decreasing alpha except "The moulage was well-timed" which if excluded resulted in an alpha of 0.91 (Table 3). We reasoned that the issue of timing may not have been impactful on the cognitive elements of authenticity.

Table 3 - All Items Scale Analysis

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted

The moulage fits logically within the scenario/presenting complaint	36.24	52.46	.67	.60	.90
The moulage is presented as a part of props/scene	36.15	54.01	.62	.60	.90
The moulage is at a sufficient level so as not to distract the learner	36.07	53.67	.66	.76	.90
The moulage is consistent with the objectives	36.07	53.43	.67	.60	.89
The moulage is not overdone	36.00	55.34	.58	.66	.90
The moulage is well-timed, where appropriate	36.24	56.45	.48	.36	.91
Position	37.03	57.72	.57	.58	.90
Detail	37.23	56.38	.67	.76	.90
Likeness to real world	37.31	55.38	.71	.81	.89
Anatomically correct	37.15	57.02	.65	.64	.90
Colour	37.24	57.33	.57	.60	.90
Size	37.06	57.12	.72	.75	.89
Shape	37.16	57.04	.67	.71	.90
Scale Statistics					
Overall Mean Score	39.75	Variance	64.81	Cronbach's α	0.91

Factor Analysis

I completed an exploratory factor analysis testing for all items (13) on the physical and cognitive authenticity scale. The Kaiser-Meyer-Olkin Measure of sampling adequacy was 0.886 and the Bartlett's Test of Sphericity was significant (p 0.00), which met the assumptions to complete a Factor Analysis.

In the first instance I completed an unrotated factor solution using the Principal Component Method. Once this was completed I completed a rotated Varimax with a component extraction threshold of .3 (anything less than this was excluded). Following scree plot (See Figure 7) and variable 13 components appeared to have two dominant underlying variables which I defined as Physical and Cognitive. Component 1 had a total of 6.5 and percentage of variance of 50.2%, Component 2 had a total of 2.4 and percentage of variance of 18.2% - the remaining components made up the remaining 31.6% (Results in Table 4).

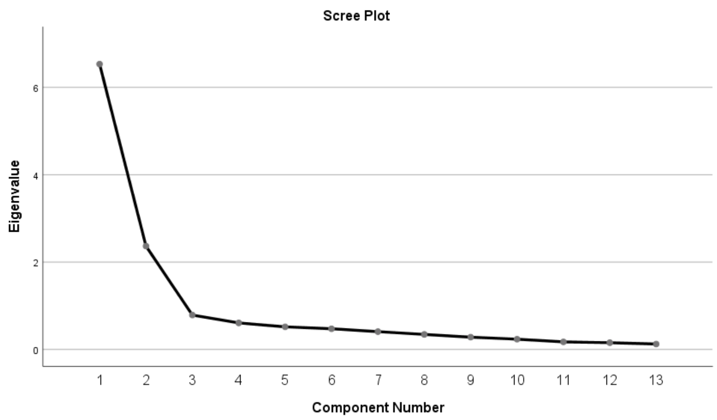


Figure 6- Scree Plot

Table 4 - Component Variance

Total Variance Explained

Component	Initial Eigenvalues Total	Initial Eigenvalues % of Variance	Initial Eigenvalues Cumulative %	Extraction Sums of Squared Loadings Total	Extraction Sums of Squared Loadings % of Variance	Rotation Sums of Squared Loadings Total	Rotation Sums of Squared Loadings % of Variance
1	6.532	50.249	50.249	6.532	50.249	4.945	38.042
2	2.366	18.197	68.446	2.366	18.197	3.952	30.404

Extraction Method: Principal Component Analysis.

The physical components of authenticity were comprised of Likeness to real world, detail, shape, size, colour, anatomically correct and position. The cognitive components were comprised of the moulage fits logically within the scenario, the moulage is presented as a part of the props, the moulage is at a sufficient level to not distract the learner, the moulage is consistent with objectives, the moulage is not overdone and the moulage is well-timed. The rotated component matrix can be seen in Table 5.

Table 5 - Component Matrix

Rotated Component Matrix

	Component	
	1	2
likenesstoreal	.887	
detail	.858	
shape	.814	
size	.813	
colour	.813	
anatomicallycor	.778	
position	.770	
nodistraction		.890
notoverdon		.821
consistentobjec		.805

partofprops		.790
Fitslogic		.770
welltimed		.552

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
a. Rotation converged in 3 iterations.

I completed a rotated component plot (Figure 8), which demonstrates the interrelatedness within components and the independence between Components 1 (Physical) and 2 (Cognitive).

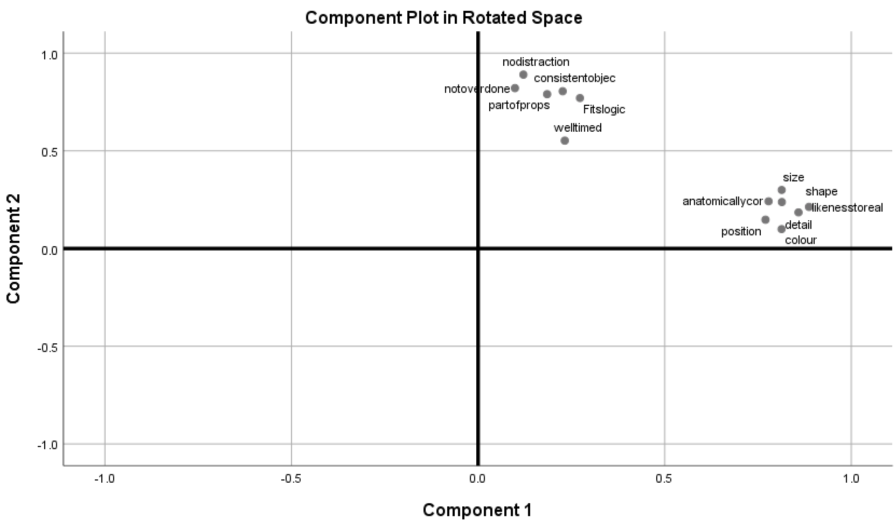


Figure 7 - Component Plot

Usability Testing

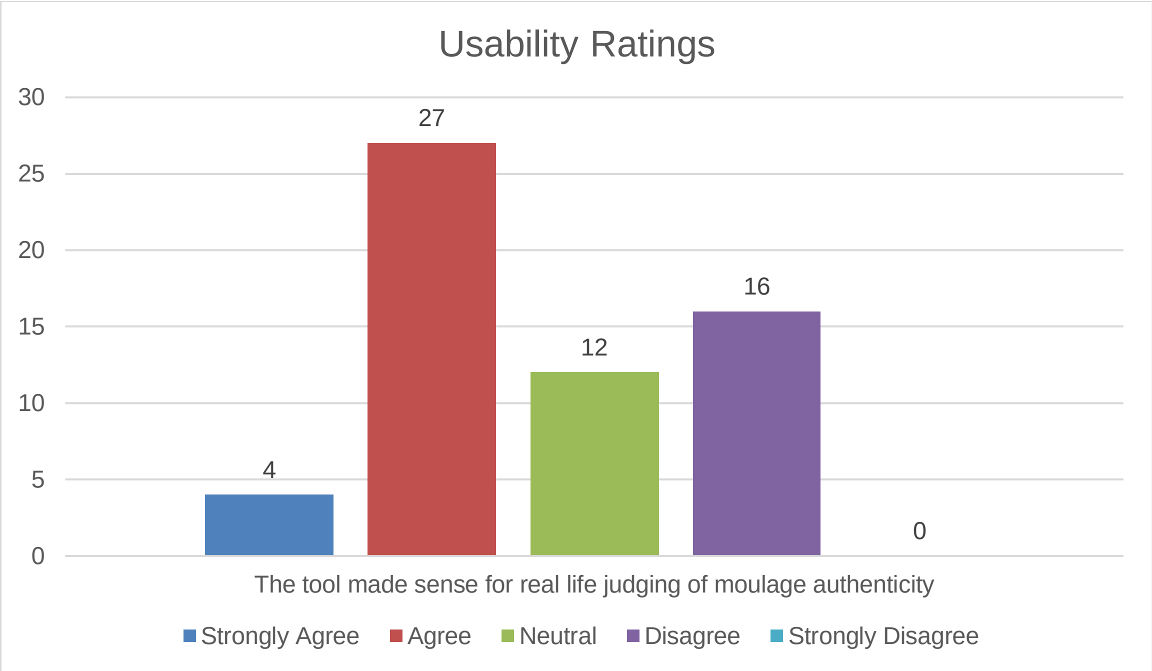


Figure 8 - Usability Ratings

Participants mostly agreed that the tool was useful, however a significant portion commented on the design of the survey deployment itself and that it was difficult to navigate, which lead them to comment in the free-text box provided that the tool was not useable in this electronic method. This was a reflection of the Survey Monkey limitations for complex image testing, as opposed to the survey content itself. If it were delivered in a physical format or digitally for a single image only (participants completed 3 image ratings) this would bridge this problem.

Discussion

The purpose of this study was to determine the reliability of the MARS tool to assess moulage authenticity. The MARS tool content validity and reliability demonstrated a strong ability to rate the authenticity of moulage in simulation.

Overall, the designed tool appeared to reliably discriminate between moulage conditions. The cognitive element analysis identified that "The moulage was well timed" could be removed, however, as the combined element testing did not replicate this issue, I did not opt to remove it. The scale analysis demonstrated clear internal reliability. Additionally, it demonstrated good construct validity as the corrected item correlation was above 0.40 for each item. These results align with best practice on scale analysis [158].

The factor analysis verified that my distinction between physical components and non-physical components (i.e. cognitive) was accurate and reliable. Thus confirming the elements created by the expert consensus study (Chapter 5) does describe authenticity appropriately. The MARS tool seems to adequately cover concepts of authenticity in moulage – it could reliably be used to determine the level of authenticity. These results confirm the expert consensus results in Chapter 5.

Considering the practical application of this work to moulage in simulation, moulage is not simply a physical aspect of simulation – it potentially contributes to broader critical thinking processes. As described in previous chapters, moulage can act as a cue to propel the simulation forward, or alternatively add a sense of reality [153]. When using moulage in simulation, simulation facilitators should not only consider the appearance of the moulage, but how it relates to the overall objectives of the activity. This aligns with previous thoughts on overall simulation realism and fidelity [159]. Cook et al [160] purport that measurements of physical quantity (e.g. height, weight) are straightforward to interpret meaning from, however components of psychometric scales are more difficult [160]. At first glance, moulage appears to simply be a physical component of simulation; however the results in this chapter confirm that it is not. Phenomenal and semantic components moulage authenticity contribute equally – perhaps more than the physical component of moulage. This work might be applicable to authenticity in simulation as a whole, but would require further independent testing to determine its validity for the same.

There were some limitations to this work. To achieve high participant numbers for testing the ability to distinguish between conditions, we needed to distribute the survey globally. It was not feasible to physically set up a variety of different scenarios and invite 60 independent clinicians to score the conditions. An alternate future method might be to present a variety of scenarios at a large, interprofessional conference to test the ability of the tool to distinguish between conditions.

Despite widespread promotion, the number of participants who completed the survey was moderate. This may have been due to the content itself or the topic. However, this was overcome, we believe, by the participants completing 3 images each, resulting in a total of 177 items being scored. However, this might be a limitation for the factor analysis due to the interdependency of the results (i.e. the participants scored 3 images each). In other words, because I did not track the respondents and they each completed 3 images, there is no way to ensure the results are independent of each other. The anonymity of respondents, limiting the ability to run interrater reliability testing.

Conclusion

Overall, the MARS appears to be a reliable tool to judge moulage authenticity. The scale analysis demonstrated inter-item reliability across both real injuries and moulages. The Factor analysis showed the strong ability of the dimensions to define moulage authenticity, and verified that there is a distinction between physical and cognitive components of moulage as presented in the results of Chapter 5. The tool would benefit from further testing in physical simulation settings to test the physical conditions more reliably.

Appendix – Survey Questions

Participants were given the following question with each image.

Please rate the authenticity of the following elements:

1. Position Answer: Low authenticity - medium authenticity - high authenticity
2. Detail Answer: Low authenticity - medium authenticity - high authenticity
3. Likeness to real world Answer: Low authenticity - medium authenticity - high authenticity
4. Anatomically correct Answer: Low authenticity - medium authenticity - high authenticity
5. Colour Answer: Low authenticity - medium authenticity - high authenticity
6. Size Answer: Low authenticity - medium authenticity - high authenticity
7. Shape Answer: Low authenticity - medium authenticity - high authenticity
8. The moulage fits logically within the scenario/presenting complaint Answer: Strongly disagree - Disagree - Neutral - Agree - Strongly Agree
9. The moulage is presented as a part of props/scene Answer: Strongly disagree - Disagree - Neutral - Agree - Strongly Agree
10. The moulage is at a sufficient level so as not to distract the learner Answer: Strongly disagree - Disagree - Neutral - Agree - Strongly Agree
11. The moulage is consistent with the objectives Answer: Strongly disagree - Disagree - Neutral - Agree - Strongly Agree
12. The moulage is not overdone Answer: Strongly disagree - Disagree - Neutral - Agree - Strongly Agree
13. The moulage is well-timed, where appropriate Answer: Strongly disagree - Disagree - Neutral - Agree - Strongly Agree
14. The moulage “fits” with the scenario/presenting complaint Answer: Strongly disagree - Disagree - Neutral - Agree - Strongly Agree

Appendix – Sample of images used in survey

Group 1: Moulage applied to manikin

Group 2: Moulage applied to Simulated Patient

Group 3: Real Injury

CHAPTER 7: MEDICAL STUDENTS PERCEPTIONS ON MOULAGE IN SIMULATION

The purpose of this study was to achieve the following research aim:

3. To determine how the use of authentic moulage impacts on engagement of participants in a healthcare simulation.

This chapter specifically addresses the following questions:

1. How does the use of moulage authenticity impact on engagement of participants in a healthcare simulation?
2. What are stakeholders' perceptions of the value of hi, lo, and no moulage in the educational process.

Paper: How does moulage contribute to medical students' perceived engagement in simulation? A mixed-methods pilot study *(Accepted pending changes)*

Publication Relevance to Thesis

I significantly contributed to the research in this paper, which forms the following chapter. I contributed, in the majority, to the conception and design of the project. I performed the entirety of data collection and the significant majority of data analysis, consulting with co-authors on occasion when the data analysis need verification. I wrote the paper and performed the edits and revisions for publication, with some assistance from co-authors with editing.

Citations to date: NA

Ethics Approval

Ethics approval was obtained and is described in the study.

Awards

The study materials, protocol and ethics application for this study are in development. This study was awarded the 2017 Society of Simulation in Healthcare Novice Researcher Grant ($10,000.00 USD), and received a University of Newcastle Seed Fund of ($8,700AUD).

Submitted to Advances in Simulation October 28, 2019

Abstract

Introduction

Moulage is used frequently in simulation, with emerging evidence for its use in fields such as paramedicine, radiography and dermatology. It is argued that moulage adds to realism in simulation, although recent work highlighted the ambiguity of moulage practice in simulation. In the absence of knowledge, this study sought to explore the impact of highly-authentic moulage on engagement in simulation.

Methods

We conducted a randomized mixed-methods study exploring undergraduate medical students' perception of engagement in relation to the authenticity moulage. Participants were randomised to one of three groups: control (no moulage, narrative only), low-authenticity (LowAuth) or high-authenticity 2 (HighAuth). Measures included self-report of engagement, the Immersion Scale Reporting Instrument (ISRI), omission of treatment actions, Time to Treat, and self-report of authenticity. In combination with these objective measures, we utilised the Stimulated Recall (SR) technique to conduct interviews immediately following the simulation.

Results

A total of 33 medical students participated in the study. There was no statistically significant difference between groups on the overall ISRI score. There were statistically significant results between groups on the self-reported engagement measure, and on the treatment actions, time to treat measures and the rating of authenticity. Four primary themes ((1) the rules of simulation, (2) believability, (3)

consistency of presentation, (4) personal knowledge) were extracted from the interview analysis, with a further 9 subthemes identified ((1) awareness of simulating, (2) making sense of the context (3) hidden agendas, (4) between two places, (5) dismissing, (6) person centred-ness, (7) missing information (8) level of training (9) previous experiences).

Conclusions

Students rate moulage authenticity highly in simulations. The use of high-authenticity moulage impacts on their prioritisation and task completion. Although the slower performance in the HighAuth group did not have impact on simulated treatment outcomes, highly-authentic moulage may be a stronger predictor of performance. Highly-authentic moulage may be preferable on the basis of optimising learning conditions.

Introduction

Engagement in simulation is described as a key to success; if a participant is engaged, the learning/simulation must have "worked". Grounded in the notion of active learning theories such as experiential learning and constructivism, engaged learners "construct knowledge from experience, meaning interpretation and having interactions with peers" (Hung et al 2006). But what is engagement? In gaming, engagement is described as being associated with qualities that pull people in [37]. Hung et al (2006) describe engaged learning as "authentic", whereby learners are able to problem-solve, make choices and interact with peers and instructors [36]. Simulation incorporates this in the very nature of its delivery – participants are given a case they must work through, often in a group. In simulation, the word engagement is often interchanged with the word "immersion". Immersion is the "subjective impression that one is participating in a comprehensive, realistic experience" [161]. This highlights the individual part of being able to suspend disbelief to participate actively in the simulation. This concept of engagement is echoed by many authors [46, 79, 162], yet there has been little discussion on what engagement means in the context of simulation. Indeed, Padgett et al raise this in a critical narrative review of the definition of engagement in simulation, agreeing that the term engagement is used loosely and without clear definition [38]. In their terms: "Learner engagement is a context-dependent state of dedicated focus towards a task wherein the learner is involved cognitively, behaviourally, and emotionally" [38]. However, Padgett et al do not explore gaming literature, the concept of suspending disbelief or the likeness between immersion and engagement [38]. For the purpose of this study, we have defined engagement as,

> *the state in which the participant is observed to be actively interacting with the simulation as if it were real*.

With the opposite being true of disengagement; the participant is unable to interact as if it were real.

Experts posit strategies to increase engagement through realism. Moulage is increasingly described as a way to increase realism in simulation. Defined as “the use of special effects makeup techniques to simulate illnesses, bruises, bleeding, wounds or other effects to a manikin or simulated patient, acting as visual and tactile cues for the learner” [153], moulage is used at varying levels in simulation scenarios. Since the publication of our commentary, [100], a number of studies have been published to explore its use and benefit in simulation. One such study Mills et al (2018) explored how immersion is influenced by the use of moulage, resulting in a significant difference between control and experimental groups where no moulage versus moulage was tested in a study on paramedicine students [124]. In this study, participants were randomised to two groups (no moulage or moulage) and researchers measured task immersion, eye-tracking and interviews. Moulage is gaining attention in other fields, such as radiology [123] where it has not been explored before, whilst areas like dermatology continue to research the use of moulage as a teaching method for melanoma identification [163, 164]. In other fields of simulation, such as military or defence training, highly-authentic moulage is often a de facto inclusion that is regarded highly important [165].

We have identified elsewhere the need to explore how moulage contributes to simulation, as opposed to a sort of de facto inclusion in simulation instructional design. We propose that moulage fits in the domains of realism suggested by Dieckmann et al [79]. That is, moulage is physical (the moulage appears real), semantic (moulage is conceptually believable – if A occurs, B will happen, so therefore I engage) and phenomenal (I emotionally engage with the case because moulage enhances first impressions). However, we do not understand precisely how moulage fits within this framework. A moulage should be believable, make sense to the viewer and not in a contradictory manner. We hypothesise that if a moulaged wound does not match the narrative or if it was portrayed inaccurately, this could disrupt the participants' engagement, potentially influencing engagement in learning activity. This hypothesis is supported by literature where episodes of disengagement occurred in simulations where the narrative or setting were not plausible or factual [67].

The aims of this study were to answer the following questions:

1. How does the use of moulage authenticity impact on engagement of participants in a healthcare simulation?
2. What are stakeholders' perceptions of the value of high and low-authenticity moulage compared to none in the educational process?

To answer these questions, we had the following hypotheses:

Hypothesis 1: Highly authentic moulage causes greater engagement in simulation participants

Hypothesis 2: Poorly authentic moulage causes disengagement in simulation participants

Methods

Participants

We recruited participants from the final 2 years of the undergraduate medical degree (5 years) at the University of Newcastle in Australia. Students were eligible to participate in the study if they had participated in simulations previously as a part of their degree. Students were not eligible to participate if they had no previous experience participating in highly-immersive simulations or if they wore glasses (due to the eye-tracking component of the study, contacts were allowed).

Based on power calculations from previous studies [60] and the size of a useful or meaningful difference, we identified that a sample of 21 participants in the control group and 18 each in the experimental groups would be needed to detect an effect size of 0.8 with a power of 90% between control and experimental wings. A slightly larger sample size (n=23) was required to detect differences of the same magnitude (0.8) between the two experimental conditions. Meta-analysis of over 1500 educational interventions suggest that the average effect size for any intervention is 0.4, so effect sizes greater than 0.4 were identified as worth pursuing and reliably detecting [166].

Recruitment took place via lectures and online postings on the course website. Flyers were placed in the student common rooms, library and student teaching areas. The invitation included information regarding the duration and location of the study, and the study aims. After a student expressed interest, they were sent the full Participant Information Statement and invited to book in a session at the simulated laboratory. Participants were randomized into control and experimental groups to participate in a trauma simulation. The control group was narrative case only, whilst experimental groups were both narrative case and moulage. That narrative case and moulage are described in more detail below. The experimental groups were further randomized to either highly authentic or inauthentic moulage. All data was collected in late Semester 2 of 2017 and 2018. The study protocol was approved by the University of Newcastle Human Research Ethics Committee (H-2017-0214).

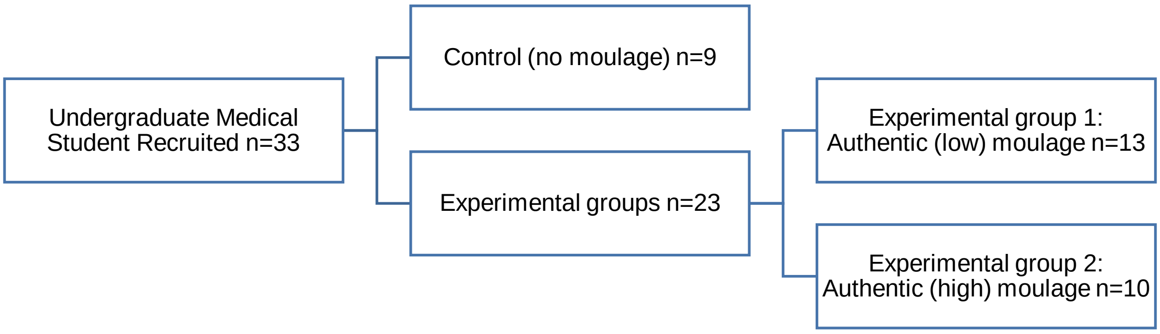


Figure 9 - Randomisation Process

Randomization

Participants were given a unique ID code using randomizer.com. The Research Assistant generated the random codes independent of the Chief Investigator (JSP), and allocated the codes at random to the participants. The Chief Investigator was only aware of the randomization on the day of the study. Participants were told that they would be randomized to one of the three groups, but were blind to the group they were allocated until the simulation commenced.

Orientation to simulation and study

Participants were given a standard simulation orientation to the location, including covering the fiction contract (the process in which the participant agrees to interact in the simulation within the set rules of simulation), confidentiality agreement and ground rules for participation in simulation, as per the INACSL Standards for Simulation [167, 168]as well as an outline of how the study would flow. At this point the participants signed consent to participate. Following this, eye-tracking equipment was applied and calibrated (the results of the eye-tracking study will be reported in a later paper). The participant was then familiarised with the manikin, props and surrounding equipment. This included talking to the manikin, conducting a physical examination and meeting the confederate. The participant was then invited to sit outside the simulation room and read the scenario brief.

Materials

Scenario

The scenario chosen was a previously assessed for content validity and peer reviewed trauma scenario [169]. The selected scenario was a male who was brought in by ambulance to the local Emergency Department (ED) following a mountain bike accident. Participants were given an ED Admissions sheet outlining the presenting complaint, and were then called in to the scenario by the confederate Endorsed Enrolled Nurse (EEN) to come and review the new patient in ED. All study conditions took place in the Chameleon Simulation Centre in a well-lit room, quiet and devoid of extraneous props. Each participant completed the scenario individually. A confederate EEN was in the room providing narrative cues and assisting with nursing tasks. The simulated emergency room was set up to replicate local emergency department rooms. The room consisted of a bed, oxygen/air outlets, suction, oxygen delivery devices, emergency resuscitation trolley, bed, IV fluids pump, observations monitor, standard equipment trolley and a bed. The stock and equipment trolley’s included mock medications, fluids, wound dressing supplies and various other medical equipment relevant to trauma scenarios.


Figure 10 - Simulation Setting for Experiment

The confederate was given training prior to the commencement of the study. They were taught to troubleshoot technical issues within the scenario, instructed on how to respond to the students and were instructed to not prompt action or correct clinical decisions that they perceived as errors. The confederate was equipped with a one-way ear piece in which the scenario manager could feed information if required.

Variable

The only differences between the groups was the appearance, i.e. moulage or no moulage.

In the control group, the manikin had no moulage applied. Instead, the confederate would give the participant a verbal cue describing the areas of injury (e.g. “there are some grazes and cuts on the face”, and “he has a bruise on his stomach” and “there is a laceration and grazing to the left arm”). In the Low and High authenticity groups, the confederate only gave verbal cues if the participant requested further information about the wounds (e.g. "no, there is no active bleeding”).

The authenticity of moulage was rated by independent clinicians from a variety of specialties using the Moulage Authenticity Rating Scale (MARS) [98] (Full makeup application description in the Appendix). Following reliability testing, we compressed the elements of the Mars into two categories – the Physical and Cognitive Scales of Authenticity. We completed a Comparison of Scale Means utilising ANOVA for 3-group comparisons, and T-Tests for 2-group comparisons. The results are detailed in Table 6.

Table 6 - Moulage Rating by Expert

Wound		Control Mean (n)	LowAuth Mean (n)	HighAuth Mean (n)	Statistical Significance* (p < 0.05)
Arm	Physical	11.2 (6)	17.3 (4)	16.0 (8)	p 0.039*
	Cognitive	9.9	23.8	12.6	p 0.000*
	All Elements	21.2	41.0	28.6	p 0.000*
Abdominal	Physical	10.5 (5)	15.0 (7)	NA	p 0.119
	Cognitive	13.5	18.6		p 0.213
	All	24.0	33.6		p 0.086
Facial	Physical	11.5 (5)	16.1 (6)	15.5 (9)	p 0.116
	Cognitive	19.6	11.8	16.4	p 0.026*
	All	31.1	28.0	31.9	p 0.563

Measures

Immersion

Video footage of the simulation was reviewed to identify episodes of engagement or disengagement. Using the Immersion Score Rating Instrument (IRSI)[162] the footage was reviewed by JSP at a later date, and the results were then discussed with the other authors. The ISRI is a tool to measure participant immersion within the simulation. Despite the use of the word immersion, we interpreted the authors' intent as to measure engagement. Although these are subjective measures, we considered them appropriate for the study at hand, particularly since the engagement of participants was measured by additional outcomes – such as eye-tracking glasses, engagement self-report and stimulated recall interviews.

Clinical Markers

Participants' performance was assessed by means of clinical performance and time to treat (that is, how long it took them to achieve expected actions). The expected clinical performance included physical assessment, administration of intravenous fluids, ordering an ultrasound, administration of oxygen and was verified by expert clinicians elsewhere [169]. This data was collected through the Laerdal LLEAP program and through observational measures. JSP extracted the Laerdal Scenario actions file and then observed the videos and noted actions taken by participants, including timestamp. These observations were compared across groups, by means of difference in time to treat and omission of actions.

Self-Report Measures

Immediately following the scenario, participants completed a survey to report their perceived engagement with the scenario and the perceived reality of the visual cues (face and content validity). This survey was an adaptation of the survey used by Pywell et al [119]. The adaptation included additional questions regarding perceived engagement and refocusing the questions on face and content validity to be trauma based (See Appendix).

In addition to this, participants rated the authenticity of moulage using the Moulage Authenticity Rating Scale (MARS) [98]. Both self-report measures were compared across groups to determine differences, if any.

Interviews

Participants were interviewed following the simulation using video-stimulated recall techniques [170]. This method was selected to explore how the moulage authenticity impacts on participant engagement (H1) and their perceptions of high and low-authenticity moulage (H2). Stimulated recall techniques are recommended to enhance recall of events and to complement eye-tracking methodologies, aligning thoughts with action [171]. The interview questions were structured with a general framework, however were flexible enough to explore areas of deeper focus. The central themes of the interview focused on engagement and moulage. The guide for interviews can be found in Appendix 2. The interviews were audiotaped and transcribed verbatim by a professional academic transcription service. Drawing from Grounded Theory techniques, the interviews were analysed using a four-phase process. The first phase was familiarisation with the literature (reading transcripts and listening to the audio recording), followed by an initial code, then a categorical coding process, and, finally, making meaning. Using a manual process, JSP coded line by line, noting sentences and phrases that described the underlying meaning. This continued until saturation was reached, at which point they were categorised in to groups. Throughout this process, JSP took memos and reflective notes to synthesise the evidence and gradually build meaning.

Statistics

IBM Statistical Software Package for Social Science (SPSS v. 23) was used for all statistical comparisons. Statistical significance was defined as a value of 0.05. We used one way ANOVA to compare groups, dependent on the level of measurement of the data (Immersion Score Rating Instrument), Time-to-action, Moulage Authenticity Rating Scale, Self-reported engagement and used further post-hoc tests (Tukey's) where appropriate to determine differences between the 3 groups. We completed Chi-squared tests with Fischer's exact to compare the clinical actions completed.

Results

A total of 33 undergraduate medical students were recruited in the latter half of Semester 2 in 2017 and 2018. Of these participants 15 were Year 4 medical students, 18 were Year 5. The participants had good exposure to simulation based education, including Advanced Life Support training. 22 (66%) of the participants were female, 11 were male

(33%). 9 were randomised to the control group, 13 to Low Authenticity (LowAuth) and 10 to High Authenticity (HighAuth) (See Figure 10).

CLINICAL ACTIONS

Clinical actions completed

Data were available from 32 of the 33 participants. Data from one participant were lost due to a technical glitch. Groups were compared on the following indices: whether they completed hand hygiene at any point during the encounter, requested an ultrasound, ordered intravenous (IV) fluids, exposed the abdomen, examined the abdomen, called for help and investigated or treated the injury cues. We performed Chi Squared statistics comparing whether groups completed expected actions.

Table 7 - Clinical Actions Completed by Participant

	C n=9 (% in group)	LOWAUTH n=13 (% in group)	HIGHAUTH n=10 (% in group)
Hand hygiene at commencement of scenario*	3 (33%)	6 (46%)	6 (60%)
Gloves	1 (11%)	2 (15%)	5 (50%)
Abdominal Ultrasound	2 (22%)	6 (46%)	5 (50%)
Intravenous Fluids	8 (89%)	12 (92%)	10 (100%)
Neuro Observations**	5 (56%)	1 (1%)	4 (40%)

Pathology	5 (56%)	6 (46%)	5 (50%)
Abdominal Palp**	8 (89%)	13 (100%)	6 (60%)
Called for help	6 (67%)	9 (70%)	6 (60%)
X-ray	3 (33%)	6 (46%)	4 (40%)
Investigated Injury Cues	5 (56%)	7 (54%)	8 (80%)
Treated Injury Cues	1 (11%)	2 (15%)	3 (30%)

*Participants did not complete any further hand hygiene throughout the scenario

**Significant differences Chi Sq between the 3 groups

In these clinical actions, there was a trend of completing clinical actions in the high-authenticity (HighAuth) moulage group as compared to other groups (neurological observations, p = .05; abdominal palpation, p = .02). Additionally, there was a trend to complete an abdominal palpation with the low-authenticity moulage (LowAuth) group (p = .03). Differences between all other indices were not significant. See Table 2 for a visual representation of what clinical actions were completed.

Time-to-treat

To determine any differences between groups on the time-to-treat, we conducted one-way ANOVA. In the instance that a participant didn't complete the action, we treated them as if they would have taken the longest time to complete the action. We compared the three groups by one-way ANOVA and further post-hoc tests (Tukey's HD) where applicable.

Table 8- Mean times to action (seconds)

						95% Confidence Interval for Mean	
		N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound
Hand Hygiene	Control	9	71.4	36.1	12.0	43.6	99.2
	LowAuth	13	51.7	43.0	11.9	25.7	77.7
	HighAuth	10	41.3	42.1	13.3	11.1	71.4
Exposes Abdomen	Control	9	69.7	43.5	14.5	36.2	103.2
	LowAuth	13	115.9	97.8	27.1	56.8	175.0
	HighAuth	10	72.4	51.4	16.2	35.6	109.1
Calls for Help	Control	9	211.3	89.8	29.9	142.2	280.3
	LowAuth	13	197.1	95.3	26.4	139.5	254.7
	HighAuth	10	245.1	97.7	30.9	175.1	315.0
Orders Fast Scan	Control	9	242.6	38.4	12.8	213.1	272.2
	LowAuth	13	220.7	60.0	16.6	184.4	257.0
	HighAuth	10	193.0	82.2	26.0	134.1	251.8
Inspects Injuries	Control	9	214.0	99.4	33.1	137.5	290.4
	LowAuth	13	252.0	95.4	26.4	194.4	309.7
	HighAuth	10	200.0	82.1	25.9	141.2	258.7

The full analysis can be viewed in Table 9. In exposing the abdomen, the LowAuth group took the longest (115.92s, SD 97.82) and the control group the shortest (69.77s, SD 43.55). Participants in the HighAuth group took the longest to call for help (245.1s, SD 97.71), while the LowAuth group called for help the quickest (197.15s, SD 95.30).

When requesting an ultrasound, the HighAuth group ordered it the quickest (193s, SD 82.28), and the Control group the slowest (242.66s, SD 38.44). The HighAuth group took the longest to order intravenous fluids (174.9s, SD 88), whilst the LowAuth group were the quickest (112.41s, SD 49.69). There were no statistically significant differences between the groups.

IMMERSION

We ran a one way ANOVA by group of the ISRI, where the mean score across all groups was 38.59 (SD 14.45) (See Table 10). There was no statistically significant difference between the experimental groups. We drilled down further to explore if there was a difference between undergraduate year and gender. There was no statistically significant result between Year 4 and 5 students, nor between genders (M/F). In a T-Test (with Levene's test for equality of variances) comparison of moulage (combined LowAuth and HighAuth) versus no moulage (C), there was no statistically significant difference (See Table 11). Despite this difference, when observing the scatterplot representation of the means, HighAuth had less variability in immersion scores (see Figure 13) as compared to both the Control and LowAuth group.

Table 9 - One way ANOVA of ISRI

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound
Control	9	33.4	17.1	5.7	20.3	46.6
Experimental Group 1	13	43.2	15.9	4.4	33.5	52.8

Experimental Group 2	10	37.4	8.2	2.5	31.4	43.2

Table 10 - T-test comparison of ISRI scores

Item (n)	**Mean (SD)**
Year 4 (14)	34.2 (14.9)
Year 5 (18)	42 (13.6)
Male (10)	38.3 (12.5)
Female (22)	38.7 (15.6)
Moulage (9)	33.4 (17.1)
No Moulage (23)	40.6 (13.2)

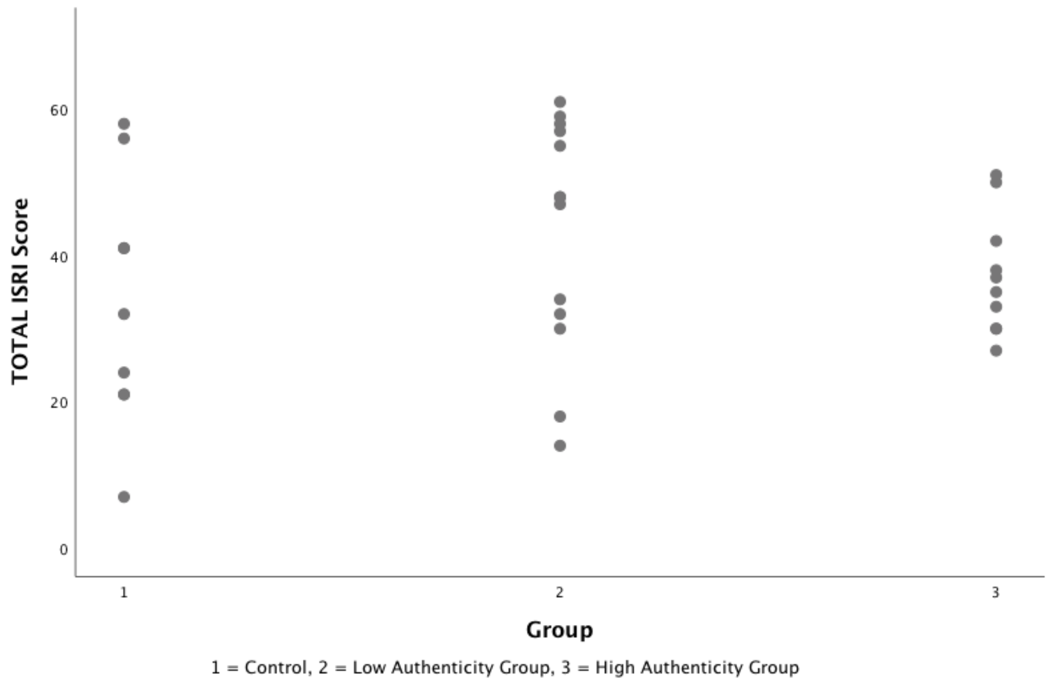


Figure 11 - Scatterplot of score distribution across groups

SELF REPORT MEASURES

Engagement survey

In all groups, the participants felt they were engaged. The participants rated moulage as important in all groups, and felt that the lack of moulage did contribute to disengagement (p. = 0.02). When exploring the realism of the scenario, the participants in the HighAuth group rated the realism higher (p = 0.01) and as representative of trauma compared to the other groups (p = 0.00). The moulage contributed to the participant's ability to treat the simulation as if it were real and made them feel like they were in a real trauma situation (p = 0.01). The presence of moulage in both the LowAuth and HighAuth groups contributed to a positive training experience (p = 0.03). Full results are presented in Appendix 1.

Moulage Authenticity Rating

When comparing participants' ratings on the authenticity of moulage, there were statistically significant differences between groups across the scales. The ANOVA identified differences between the groups in the Physical, Cognitive and All Elements Scales. Overall, the participants rated the moulage as most authentic in the HighAuth group when rating the elements individually (position, p = 0.02; detail, p = 0.00; likeness to real world; p = 0.00; colour, p = 0.00; size, p = 0.04) and in the global rating of authenticity (p = 0.00). When comparing the Physical and Cognitive Scales where there was little difference between the LowAuth and HighAuth group. In post-hoc analysis of the Physical Scale, there was a statistically significant difference between Control and HighAuth (p = 0.00) and Control and LowAuth (p = 0.02). In post-hoc analysis of the Cognitive Scale, there was a statistically significant difference between Control and HighAuth (p = 0.00) and Control and LowAuth (p = 0.00). In the All Elements Scale, there was statistical significance between groups (p 0.00) and within Control vs HighAuth (p 0.00), but not Control vs LowAuth or LowAuth vs HighAuth. The use of moulage was strongly correlated with a rating of authenticity, as opposed to no moulage. The full analysis of results are accessible in Appendix 1.

INTERVIEWS

Thematic summary

Four primary themes emerged from the participant interviews, including: (1) the rules of simulation, (2) believability, (3) consistency of presentation, (4) personal knowledge. Within these themes, subthemes appeared: (1) awareness of simulating, (2) making sense of the context (3) hidden agendas, (4) between two places, (5) dismissing, (6) person centred-ness, (7) missing information (8) level of training (9) previous experiences.

The Rules of Simulation

Participants described the process of determining the rules of simulation and learning how to settle into simulation. They expressed challenges determining if what they were doing was an actual part of the simulation or a condition of the simulation. Participants described instances of attempting to progress through the simulation whereby they needed to make sense of the context of simulation, determine if there were hidden agendas; they demonstrated an experience of being between two places to make meaning of the rules of simulation. That is, they were aware they were simulating, yet they were mentally processing the conditions of simulation versus reality at the same time.

Awareness of "simulating"

The more participants were aware of the simulation, the less engaged they were; meaning they were not necessarily engaged in learning, but more focused on determining the rules of simulation. For example, Participant 22 (Control group) expressed "*as soon as I looked and then saw it was like crystal clean…it just like kind of* *pulls you back in, okay it's a simulation*". Participant 58 (Control group) said regarding the lack of moulage and its contribution to engagement "*the engagement in believing it was real was less so. Like I took it as oh this is a simulation now, I'm going to be doing a simulation*…"

They identified that they had a constant background awareness that they were simulating, at varying degrees, depending on the level of authenticity presented. Participants described this type of engagement as more of a check-box activity, a "*going through the motions*" as opposed to meaningful learning activity.

"I guess at the back of my mind there's always this idea of that this is just a simulation. Yeah. I think I wasn't - I don't know, I think I wasn't having that feeling, oh okay this is real, I really have to do something about this patient, yeah. It was more like going through the motions" (Participant 20, Experimental Group)

Making sense of the context

Participants described attempting to make sense of the simulated conditions by verifying cues presented, searching for additional cues (that they otherwise wouldn't look for in a real patient) and questioning their own judgements. Participant 14 (Control group) identified feeling confused – *"…is this the site or am I just imagining it…I disengage and went into my own thoughts because…I wasn't 100 percent sure that what I was…an issue*". This confusion was echoed by Participant 39 (LowAuth), they said "…*you can't visualise so you don't know whether he is supposed to have a bruise or whether he really doesn't have any bruise. So you have to assume…*"

Hidden agendas

Participants felt there were hidden purposes to the simulation itself. In some instances they described taking the confederates' cues (instead of visually presented) as if to mean there was importance to the cue, leading them to pursue that particular path, Participant 14 says "*oh okay, I'm missing something again*". In their mind, if a confederate voiced a cue, there was hidden meaning behind it – "*they're telling me about it so it must be the main important thing*" (Participant 50, HighAuth). Participants expressed an expectation that there was something going to happen – the patient would "crash" and require emergency treatment, mostly because prior scenarios they were involved in went down the path of Cardiopulmonary Resuscitation. For example, Participant 12 (LowAuth) noted "*I thought you're going to make him crash on me. It's like a classic*".

Between two places

This subtheme describes the degree to which participants were aware that they were "in" a simulation. Multiple participants described "stepping in" and "stepping out" of the simulation, for example, Participant 12 (LowAuth) says: "[I]..*have to switch out of the scenario to check things out. In real life you can either see it's happening or it's not*". When they are fully engaged, participants are able to progress through the simulation and engage with the cues presented; when they are confused about the cues presented or unsure of the believability, participants described needing to "step out" to verify the conditions of the simulation – "*I did disengage in the sense that I had to then pull myself out of it and thought – all right, let's just evaluate what's happened, rather than keep rolling on*" (Participant 10, LowAuth)

Believability

Throughout the interview analysis, participants repeatedly described a desire or need to be able to "believe what they see". They identified that they wanted visual cues to be convincing as they felt the cues contributed to overall engagement and sense of reality. Participants expressed that the lack of reality created confusion, leading them to not take the scenario seriously. The students identified that this is a crucial aspect for their learning, as they felt there was no point in a simulation if it did not allow them to practice an assessment in an authentic way. Participant 40 (HighAuth) describes, "*they look human-like…it sets you up very well for a clinical scenario…*" and Participant 50 (HighAuth) highlights "*we're trained to always be looking at the whole page …looking for every little detail about the patient to see what you can glean about their clinical situation."* Believable moulage encouraged them to treat the scenario as if it were real, and to physically complete actions, instead of pretending to.

Dismissing

A consistent theme in the interviews was the idea of dismissing or ignoring the cues if they were delivered verbally (C) or represented poorly (LowAuth). Participants in LowAuth expressed they viewed they assumed the moulage was unimportant due to the unidimensional aspect.

On the inclusion of moulage, Participant 40 (HighAuth) says *"it just gives it a good indication of where they've been hit which you - we don't have otherwise in these trauma cases that we get… otherwise you just have to ask everything. You don't know what he has and what he doesn't have unless you're specifically told…you'd never ask that or you wouldn't normally ask that in a normal clinical situation because you can see it."* When the reasons for dismissing where explore further, participants described feeling overloaded with information, causing them to forget – "*I missed that cue. I completely forgot that the nurse …said tha*t" (Participant 21, LowAuth).

Person-centredness

Participants described the impact of authentic moulage in terms of how they approached the patient. For example, they valued engaging with the patient verbally, and the moulage provided a trigger to remind them to take the simulation seriously; in their view, the interaction became more patient-focused because of the presence of moulage. For example, Participant 14 (control) says “*I snapped out of the situation again…thinking more in terms of a manikin than a human”*.

Consistency of presentation

Participants valued the consistency of presentation of visual cues and how the cues interacted with the rest of the story. They repeatedly described that the combined cues contributed to how well they engaged in simulation. It was not one single aspect that contributed more.

Missing information

Participants described missing information as a trigger for disengaging from the simulation. In these instances, they described being reminded that it was a simulation, and that there were limitations. Additionally, they felt that missing information was a limitation to learning how to assess patients; in their view, authenticity forced independent thinking and assisted them to understand how they might behave in real life. Participant 1 (HighAuth) says “*the moulage is good and it’s showing what it’s meant to…that would be really good, but if it’s just like a sticker or something that says ‘blood here’, then that might detract from the situation because I’m like I’ll have to ask heaps of questions about that sort of thing.”*

Personal Knowledge

Personal knowledge was described as a cause of disengagement in the simulation. This was two-dimensional: the level of clinical training the participant had and the previous experiences in simulation.

Level of training

Participants described being unable to progress in the simulation if they got to a point at which they had no experience. For example, deciding what treatment decision would come next, Participant 13 (HighAuth) described feeling at the limit of what they could do after attempting to manage the blood pressure: "*I disengaged a little bit here but this is just my lack of knowledge, rather than the actual situation itself*".

Previous experiences

Beyond this, the participants repeatedly referred to their previous experiences in simulation and how that influenced their interaction with the moulage. Participants described confusion between conditions of simulations and simulated assessments. For example, Participant 50 (HighAuth) described simulated formative assessments where instead of *doing* the clinical activity, they *talked* about what they would do – "*I'm used to OSCEs* [Objective Structured Clinical Examinations]…*I say everything out loud…It's the worst, it's so bad clinically*". In addition to this, participants described the lack of authenticity in previous simulations (non-OSCE type simulations) lead them to treat future simulations with less believability.

"I've done previous simulations before where it's like you're very much, you look at someone and you say what are the obs? How is the heart rate, kind of thing and you just go from there? And I sort of just went back into that … as opposed to actively searching for wounds or actively feeling the pulse…" (Participant 58, Control)

Discussion

The study described sought to explore the potential relationship between the authenticity of moulage and participant engagement in undergraduate medical students. To our knowledge, this is the first study of its kind, in any health professions field.

We predicted that higher levels of authenticity would improve participant engagement in simulation (H1). This hypothesis was supported by the self-report results, whereby students rated highly-authentic moulage as less likely to contribute to episodes disengagement and lack of moulage was likely to contribute to disengagement (H2). However, participants in all three groups agreed that they felt engaged throughout the scenario, which makes H1 less plausible. This survey finding was supported by the results of the ISRI, in which there were no significant differences between groups. We are unsure if this is due to the small study size or a true representation. In the scatterplot representation (Figure 13) of the ISRI scores, the control group had more widely distributed responses; the pattern of HighAuth results might suggest more consistent engagement with the inclusion of authentic moulage than the other groups. These findings of the authenticity rating scale (MARS) also suggested that some moulage, as opposed to authentic moulage, was sufficient for engagement (further making H1 less plausible). One explanation for the ability to engage regardless of authenticity might be that medical students are known to have high levels of motivation – they may already have motivation to engage within a simulation [172]. This was echoed in the interviews with participants, where they talked about an ability to just continue on and reset their engagement. However, participants also discussed constantly searching for something to engage with, either by responding to visual cues or by way of dismissing what they were unable to reconcile within the simulation. This could describe a sort of disengagement, supporting H2. However, perhaps the ability to engage despite the level of authenticity is as a result of extrinsic motivator factors, whereby the individual is motivated by pressure of others (such as the presence of a confederate nurse or the continual flow of the simulation) or perhaps this is what Padgett et al refer to in being “focused towards a task”.

A secondary aspect of the study was to explore students’ perceptions of the authenticity of moulage in simulation. All three groups identified that the authenticity of moulage is important in simulation, and participants in the Control or LowAuth moulage groups did not perceive their encounter to be a realistic representation of a trauma scenario in the survey. However, their limited exposure to simulation and real trauma may have limited their ability to truly rate this. From an opposing perspective, perhaps this reinforces the importance of accurate moulage portrayal for inexperienced clinicians. Extending on this idea of perceiving authenticity, the participants highlighted the impact of previous simulation authenticity and design; that is, perhaps the prior exposure to simulation has a stronger impact on their perception of reality in simulation, than the design of this simulation itself?

We anticipated that the moulage groups would act quicker than the control in the time-to-action index. This was not supported by the data – in fact, in some instances the time-to-action was slower in the HighAuth group. The HighAuth group took (on average) 245.10 seconds to call for help, approximately 30 seconds longer than the control group and 50 seconds longer than LowAuth. Although the results were not significant, we hypothesise that HighAuth had more visual items to prioritise and consider as a part of their assessment process. Interestingly, the Control group exposed the abdomen quicker than LowAuth (around 40 seconds difference), and HighAuth was very similar to the control group timing (3 seconds longer). It is plausible that this also is due to cue processing and the focus on audible cues may have prioritised their clinical decisions. In the interviews, participants identified they focused on certain verbal cues more than others as they believed perhaps there was hidden meaning in them or the confederate was trying to direct them a certain way. This doesn't explain why the HighAuth group exposed the abdomen so quickly, perhaps the visual cues on the face and arms may have triggered a need to investigate, demonstrating the effects of physical and semantic realism. However, this would appear unlikely given the participants discussion in interviews where they expressed the positive views towards moulage being included and the sense of urgency when it was present (demonstrating phenomenal realism).

The HighAuth group administered intravenous fluids slower (at least 50 seconds slower) than the LowAuth and control groups – again, this might be attributed to the number of visual cues that needed processing, signaling their active engagement with the simulation. These results differ from Mills et al (2018) where they found in a comparison of moulage versus no moulage, that the paramedicine students in a moulage group were quicker to respond in time-to-treat [124]. Although there were differences in these times-to-treat, we do not interpret them as clinically-significant. A one-minute difference in these items is unlikely to be life-threatening.

Interestingly, the participants of the HighAuth group were more likely to complete neurovascular observations as compared to the other two groups ($p = 0.05$). However, LowAuth were more likely to complete an abdominal palpation ($p = 0.03$). The HighAuth group applied gloves more often as compared to the other groups combined. The trend to conduct an abdominal palpation continued in the combined LowAuth/Control group ($p = 0.02$). We considered that in the case of the high-authenticity group completing neurovascular observations, this might have been due to the additional visual stimuli of blood that triggered the need (signaling adequate conceptual realism) to check pupillary response and other neurovascular indicators. As hypothesised early in regards to the abdominal palpation, we felt that the absence of other distracting factors (such as lacerations and grazing), the participant focused on the visual and audio cues of the abdominal injury. It was unsurprising to us that the HighAuth were more likely to apply gloves, students expressed in the interviews "*oh I saw the blood and thought, I need to put gloves on*"; this could have interesting implications for the role of moulage in teaching the use of gloves and personal protective equipment (PPE).

In considering the comparisons of moulage versus no moulage (Control versus LowAuth/HighAuth) and HighAuth versus LowAuth/Control, it was interesting that the significant results existed in the latter comparison, as opposed to the first. We interpret this to mean that high authenticity moulage has a more directive effect than the low or no moulage conditions.

In rating the moulage authenticity, participants rated the moulage, or lack of moulage, accordingly. This confirmed the ratings from the other self-report. Students consistently rated the control group moulage as low authenticity, LowAuth as medium authenticity and HighAuth as high authenticity. There has been no previous exploration of moulage authenticity and participants' interaction with varied levels of moulage.

Implications for moulage use

Although moulage may not impact clinical decisions detrimentally, this might not be enough to consider that moulage is insignificant. As we have seen in the interviews, participants identified that they spent significant periods of time trying to determine the conditions of simulation. This is supported by work exploring the process of suspending disbelief (SOD) in nursing students whereby authors state "enhanced environmental fidelity promotes SOD" [47]. Expanding on this further, if the conditions of simulation are not consistent across all exposures in a curriculum, it seems that this has impact on their ability to suspend disbelief, spending more time on focusing on deciphering the relevance. The underlying message here is that consistency across simulations is key.

Beyond this, moulage might contribute as a visual cue more significantly than expected – as demonstrated by the participants' use of gloves and the completion of neurovascular observations and the students' views. Simulation provides an opportunity to rehearse clinical practice and develop the ability to manage complex situations. Students described not taking the simulation seriously or "faking" it; what is the implication for this in transferring learning? Although our primary focus on this study was the impact on engagement, there is a potential link here. If the lack of authenticity of moulage prompts participants to take shortcuts, then it is worth questioning if we are contributing to negative learning? What we mean by this is the inadvertent, incorrect messages that we send to participants. In this scenario, no or poorly authentic moulage reduced the likelihood of applying PPE, sending the message that gloves are unimportant, thereby leading to “habitual unsafe behaviour” as described by Weller et al [26]. The broader result might be an artificial type of learning, which we feel the students alluded to in their comments on “doing it for the sake of doing it”. Another extension of this negative learning might be the example of the slower abdominal palpation in the high-authenticity group – by not exposing participants to real conditions distracting factors, we might be inadvertently training them to only look for the obvious. Creating an authentic environment is often limited by cost, however we would argue that not taking full advantage of simulation (significant expenditure is already there) would be a missed opportunity for rehearsing clinical practice.

Although not generalisable for all situations, the moulage might be better off being authentic. Moulage added complexity to the scenario. Highly-authentic moulage might provide more consistent performance behaviours – what’s the implications of this? High-stakes assessment? Might not be important for technical skills. Low-authenticity moulage might be more confusing than high-authenticity.

Limitations

Despite repeated efforts to recruit participants, we had no success in recruiting the required number indicated by statistical power calculations. The study was advertised with many weeks in advance and delivered at alternate times that might be suitable for students study schedules, including extending the study for an additional year. The simulation centre was based on the same site where students attended classes and placements. This provides limitations for the interpretation of results – the data results may have been too low to detect sizes of effect. Despite this, we did achieve statistically significant results that seemed to be accompanied by an adequate effect size. We recognise the limitations of a single assessor to determine the clinical actions completed and the time-to-treat information. A more robust approach might have been to have two assessors to then confirm the reliability of the judgement. This limitation is also extended to the coding of the interviews – although Grounded Theory techniques do not typically use multiple coders, we did not utilise the whole breadth of Grounded Theory. In this instance, it may have strengthened the work by having a second coder. Unfortunately, time and budgetary restraints limited the feasibility of this.

The type of scenario used could be a potential limitation. Namely, a trauma situation may have more weight on the importance of engagement, as opposed to, for example, a dermatology scenario. Conversely, the urgency of a trauma scenario may have enough impetus to engage participants regardless of the level of authenticity; whilst the authenticity of dermatology might be more important than the authenticity of a trauma simulation.

Conclusions

Exploring engagement is an emerging topic in simulation, with new techniques for measurement becoming available. These methods might provide better guides for measuring engagement. Other areas of work that should be explored include investigating how the quality of previous simulations determine engagement with scenario and how moulage influences on so-called negative learning and developing good clinical habits.. Additionally, further work could be done to explore the relationship of authentic moulage and working memory or cognitive load. This work would be interesting if replicated in a different clinical environment – for example, obstetrics, and other emergency scenarios. And, finally, it would be beneficial to explore the impact of authentic moulage on fully-qualified clinicians or in other health professions groups.

This study adds to our understanding of the role moulage can play in the participants engagement in simulation. Within the context of undergraduate medical students, the use of authentic moulage may provide more consistent patterns of engagement, as compared to no or poor-quality moulage in simulation. Additionally, moulage may provide a more realistic process of prioritising care, thereby contributing to deep learning. We suggest that the authenticity of moulage contributes to learner engagement by highlighting the importance of the activity, allowing them to fully rehearse an activity and minimises instances of determining what is real and what a condition of the simulated environment is.

Supplementary Data

Appendix 1: Supplementary Data – Statistics

Self-reported Engagement Data

ANOVA

		Sum of Squares	df	Mean Square		Sig.
I felt engaged in the simulation	Between Groups	.724	2	.362	.059	359
	Within Groups	10.246	30	.342		
	Total	10.970	32			
At no point did I disengage from the simulation	Between Groups	1.866	2	.933	.399	263
	Within Groups	20.013	30	.667		
	Total	21.879	32			
The appearance of moulage contributed to my engagement in the simulation	Between Groups	3.081	2	1.540	.939	161
	Within Groups	23.829	30	.794		
	Total	26.909	32			
The appearance of moulage did not cause me to disengage in the simulation*	Between Groups	9.014	2	4.507	.231	024
	Within Groups	31.956	30	1.065		
	Total	40.970	32			
The authenticity of moulage is important in simulation.	Between Groups	2.731	2	1.366	.878	170
	Within Groups	21.814	30	.727		
	Total	24.545	32			
This simulation was a realistic representation of a trauma scenario*	Between Groups	6.513	2	3.256	.364	010
	Within Groups	18.214	30	.607		
	Total	24.727	32			
The moulage used was a realistic representation of a trauma scenario*	Between Groups	15.310	2	7.655	1.067	000
	Within Groups	20.751	30	.692		
	Total	36.061	32			
	Between Groups	18.950	2	9.475	2.397	000

The trauma victim looked similar to a real trauma victim*	Within Groups	22.929	30	.764		
	Total	41.879	32			
The appearance of the simulator made me feel like I was in a real trauma situation*	Between Groups	5.343	2	2.672	.869	032
	Within Groups	20.717	30	.691		
	Total	26.061	32			
It was easy to treat the simulator as a trauma victim*	Between Groups	6.065	2	3.032	.752	008
	Within Groups	15.814	30	.527		
	Total	21.879	32			
The simulation compares favorably with other simulation experiences I have had*	Between Groups	3.130	2	1.565	.306	050
	Within Groups	14.203	30	.473		
	Total	17.333	32			
This simulation would offer a good learning opportunity for training and assessment of trauma	Between Groups	1.065	2	.532	.246	302
	Within Groups	12.814	30	.427		
	Total	13.879	32			
The appearance of the victim contributed positively to the training experience*	Between Groups	5.430	2	2.715	.792	034
	Within Groups	21.479	30	.716		
	Total	26.909	32			

Post-hoc tests for self-reported engagement

Multiple Comparisons

Tukey HSD

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
The appearance	1	2	.77778	.44095	.199	-.3093	1.8648

of moulage did not cause me to disengage in the simulation*		3	1.37778*	.47421	.018	.2087	2.5468
	2	1	-.77778	.44095	.199	-1.8648	.3093
		3	.60000	.42732	.352	-.4535	1.6535
	3	1	-1.37778*	.47421	.018	-2.5468	-.2087
		2	-.60000	.42732	.352	-1.6535	.4535
This simulation was a realistic representation of a trauma scenario*	1	2	.52381	.33291	.272	-.2969	1.3445
		3	1.16667*	.35801	.008	.2841	2.0493
	2	1	-.52381	.33291	.272	-1.3445	.2969
		3	.64286	.32262	.131	-.1525	1.4382
	3	1	-1.16667*	.35801	.008	-2.0493	-.2841
		2	-.64286	.32262	.131	-1.4382	.1525
The moulage used was a realistic representation of a trauma scenario*	1	2	.62698	.35533	.199	-.2490	1.5030
		3	1.75556*	.38213	.000	.8135	2.6976
	2	1	-.62698	.35533	.199	-1.5030	.2490
		3	1.12857*	.34435	.007	.2797	1.9775
	3	1	-1.75556*	.38213	.000	-2.6976	-.8135
		2	-1.12857*	.34435	.007	-1.9775	-.2797
The trauma victim looked similar to a real trauma victim*	1	2	1.07143*	.37351	.020	.1506	1.9922
		3	2.00000*	.40168	.000	1.0097	2.9903
	2	1	-1.07143*	.37351	.020	-1.9922	-.1506
		3	.92857*	.36197	.040	.0362	1.8209

	3	1	-2.00000*	.40168	.000	-2.9903	-1.0097
		2	-.92857*	.36197	.040	-1.8209	-.0362
The appearance of the simulator made me feel like I was in a real trauma situation*	1	2	.81746	.35505	.071	-.0578	1.6927
		3	.98889*	.38182	.038	.0476	1.9302
	2	1	-.81746	.35505	.071	-1.6927	.0578
		3	.17143	.34407	.873	-.6768	1.0197
	3	1	-.98889*	.38182	.038	-1.9302	-.0476
		2	-.17143	.34407	.873	-1.0197	.6768
It was easy to treat the simulator as a trauma victim*	1	2	.19048	.31020	.814	-.5743	.9552
		3	1.03333*	.33360	.011	.2109	1.8557
	2	1	-.19048	.31020	.814	-.9552	.5743
		3	.84286*	.30061	.023	.1018	1.5839
	3	1	-1.03333*	.33360	.011	-1.8557	-.2109
		2	-.84286*	.30061	.023	-1.5839	-.1018
The simulation compares favorably with other simulation experiences I have had*	1	2	.46825	.29398	.264	-.2565	1.1930
		3	.81111*	.31615	.040	.0317	1.5905
	2	1	-.46825	.29398	.264	-1.1930	.2565
		3	.34286	.28489	.460	-.3595	1.0452
	3	1	-.81111*	.31615	.040	-1.5905	-.0317
		2	-.34286	.28489	.460	-1.0452	.3595
The appearance	1	2	.730	.362	.125	-.16	1.62

of the victim contributed positively to the training experience*		3	1.044*	.389	.030	.09	2.00
	2	1	-.730	.362	.125	-1.62	.16
		3	.314	.350	.646	-.55	1.18
	3	1	-1.044*	.389	.030	-2.00	-.09
		2	-.314	.350	.646	-1.18	.55

*. The mean difference is significant at the 0.05 level.

Moulage Authenticity Rating Scale Results

ANOVA

Physical

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	195.261	2	97.631	10.232	.000
Within Groups	276.708	29	9.542		
Total	471.969	31			

Multiple Comparisons

Dependent Variable: Physical

Tukey HSD

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
1	2	-3.76923*	1.33946	.023	-7.0772	-.4612
	3	-6.40000*	1.41928	.000	-9.9051	-2.8949
2	1	3.76923*	1.33946	.023	.4612	7.0772
	3	-2.63077	1.29928	.124	-5.8395	.5780

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
3	1	6.40000*	1.41928	.000	2.8949	9.9051
	2	2.63077	1.29928	.124	-.5780	5.8395

*. The mean difference is significant at the 0.05 level.

ANOVA

Cognitive

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	168.211	2	84.105	8.718	.001
Within Groups	279.758	29	9.647		
Total	447.969	31			

Multiple Comparisons

Dependent Variable: Cognitive

Tukey HSD

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
1	2	-4.80342*	1.34682	.004	-8.1296	-1.4772
	3	-5.41111*	1.42708	.002	-8.9355	-1.8867
2	1	4.80342*	1.34682	.004	1.4772	8.1296
	3	-.60769	1.30643	.888	-3.8341	2.6187
3	1	5.41111*	1.42708	.002	1.8867	8.9355
	2	.60769	1.30643	.888	-2.6187	3.8341

*. The mean difference is significant at the 0.05 level.

Multiple Comparisons

Dependent Variable: Combined

Tukey HSD

95% Confidence Interval

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
1	2	-8.57265*	2.39442	.003	-14.4860	-2.6593
	3	-11.81111*	2.53709	.000	-18.0768	-5.5454
2	1	8.57265*	2.39442	.003	2.6593	14.4860
	3	-3.23846	2.32259	.357	-8.9745	2.4975
3	1	11.81111*	2.53709	.000	5.5454	18.0768
	2	3.23846	2.32259	.357	-2.4975	8.9745

*. The mean difference is significant at the 0.05 level.

ANOVA

OVERALL (Global rating)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.360	2	3.680	7.897	.002
Within Groups	13.515	29	.466		
Total	20.875	31			

Multiple Comparisons

Dependent Variable: OVERALL (Global rating)

Tukey HSD

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
1	2	-.598	.296	.125	-1.33	.13
	3	-1.244*	.314	.001	-2.02	-.47
2	1	.598	.296	.125	-.13	1.33

	3	-.646	.287	.079	-1.36	.06
3	1	1.244*	.314	.001	.47	2.02
	2	.646	.287	.079	-.06	1.36

*. The mean difference is significant at the 0.05 level.

Appendix 2 - Stimulated Recall Interview - Instruction for Interviewer

Duration: 40 mins

The following sentence/paragraph is to be read to the participant at commencement of the Stimulated Recall Interview (SRI).

“We will now commence the Stimulated Recall Interview. I will play back the video of the simulation, and allow you to reflect on your engagement with the simulation. I have watched the video and made note of areas of interest (<u>in engagement and disengagement, and related to moulage)</u> that occurred in the simulation, and have some questions. I would like you to watch the video, and stop it at any point to describe what you were thinking regarding your engagement in the simulation/moulage. If you become too involved watching the video, I will stop the video at the pre-annotated points of relevance/interest and ask questions."

Crafting questions:

Questions will be crafted based on your observation of the simulation activity. Using the Immersion Rating Scale as a guide, your questions should be focused on activities related to engagement, disengagement and moulage.

Do not ask questions about:

- Clinical decisions
- Teamwork
- Communication

Do ask questions about:

- Moulage (in general, its appearance, their interaction with moulage)
- Engaging in the activity or periods of disengagement

In general terms:

What happened?

Why?

What did you think about…(example)?

Example questions:

<u>When you first saw</u> the moulage/narrative of moulage, what did you think?

<u>I noticed you did not address</u> the moulage/narrative of moulage, what were you thinking about it?

<u>When you assessed</u> the wound (moulage), what did you think?

Appendix 3 – Engagement Survey Questions

Please rate your agreement with the following statements:

1. I felt engaged in the simulation
2. At no point did I disengage from the simulation
3. The appearance of moulage contributed to my engagement in the simulation
4. The appearance of moulage did not cause me to disengage in the simulation
5. The authenticity of moulage is important in simulation.
6. This simulation was a realistic representation of a trauma scenario
7. The moulage used was a realistic representation of a trauma scenario
8. The trauma victim looked similar to a real trauma victim
9. The appearance of the simulator made me feel like I was in a real trauma situation
10. It was easy to treat the simulator as a trauma victim
11. The simulation compares favorably with other simulation experiences I have had
12. This simulation would offer a good learning opportunity for training and assessment of
13. The appearance of the victim contributed positively to the training experience

Appendix 4 – Moulage Application

In the low-authenticity moulage group, a single red crème was applied using a latex-free sponge to all three injury sites. In the high-authenticity group, the single red crème was applied to the abdomen to depict a Day 1 reddened bruise. Hand-cast silicone wounds were created to match the manikin's skin tone and were used as the base for the arm and head grazes and lacerations. Further makeup was applied to add detail and contribute to the authenticity. This included Ben Nye charcoal for dirt, Red crème for reddened areas on the wound, Ben Nye theatre blood for depicting fresh blood, and Ben Nye dried blood to depict scabbing and grazing (Figures 1 2 and 3).

Figure 12- Control

Figure 13 - Experimental Group 1

Figure 14 - Experimental Group 2

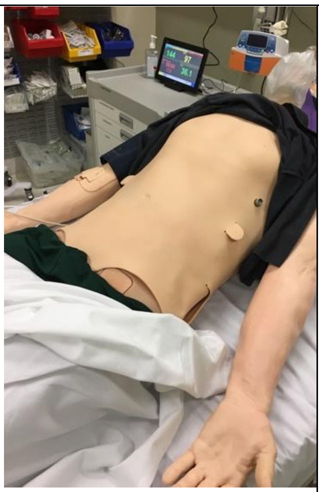


Figure 15- Control Group

Figure 16 - Experimental Group 1

Figure 17 - Experimental Group 2

CHAPTER 8: EVALUATING ENGAGEMENT IN RELATION TO MOULAGE IN SIMULATION

The purpose of this study was to achieve the following research aim:

3. To determine how the use of authentic moulage impacts on engagement of participants in a healthcare simulation.

This chapter specifically addresses the following questions:

1. How does the use of moulage authenticity impact on engagement of participants in a healthcare simulation?
2. What is the impact of hi vs lo authenticity of the moulage design on the engagement as measured by eye tracking?

Paper Title: Measuring the engagement of medical students in simulation using eye-tracking methodology: a randomised comparison study (*under review*)

Publication Relevance to Thesis

I significantly contributed to the research in this paper, which forms the following chapter. I contributed, in the majority, to the conception and design of the project. I performed the entirety of data collection and the significant majority of data analysis, consulting with co-authors on occasion when the data analysis need verification. I wrote the paper and performed the edits and revisions for publication, with some assistance from co-authors with editing.

Citations to date: NA

Copyright: NA

Ethics approval

Ethics approval was obtained and is described in the study.

Awards

The study materials, protocol and ethics application for this study are in development.

This study was awarded the 2017 Society of Simulation in Healthcare Novice Researcher Grant ($10,000.00 USD), and received a UON Seed Fund of ($8,700AUD).

Submitted to Medical Teacher on October 30, 2019

Abstract

Introduction

Ensuring participants of simulation are active in their learning and making the most of the activity are major considerations for healthcare simulation designers. Various strategies are used to achieve this, including the use of environmental cues like moulage. It is unclear the impact that moulage has on visual intake and engagement in simulation. In this study, we explore the impact of varied levels of moulage authenticity on engagement using eye-tracking methodology.

Methods

We randomized undergraduate medical students to three groups: control, low-authenticity moulage and high authenticity moulage. Each group participated a trauma scenario wearing eye-tracking glasses. In our analysis we compared visit counts and average visit duration for the Areas of Interest. In addition, we compared Foveal Stabilisation (the time between movements) counts, duration of first Foveal Stabilisation and average Foveal Stabilisation time. Following this, we completed purposive scan path sampling. In conjunction with these we utilised Stimulated Recall Interview Techniques to explore participants thinking and experiences.

Results

33 Participants completed the study, 32 sets of data were analysed. Statistically significant differences were present in Areas of Interest (AOI) average visit counts (Arm Injury, Mean 11.6, p .010), visit durations (Confederate, mean .54s, p .030), total visit duration (Arm Injury, Mean 3.17s, p .016) and Foveal Stabilisation counts to AOI (Arm Injury, Mean 14.4, p .035). Scanpaths demonstrated differences in looking patterns, lookbacks and clustering of views.

Conclusions

The representation of moulage appears to contribute to whether medical students pay attention to stimuli, prioritise care and engage with the patient. Lack of detail in moulage representation increases visual searching and reduces time spent looking and talking with the patient. Authentic moulage contributes to more structured and focused looking patterns. Detailed stimuli is required for maximising visual intake opportunity and may be a predictor for successful engagement in simulation. Further research is warranted to

explore this phenomenon in other specialties, disciplines and with the lens of exploring emotion and empathy.

Introduction

Engagement is a hot topic in simulation based medical education (SBME). Engagement in learning is described as the process in which a learner is motivated and actively participating in their own learning [38]. Engagement is thought to be particularly important in simulation due to its experiential nature. Whilst the definition of engagement in simulation is yet to be universally agreed upon [38, 173], we define it as "*the state in which the participant is observed to be actively interacting with the simulation as if it were real*." (Stokes-Parish, under review).

SBME is utilised at all levels of health professions education, both undergraduate and postgraduate. Simulation uses a variety of methodologies to deliver the desired learning outcome – simulated patients, manikins, task trainers and/or hybrid simulation designs used. To optimise the outcomes of SBME, cues and props are used to situate the learner in context and provide believability, thus *engaging* the learner in the activity. In combination with effective orientation and debriefing, the environment of simulation can lead to transformational learning [174].

One of these environmental cues is modern moulage; the use of special effects makeup techniques to replicate illness and other effects, like wounds. Historically moulage was the use of moulds to create wax replicas of wounds in the 16th century [153], now it has evolved to the modern day use of special effects makeup. In Dieckmanns' hypothesis of realism, he posits that realism is comprised of 3 elements: Physical, semantic (conceptual) and phenomenal (emotional) realism. In our hypothesis (reference), we propose that moulage contributes to all three elements of realism. Obviously it is a physical component of overall simulation realism, however it also contributes to the conceptual and emotional aspects. Moulage uniquely contributes to participants' ability to move from A to B, e.g. the moulage in the simulation presented provides a cue that abdominal injury has occurred, thereby suggesting that there should be further investigation. Emotionally, moulage contributes to the ability for the participant to "buy-in", emotionally investing in the simulation.

Moulage has become an area of interest for simulation educators due to the expense of its use and the large amount of "unknowns" about its effectiveness. We have highlighted the need for this research in previous work [100]. In this study, we outline the effects of varied levels of moulage and utilise eye tracking methods to demonstrate the effect.

Aims

The specific aims of this study were to explore the following question:

- What is the impact of high versus low authenticity moulage on the engagement as measured by eye tracking?

Hypotheses

- The high authenticity moulage participants would be more engaged (in the context of eye tracking visit the moulage more frequently)
- Poorly authenticity moulage participants were be less engaged (in the context of eye tracking visit the moulage less frequently)

Methods

The full scenario conditions and design have been reported elsewhere (Stokes-Parish, under review).

Participants were randomized into control and experimental groups to participate in a single trauma simulation. The control group was narrative case only, whilst experimental groups were both narrative case and moulage. The experimental groups were further randomized to either highly authentic or inauthentic moulage. The study protocol was approved by the University of Newcastle Human Research Ethics Committee (H-2017-0214).

We utilised mobile eye tracking glasses in combination with Stimulated Recall Interviews to determine students' visual attention and engagement. The results of the Stimulated Recall analysis are described elsewhere (Stokes-Parish, under review), we will expand those results here.

Eye Tracking Methods

We used the Tobii Pro Glasses 2.0 (50Hz) to record the participant behaviours and pupil movement [175]. The Tobii Pro Glasses 2.0 are a system with 4 eye tracking sensors, 2 per eye. The eye tracking glasses are similar in appearance to personal protective glasses. The glasses were calibrated using the single-point calibration processes required for the Tobii Pro Glasses 2.0. Each participant was immersed in a 5-minute familiarisation activity to reduce awareness of the glasses whilst participating in the simulation. Before detailing the results, we briefly outline the basics of eye tracking and the rationale for its use as a measure for engagement. The participant wore the eye tracking glasses for the duration of the simulation. During the simulation the participants eye gaze was recorded. At the completion of each simulation, the video recording was saved and played back for the stimulated-recall interview (see previous paper).

Evidence for eye-tracking as a measure of engagement

Eye tracking is a methodology in medical education that has been used to improve gaze strategies in surgical training, understand perceptual-cognitive mechanisms when interpreting electrocardiograms, improve lung nodule detection [176] and grading of neoplasms in pathology [177, 178]. In newer applications, eye-tracking has been used as a feedback tool for undergraduate health professions students [179] and to demonstrate proficiency in clinical practice [178].

Eye tracking captures a number of measures to understand what the fovea is processing and has taken attention to [171]. Measuring duration of fixation, number of fixations, dwell time and number of dwells could give a good indication of engagement, or lack of, with moulage. The eyes are constantly processing visual cues, whether unconsciously or consciously, and trigger a variety of responses in cognitive functions, emotion and physiological effect [86, 88, 180]. Fixations reflect the moment when an individual stops scanning a room, and settles on a focal point; at this point, the individual begins processing information, and reflects engagement of attention [180]. A saccade, on the other hand, is a rapid eye movement, as opposed to fixing on a focal point. The saccade occurs between the fixations, and experts suggest it is unlikely to contribute to information intake due to the poor quality of image received by the retina; a saccade might be in response to a sudden movement or a reflection of a deliberate shift in attention [180]. An average saccade duration is between 20 and 40 milliseconds (ms), whilst a fixation duration varies between 50-600ms [171].

In our study, we have utilised dynamic footage; the participant moves in real time with the glasses on, moving their head and eyes based on the scenario. This is an important distinction between traditional eye tracking studies, whereby the eye tracking was typically static or stationary. In this, the most relevant moments to explore are the moments of smooth pursuit, where the fovea aligns itself with moving objects.

Eye tracking algorithms have been designed to make assessments on the fixation and visits through a variety of techniques. The traditional algorithms were designed for static studies, such as reading or watching a computer. While the emergence of eye tracking has led to the need to develop algorithms for assessing dynamic footage, where the fovea, head and subjects move. In particular, the work by Andersson et al [181] compared the accuracy and reliability of computer analysis versus human analysis in eye tracking algorithms. In summary, they highlight that standard fixation (the point at which the fovea stops moving) detection methods are not appropriate to use in situations where dynamic stimuli or smooth pursuit are predominant – “standard algorithms should not be accurate for data from dynamic stimuli” [181]. Instead of measuring when the starting point of the fovea settling, the proposed approach should be to define a fixation as the periods between detected movements.

Method of Eye Tracking Analysis

The data from the Tobii Pro Glasses 2.0 was exported to Tobii Pro Lab and each video was coded for Areas of Interest. We identified 5 Areas of Interest (AOI) a priori:

- Facial Wounds
- Arm Wounds
- Abdominal Wounds
- Observation Monitor, and
- Confederate.

JSP completed the AOI coding was frame-by-frame – this process included selectively tagging each AOI and “anchoring” to the respective AOI. The frame-by-frame location was assessed and corrected. After analysing the coding reports, we identified samples of interactions of interest for scan paths via a purposive sampling method. Due to the time intensive nature of coding eye-tracking, it is considered normal practice to have a single coder in this process[171].

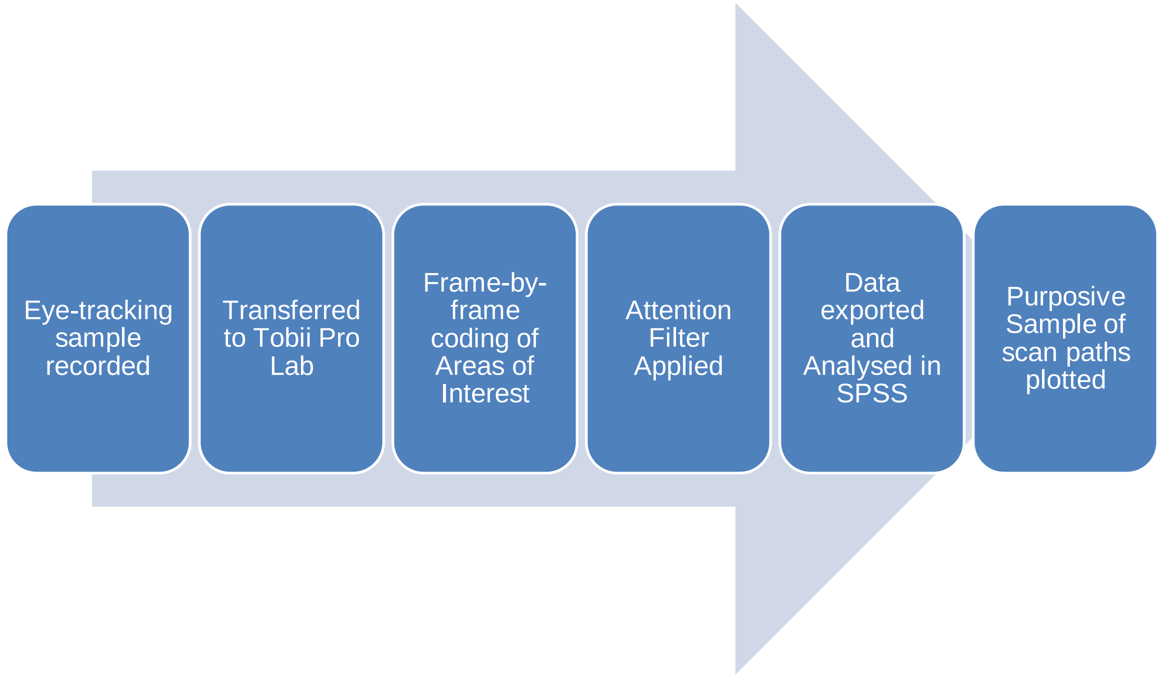


Figure 18 - Eye tracking Coding Workflow

Statistical Analysis

IBM Statistical Software Package for Social Science (SPSS v. 25) was used for all statistical comparisons. Statistical significance was defined as a value of 0.05. We used one way ANOVA to compare groups and used further post-hoc tests (Tukey's) where appropriate to determine differences between the 3 groups. When comparing combinations of the groups, we utilised Independent T-Tests.

Results

Participants

A total of 33 undergraduate medical students were recruited, with 32 eye-tracking samples selected for inclusion in this analysis. One dataset was lost during the recording process. The students participated during Semester 2 in 2017 and 2018. 9 were randomised to the control group, 13 to Low Authenticity (LowAuth) and 10 to High Authenticity (HighAuth).

Eye Tracking Metrics

We compared visit counts, and average visit duration for the Areas of Interest. In addition, we compared Foveal Stabilisation (the time between movements) counts, duration of first Foveal Stabilisation to AOI and average AOI Foveal Stabilisation (FS) time.

According to Tobii, visits are defined as the portion of gaze data (including missing data) between the start of the first FS on the AOI until the end of the last FS on the AOI, before an exit saccade. For FS detection using the Tobii Pro Lab IVT Attention filter, the velocity threshold is 100*/s. This filter was specifically designed for dynamic footage analysis, to enable more accurate saccade detection. At 30*/s we will underestimate periods of attention, while in 100*/s we might over estimate. Based on the evidence available, we selected to abstract coding data from the eye tracking using the IVT-Attention filter [181]. The algorithm has a pre-set threshold to discard Foveal Stabilisations below 60ms. We did not adjust this threshold in our study, due to the lack of evidence for determining intake in dynamic footage situations [181]. Throughout the results we refer to the period between movements as the FS, as opposed to fixations.

Visit Counts

The AOI Average Visit Count can be seen in Figure 21. The mean visit count for the arm was 11.6 (SD 9.8), there was a statistically significant difference between groups (p 0.010). Participants in the HighAuth group viewed the arm injury the most (Mean 19, SD 9.9), the control group viewed the arm injury on average 10 times (SD 9), and the LowAuth group viewed the least (Mean 7.3, SD 6.9). There was a statistically significant difference between the LowAuth and HighAuth groups (p .008). All other results were not statistically significant.

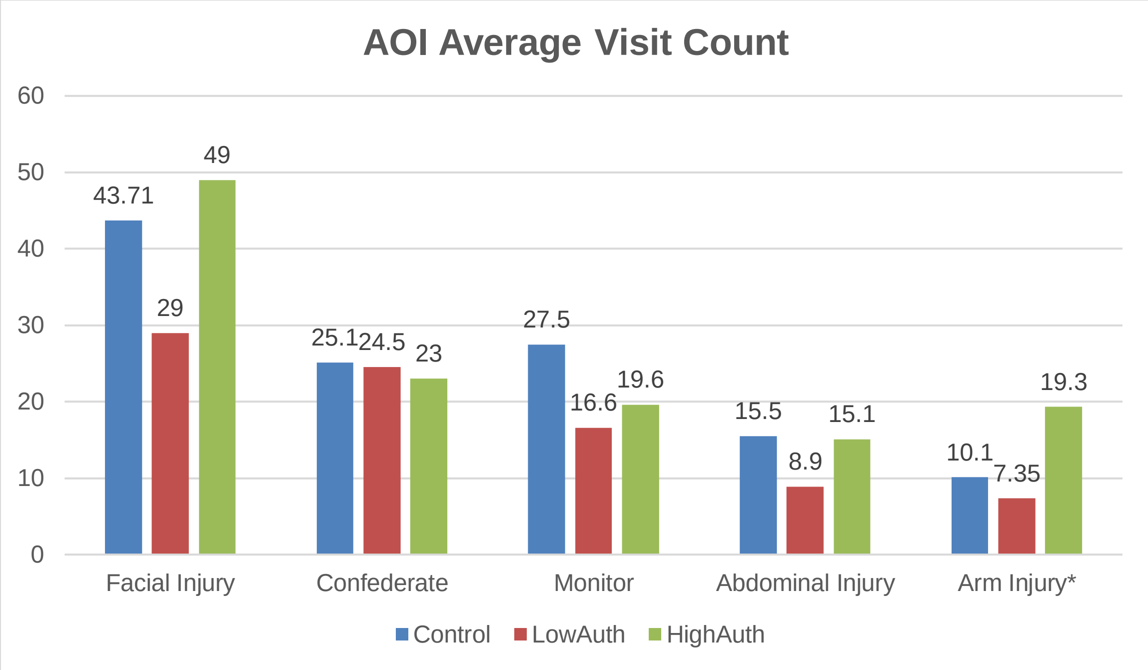


*Figure 19 Average visit count to AOI, * denotes significance*

We completed a T-Test to compare HighAuth versus combined Control and LowAuth, in which there was a statistically significant result on the Arm AOI (p 0.003). All other results were not statistically significant, including a comparison of No moulage (Control) versus moulage (HighAuth and LowAuth combined).

Table 11 - High vs Control and Low T Test of Visit count

Area of Interest (AOI)	**Group**	**Number in Group**	**Mean Duration (seconds)**	**Standard Deviation**
Abdominal Injury	Control	6	.1933	.10596
	LowAuth	10	.2280	.12044
	HighAuth	9	.2878	.19835
Arm Injury	Control	7	.2386	.19600
	LowAuth	14	.2129	.17189
	HighAuth	9	.3378	.18206
Confederate*	Control	8	.4813	.24074

	LowAuth	14	.4357	.25428
	HighAuth	10	.7520	.34295
Facial Injuries	Control	7	.3829	.16111
	LowAuth	14	.3321	.16197
	HighAuth	9	.4933	.32909
Observations Monitor	Control	8	.7400	.49077
	LowAuth	13	.5323	.43628
	HighAuth	9	.8700	.77664

*Statistically Significant Result

The average visit durations can be seen in Table 13. Participants looked at the confederate for an average of 545ms (SD 307). The HighAuth looked at the confederate for the longest period (Mean 752ms, SD 342ms), the Control group the shortest (Mean 481ms, SD 240ms) and the LowAuth group were slightly behind this at 435ms (SD 254ms). This results demonstrated a statistically significant difference between (p. 030) and within groups HighAuth and LowAuth (p. 029). There were no other statistically significant results.

Table 12 AOI Average Visit Durations

AOI		**Number in Group**	**Total Duration (Seconds)**	**Std. Deviation**
Abdominal Injury	Control	6	3.8833	5.37974
	LowAuth	10	2.3630	2.08615
	HighAuth	9	6.8211	9.68085
Arm Injuries*	Control	7	3.1771	3.84109

	LowAuth	14	2.0329	2.81192
	HighAuth	9	7.3056	5.55639
Confederate	Control	8	12.8738	10.17054
	LowAuth	14	13.1100	13.68991
	HighAuth	10	16.1210	10.91435
Facial Injuries	Control	7	18.0200	14.47182
	LowAuth	14	11.9814	14.33077
	HighAuth	9	31.2533	38.26649
Observation Monitor	Control	8	24.2000	25.35061
	LowAuth	13	11.6385	13.85828
	HighAuth	10	13.0960	9.66421

*denotes significant result

The mean total visit duration to the arm injury was 3.88s (SD 4.53). The HighAuth group looked at this injury for a total of 7.30s on average (SD 5.55s), and the Control (Mean 3.17s, SD 3.84s) and LowAuth (Mean 2.03s, SD 2.81s) groups were similar – the results were statistically significant between and within groups (Between p .016; Within Groups LowAuth and HighAuth p .013).

Foveal Stabilisation

We compared the First Foveal Stabilisation duration to AOI across the groups, there were no statistically significant responses (See Figure 22). In addition, we compared Foveal Stabilisation count to AOIs across group (See Figure 23 and Table 14). There was a statistically significant difference between groups on the Arm Injury AOI, with the post-hoc Tukey's showing a statistically significant difference between the LowAuth and HighAuth groups. No other results were statistically significant.

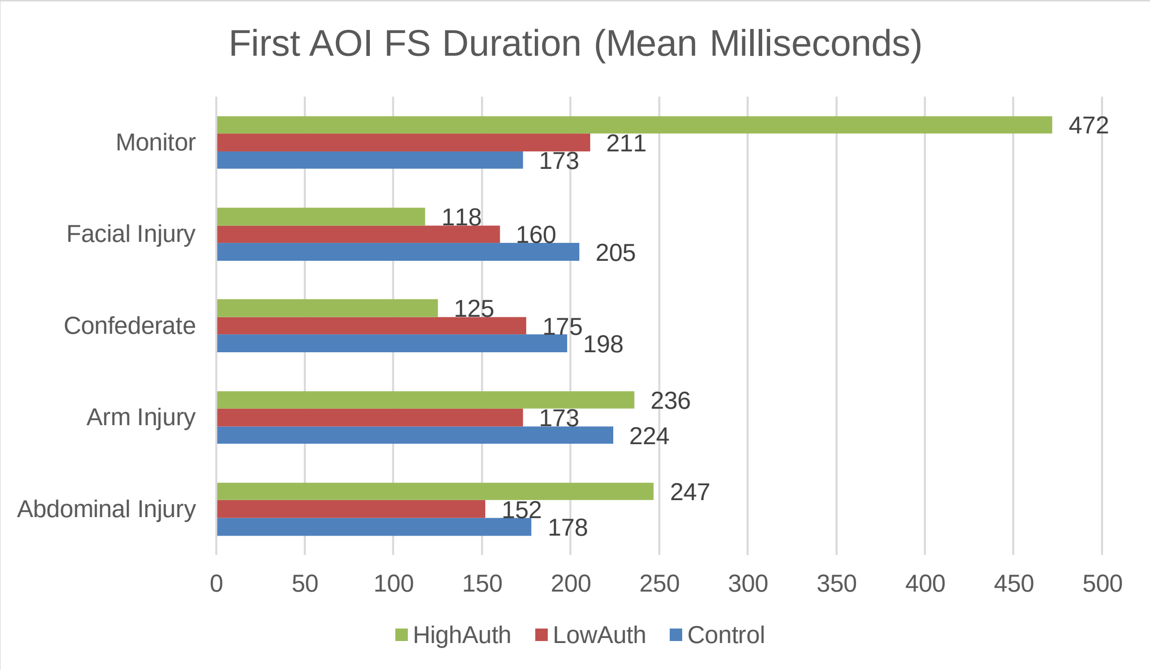


Figure 20 - First AOI FS Duration

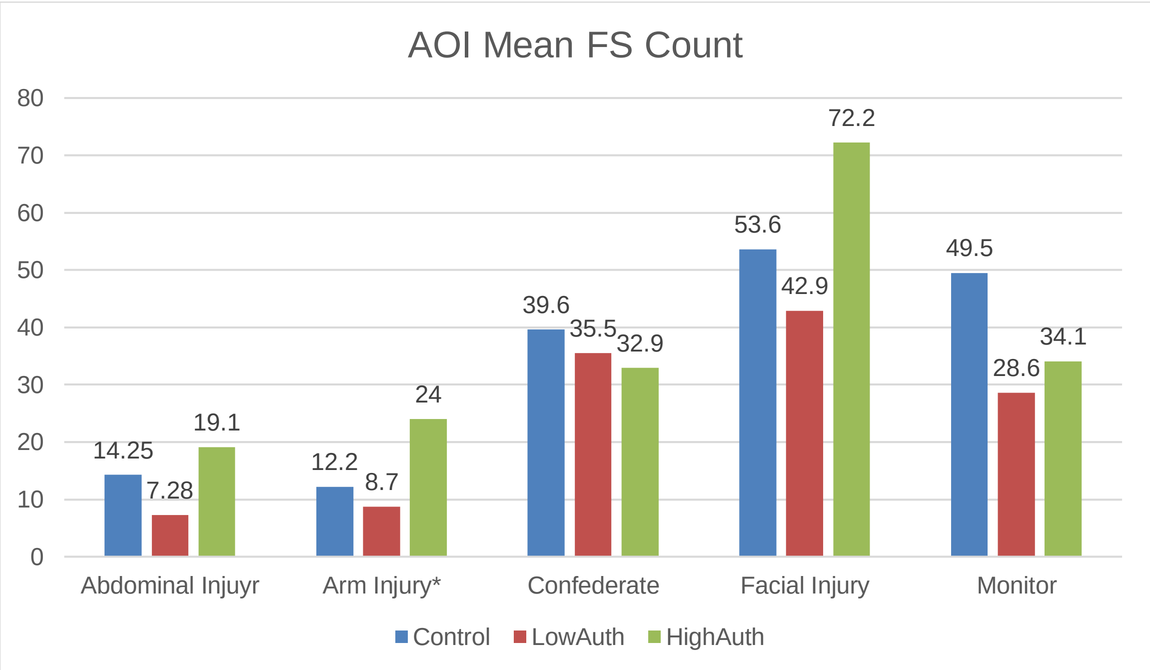


*Figure 21 - AOI Mean FS Count, *denotes significance*

Table 13 – Mean Count of FS to Arm ANOVA

Count FS ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Arm	Between Groups	1404.268	2	702.134	3.781	.035
	Within Groups	5385.232	29	185.698		
	Total	6789.500	31			

Eye Tracking Scanpaths

The scanpath depicts looking patterns (location, time and duration of attention) of the medical students when engaging with the various AOIs [171]. Following quantitative data analysis, we selected a purposive sample of high-quality gaze plots pertaining to each AOI. We present these here.

First Look at Overall Scene

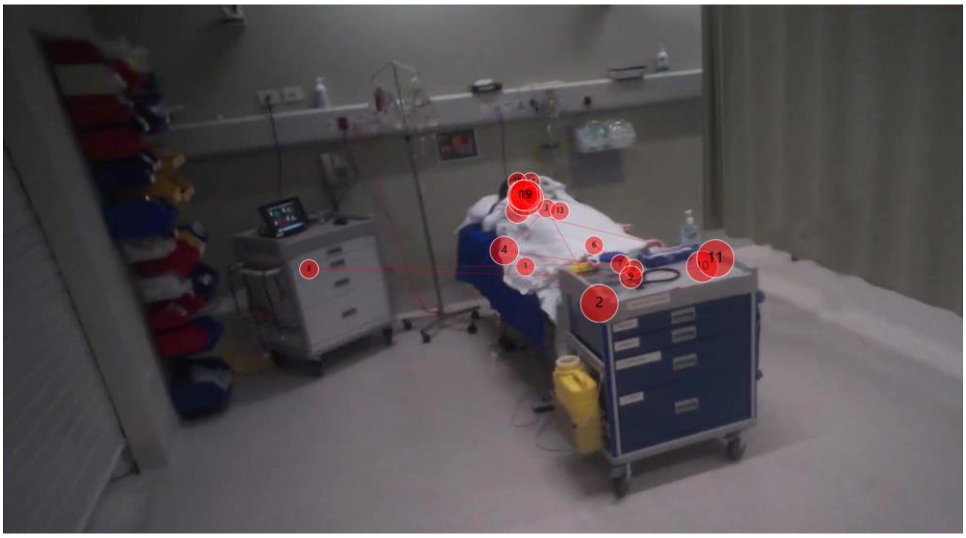


Figure 22 First Look Overall Scene (Participant 1, HighAuth)

Figure 23 - First Look Overall Scene (Participant 20, LowAuth)

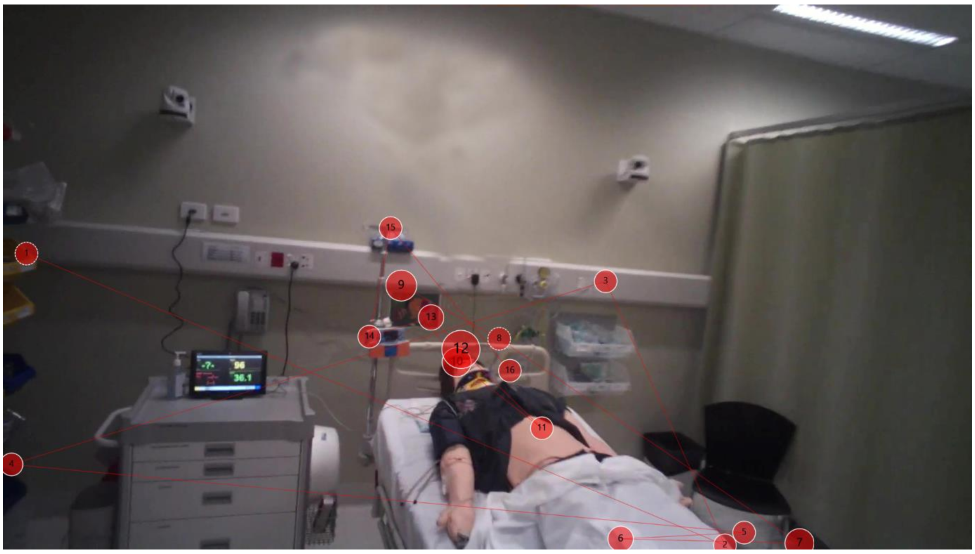


Figure 24 - First Look Overall Scene (Participant 11, Control)

In the side by side comparison of the First Look at scanpath samples we can see differences between the direction of the scanpath, the number of visits (the round circles) and the lookbacks present. In the Control group example, the pattern of observation is very direct, with the larger circles denoting a longer period of time dwelling on that point. In the LowAuth example, the scanpath is scattered and there is only a single, dominant visit. In the HighAuth sample, we noted that the scanpath is highly clustered with some central areas of visits, however the dwell times are not as long as the control group. The HighAuth example shows a very detailed consideration of the cues presented as they examine the abdomen. In the LowAuth we see that the observation appears not very focused, indicating confusion about what they are seeing or a lack of significance.

Figure 25 - First Look Abdominal Injury (Participant 13, HighAuth)

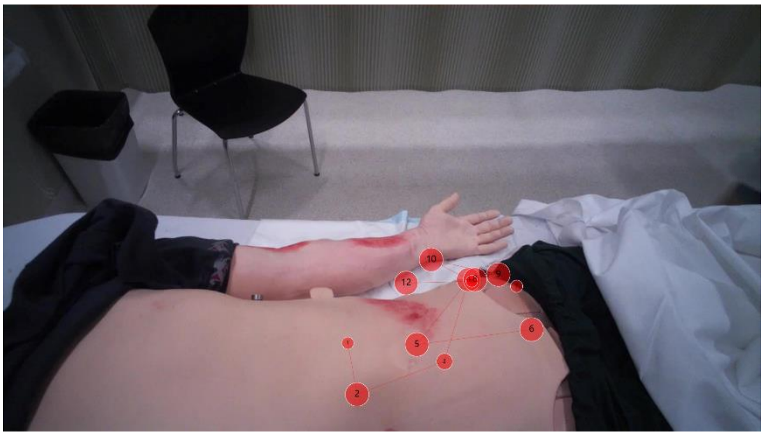


Figure 26 - First Look Abdominal Injury (Participant 10, LowAuth)

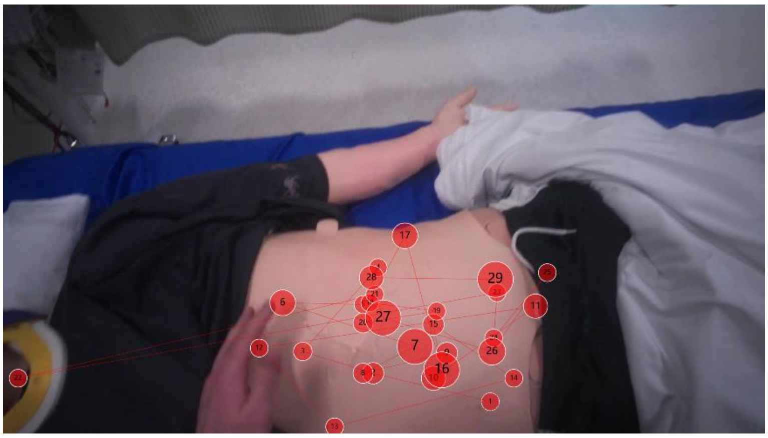


Figure 27 - First Look Abdominal Injury (Participant 15, Control)

First Look at Arm Wound

Figure 28 - First Look Arm Injury (Participant 50, HighAuth)

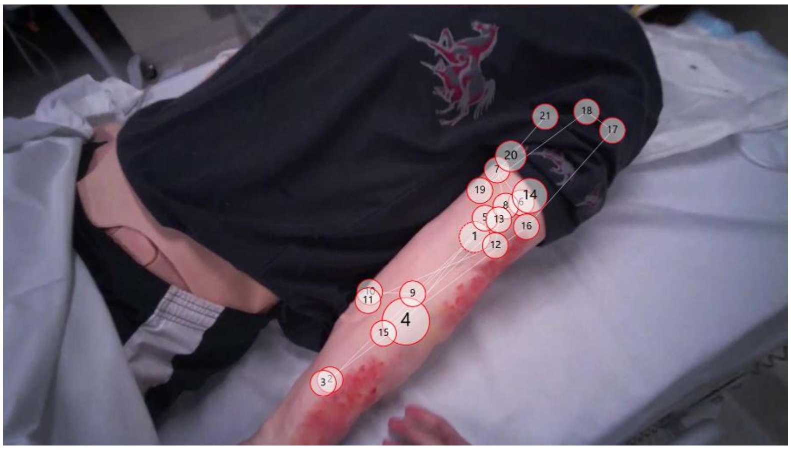


Figure 29 - First Look Arm Injury (Participant 39, LowAuth)

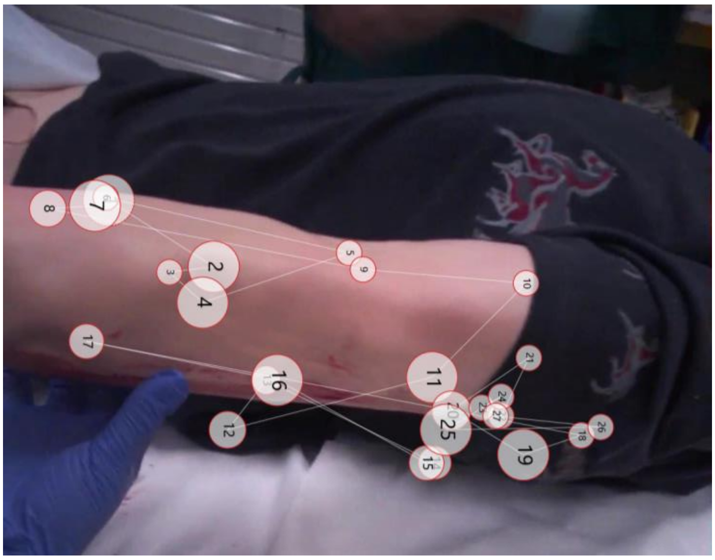


Figure 30 - First Look Arm Injury (Participant 37, Control)

Discussion

In this research we sought to explore how the authenticity of moulage influences engagement as measure by eye tracking. To our knowledge, this is the first study to investigate moulage authenticity in simulation.

We predicted that higher moulage authenticity would lead to higher participant engagement in simulation. The HighAuth group viewed the facial wound AOI more frequently than both the Control and the LowAuth, although the control was similar to the HighAuth. This could indicate that the participant was more engaged with the patient and was finding the relevant information. This doesn't explain why the LowAuth group looked at the face less frequently than both of the other groups, as we would have presumed that the reddened area would have been a trigger to revisit the area. In our previous work (Stokes-Parish et al, under review), Stimulated-Recall Interview analysis revealed that participants either ignored or forgot about the visual injury cues throughout the simulation. Some participants described "dismissing" the moulage in the LowAuth setting as they assumed this representation meant that the injury was unimportant (Stokes-Parish et al, under review). This effect was replicated in the Abdominal and Arm Injury cue visit counts, where the HighAuth group visited the cues the most amount of times in both instances. We hypothesise here that the reason that the LowAuth moulage group had lower visit counts is due to the lack of three-dimensional appearance and colour contrast. The literature on visual attention indicates that visual intake is influenced by the representation of the stimuli [87].

When considering the visit durations, we found that the HighAuth group looked at the confederate for the longest. When formulating our hypothesis, we anticipated that the HighAuth group might not need to rely on the confederate as much with the added visual cues. However, these results (Duration of First FS to Confederate AOI, Average Visit Count) would suggest that the more interaction with the confederate was an indication of higher levels of engagement within the scenario, whereby they interacted naturally with more complex stimulus. In our previous report (Stokes-Parish et al, under review) we found that participants took longer to initiate some treatments in the HighAuth group. We hypothesise that more complex stimuli lead to the longer cue processing forcing them to appraise and prioritise differential diagnoses. This cognitive appraisal is more reflective of real life conditions – they must appraise the priority at the same time as interpreting the results.

The overall low number of visit counts in the LowAuth group indicates a higher proportion of visual searching time throughout the scenario, as opposed to attention time. This is demonstrated by the analysis of the scanpaths, where the LowAuth and Control group participants appeared to have more scattered scan paths with no areas of high attention, indicating that visual intake might be lower. The Theory of Visual Attention describes the process in which we select items to focus our cognitive efforts on based on the field of view. In this process, we consciously and unconsciously filter the visual cues in our field of vision for relevance and importance relative to the activity at hand [86]. When considering semantic realism (whereby a cue must be presented with enough information to be conceptually believable) [182], and semantic representation [183], the LowAuth and Control groups appear to be unable to see the stimuli (the wound) in enough detail, therefore they cannot jump from A to B (as demonstrated by the scattered scanpath). This is also reflected in the interview theme of “believability” (Stokes-Parish, under review), whereby students described desiring to believe what they see. When participants could not clearly identify cues, they were “*looking for every little detail... [to] glean…their clinical situation*”, which is aligned with their visual searching in the scanpath examples.

The high number of visit counts to the facial injury over the other areas of interest is unsurprising given the communication between the participant and the manikin. It is interesting to us, this focus on the patient as a by-product of visual authenticity; perhaps this represents a stronger interest in the patient or a type of empathy due to the emotive response evoked by visual cues [183]. The high number of visit counts is consistent with other work by Browning [184] whereby the face was the more frequently visited AOI. However, their work may have underreported interest in the area due to the threshold for Foveal Stabilisation (referred to as Fixation, set at 150ms). In addition, they did not explore duration of visits or scanpaths as a means of determining attention. In work by

Mills [124], average fixation durations were measured, but visit counts were not. In addition, the fixation threshold was set far higher than recommended levels (400ms), so we would argue that the results presented were not reflective of attention. In both of these studies, the algorithm applied to analysis was not described, limiting the replicability of results.

Limitations

The study does present limitations for the interpretation of results – the participant number may have been too low to detect sizes of effect. Despite this, we did achieve statistically significant results that seemed to be accompanied by an adequate effect size. In addition to this, we would argue that eye-tracking is a mixed methodology, therefore we present a suitable number of results for qualitative analysis. In addition to this, if we had recruited the expected number of participants, the data analysis would have been time-consuming and unfeasible.

There remains a lack of guidelines for best analysis practice in “dynamic footage” eye-tracking situations. Despite this, we believe our rationale for analysis methods is in line with the best available evidence internationally. We did not limit ourselves to static analysis measures and maximised the data we did have.

A further limitation related to eye tracking methodology is quality of data capture. The eye tracking quality might have been limited by the participants, shape of pupils, colour of the pupils, the presence of makeup on eyelashes and any hair that might have accidentally fallen into the field of view. We attempted to avoid these issues by taping hair back, calibrating the eye tracking system and a stringent inclusion/exclusion criteria.

Future Research and Conclusion

Engagement, and subsequently visual intake and attention, is an underexplored area of simulation. We would suggest the need to trial and rehearse varied levels of moulage in simulation to determine necessary levels for environmental realism. The simulation community should consider exploring moulage authenticity in simulation with the lens of Theory of Visual Attention to determine the impact on memory, emotion and patient outcomes. Furthermore, this work would benefit from expansion to other health professions at varied levels of training to better understand the broader impact.

In this study we explored the link between moulage and engagement in simulation. Overall, the results demonstrated evidence for high authenticity in moulage portrayal as a way of maximizing visual attention in complex simulations. Detailed stimuli is necessary for maximising opportunity for visual intake and may be a predictor for success in simulation.

Glossary

Foveal Stabilisation (FS): The point between any two saccades, during which eyes are relatively stationary and virtually all visual input occurs. A threshold of 100*/s was set to classify a FS

Saccade: The rapid motion of the eye from one fixation to another.

Scanpath: The path of pupil visual attention

Visit duration: The duration of all Foveal Stabilisation and saccade durations within one area of interest.

CHAPTER 9: DISCUSSIONS AND CONCLUSIONS

Since commencing this PhD, the empirical evidence for moulage has improved. Instead of seeing work focusing on technical reports or unequal comparisons (e.g. simulation versus lecture), there is an emerging amount of work exploring how moulage impacts learning and other aspects of clinical care [60, 123, 124, 136, 185]. This dissertation on moulage is the first of its kind; to my knowledge it is the first PhD on moulage in simulation worldwide. Not only does it expose new ideas on moulage, it extends our knowledge of participant engagement in simulation. To bring the broader studies together, I discuss the current literature on moulage in simulation, emerging evidence of views on moulage authenticity, the perceived realism of moulage, implications of authenticity and the potential issues with disengagement. I outline a conceptual approach to linking authenticity and engagement, before summarising the strengths and limitations of the work. Finally, I conclude with suggestions for future work in the field with recommendations for how to best consider authenticity in the context of simulation work.

Empirical Evidence for Moulage

A primary focus of this thesis was to examine the current literature for evidence on its use in simulation, the impact on engagement in simulation and the implications on simulation design. The lack of evidence for moulage in simulation was unsurprising. It is largely considered a technical skill reserved for simulation operations support staff [153]. Whilst the details of debriefing are discussed widely in the literature and are keynote topics for simulation and medical education conferences [186-189], moulage is the forgotten sibling. I outlined the need for it to be considered as an aspect of simulation success in its own right in Chapters 1 and 2. The systematic review provided an in-depth summary of current use and evidence for moulage in simulation, with suggestions for how the simulation community could explore this further. This work has now been cited as the instigator for a variety of studies – including work for paramedicine, radiography, dermatology practice and mental health nursing [123, 124, 136, 190]. This ground work provided the necessary evidence to propel the studies described in this dissertation, and will inform moulage research into the future.

Views on Moulage Authenticity

Now moving to what experts think of moulage in simulation, I discuss the key components of authenticity and outline how experts' views differ from participants. The Delphi study (Chapter 5) presents foundational work for the definition of authenticity in moulage, with potential broader application to simulation as a whole. The work provides a framework for discussing authenticity within the setting of simulation, a key objective of this doctoral work. The resulting work demonstrated key measurable dimensions of authenticity, that were not specific to a particular clinical condition, demonstrated by the later testing across a variety of conditions (simulated or real). The elements described two underlying key dimensions of moulage authenticity: physical and cognitive authenticity. Under the physical components of moulage authenticity, experts identified the following: position, detail, likeness to real world, anatomically correct, colour, size, shape. Experts further classified cognitive components of authenticity as:

- The moulage fits logically within the scenario/presenting complaint
- The moulage is presented as a part of props/scene
- The moulage is at a sufficient level so as not to distract the learner
- The moulage is consistent with the objectives
- The moulage is not overdone
- The moulage is well-timed, where appropriate.

Experts were clear that moulage authenticity was a priority for simulation; the students' opinions echoed this.

When it comes to rating authenticity, the students' ratings of moulage were somewhat different from the experts' views. Perhaps this reflects the level of experience or it might be due to the use of a manikin-based scenario. A manikin clearly denotes that the scenario is fabricated, whereas a simulated patient appears closer to real life. In addition, the instances where the students rated the moulage as higher in authenticity may be due to the fact that they were *insitu*, as opposed to viewing the conditions via electronic imaging in a cropped format (the experts' online survey – Chapter 6). Perhaps this is a limitation of the reliability and validity testing for the conditions of moulage in the experiment.

Regardless, the simulation community would benefit from further conversations regarding the application of this consensus work, including expanding the expert base to areas such as the Middle East, Asia and South America. A comprehensive discussion on the challenges of moulage in non-western medical education would ensure diversity of representation. Furthermore, although the tool appeared to encapsulate overall themes of authenticity, this might not be applicable to specific specialist areas. As it stands, the tool may not provide the level of detail required to provide a reliable assessment of melanoma authenticity, for example. For example, if you were to use the tool for melanoma assessment, you might gather dermatologists and simulation experts to clarify the detailed definitions of moulage authenticity for melanoma.

Moulage and the Realism Hypothesis

Moving now to moulage and the concept of realism. Dieckmann's realism posits that realism is formed by three main components: physical, semantic and phenomenal [79]. I utilized this as a theory base for the authenticity body of work. In exploring with regards to moulage, how does moulage work with this?

Physical realism describes the physical, measurable components of realism. The next type of realism, semantic, is conceptual; for example, in this research, does the portrayal of the abdominal bruise in the LowAuth (simple application of red crème with no detail or definition) group facilitate moving to a decision or treatment path. Conceptual realism might also refer the ability for a verbal cue to propel a participant to next steps in a scenario.

In the opening chapters, I proposed that moulage might impact a more narrow area than previously thought. With regards to perceived realism, Study 3 highlighted both the perceived value of authentic moulage and the perceived realism. Not dissimilar to the work demonstrated by Wilson et al (2018) described in Chapter 1, the moulage contributed significantly to the flow of the simulation, triggering students to progress throughout the scenario. In Chapter 7, I highlighted that the perception of realism was influenced by a participant's previous experiences with simulation and the other experiences the participant had been involved with. For example, students described expecting the moulage to be poor quality or low-authenticity, which lead to uncertainty around how to engage with the moulage. In the simulation, one student identified that they had a background in drama, which helped them get over the challenges of buy-in by identifying the greater purpose of simulation.

Phenomenal realism incorporates the emotional sway the moulage might have – and is directly linked to the physical persuasiveness. I hypothesized that these three components are interrelated, instead of being separate items. Noting the results of the scanpaths for the abdominal bruise and arm injuries, I argue that they are linked and that in the instance of Low-authenticity moulage, the participants struggled to focus and had scattered scanpaths – which is suggestive of confusing presentation of cues, leading to an inability to process and prioritise. High-authenticity was more convincing to the believability of the scenario and overall authenticity, reflected in the clustered scanpaths in this group. This evidence suggests that participants may need more experience with the conditions of simulation to familiarize themselves with how to interact in an artificial environment. Or to put it another way, simulation participants need opportunities to learn the rules of simulation.

To maximize the realism and perceived realism of moulage, I now outline some strategies to apply this to simulation practice. Providing a pre-brief that includes the rules of simulation may not be enough to assist students with familiarization; an orientation simulation might be required prior to each simulation (as opposed to a one-off occasion). Paying attention to the different rules of simulation should be at the front of mind for simulation designers – the rules of simulation might be different in each simulation on a different day, with a different scenario facilitator and at a different location. Standardization of the rules of authenticity would ensure transparency of process and enable facilitators to adjust the briefing provided/required.

An important consideration of this discussion regarding realism is that my interpretation of physical realism may be similar to the Rudolph et al (2007) commentary [46]. The original realism theory identifies physical moulage as something that can be measured – for example, the depth of a wound in millimeters or the colour of the graze in using colorimetry (although this might be difficult to achieve). When developing this conceptual work, I drew from Hall et al's (2003) discussion on realism in the arts, in which they discuss the concept of perceptual persuasiveness – or how real an individual perceives the visual scene to be [75]. This may be limitation of my understanding of realism, although it is worth noting that this confusion exists in much of the simulation literature, so reinforces the need for more discussion and research to clarify how to measure realism in simulation.

Dual Awareness and Triggers of Disengagement

The engagement and how moulage may or may not contribute to simulation is a key objective of this thesis. This section achieves the objectives outlined in the introduction chapters – to explore how the use of authentic moulage impacts on engagement.

In Chapter 1, I raised the suggestion that moulage might contribute to the phenomenon of dual awareness [76, 77]; whereby moulage hinder or help the participants ability to move between executive (comparing constructed imagery with reality) and entertainment (engaging with fiction as if it were real) spaces. In Study 3, this effect was demonstrated by the participant interviews; students frequently described a sense of being between two places. When recounting this, the students noted that being engaged meant they were not aware they were simulating, and when they realised it was a simulation, they were not engaged, "*as soon as I looked and then saw it was like crystal clean…it just like kind of pulls you back in, okay it's a simulation*". To them, this meant they took the event more seriously and perceived it to have better learning outcomes; ergo they it would lead to better preparedness for practice. As demonstrated in Study 3 (Chapter 7), the students noted unrealistic aspects of the simulation led them to realise "*this is a simulation*"; to them, this was a disengagement and required effort to buy-in again. In Tan's work, this event is described as a rationalization which inhibits emotional arousal, and therefore detracts from the learning experience [77]. Emotional arousal was not measured, but would be an interesting avenue to pursue for further research.

Interestingly, perhaps it is worthwhile to consider the impact of authenticity on visual intake with more gravity. Our eyes constantly appraise the contents in our field of view. This intake triggers emotive responses and other autonomic processes that we are not always aware of [180]. Items that have greater contrast and defined edges have a stronger effect on these processes, causing the cognitive efforts to focus on these objects of interest [85, 86]. This is reflected in the scanpaths on the High Authenticity moulage, highlighting the broader impact of detail in moulage. Perhaps considering visual intake should direct future research to explore disengagements. In simulation, the theories of Visual Attention encompass a "semantic" intake – the reference here to semantic is not dissimilar to semantic realism, meaning that some visual intake is conceptual. Our cognitive processes make an assumption about what is seen, even with a representative item. I observed this in Study 3, where participants made assumptions of what they saw when there was insufficient information, i.e. the red colouring in the LowAuth group was ignored because participants *did not see it* (moulage).

The results of Study 3 (Chapter 7 and 8), namely the interview results, echo that of a previous case study using an anaesthetic simulation. This study observed mini episodes of disengagement when the flow or rules of simulation did not reflect reality [67]. In this example, when a process in the scenario “broke the rules” of reality (e.g. getting immediate scan reports), the participants were observed to disengage. This disengagement was described as a “glitch”, where the participants giggled or indicated the scenario was make believe. In the work I present, students noted small episodes of disengagement when there was a mismatch in the simulation design or flow, causing them to check the conditions of reality versus simulation. For example, checking with the confederate what the moulage was meant to be portraying.

Taking the experiment into account and in response to the hypothesis in Chapter 1, I would consider that the perceptual persuasiveness (i.e. authenticity of moulage) directly contributes to the engagement of learnings in simulation. Effort should be made to minimize these episodes of “glitching”, or at the very least, to provide ways for participants to re-engage in the scenario. This might be achieved through testing the effect of the moulage through a series of simulation rehearsals; the simulation should be tested with a variety of potential treatment pathways. For example, a rehearsal should include specific validity testing to assess for engagement, perceptual persuasiveness and rating of authenticity. In addition to this, it might be worthwhile to assess the predictability of responses, e.g. does one model of authenticity provide a more reliable simulation pathway or engagement levels than another.

Developing Mental Models of Assessment

In opposing arguments to high levels of authenticity, other authors [90-92] posit that a representation or symbol is all that is required to trigger engagement (as discussed in Chapter 1). The results outlined in Chapter 7 and 8 suggest otherwise. Undergraduate/pre-registration learners have few previous experiences to construct beliefs and theories about clinical conditions, as they highlighted in the semi-structured interviews. Secondly, I would argue that the relationship between the observer and the resemblance (e.g. the moulage) has high-stakes consequences in a trauma situation, for instance. Whilst the moulage may not be crucial to the final diagnosis, it may be essential for differential diagnosis. Participants noted that they rated the necessity of accuracy of portrayal as high, due to their novice assessment practices. This reference to their own novice level of knowledge and experience, raises the thought that experienced learners might have an alternate perspective on moulage authenticity in simulation.

Using inauthentic moulage or inauthentic props in simulation may cause the learners to create “shortcuts”, or skip over components of assessment, in their mental models - *we’re trained to always be looking at the whole page …looking for every little detail about the patient to see what you can glean about their clinical situation.”* The results of doing so are not insignificant; training doctors must be equipped to deal with a variety of clinical scenarios that require attention to detail and well-developed assessment skills. In the participants’ viewpoint, presenting no moulage and low-authenticity moulage undermines this process of developing assessment skills. Another aspect to consider in relation to the participants interaction with moulage is the dismissal of moulage in the control and low groups. What is the impact of this? I propose that perhaps there are unintended consequences of dismissing moulage.

The Unintended Consequences of Moulage, Or Lack Of

Experts identified that distracting moulage might have an unintended consequence. Students identified the moulage as being “reorienting”, the participants did not cite the moulage as a distraction in the simulation. Where moulage did have an unintended consequence was in the low-authenticity group, in which the participants assumed the moulage had no importance within the simulation due to the portrayal. In the high-authenticity group the participants assessed its (the moulage) importance and included it in most of their assessment processes, exploring the item further with the confederate. As identified in Chapter 7, perhaps the unintended consequence of low authenticity is to create a pattern of “dismissal” in clinical assessment. In comparison to the high-authenticity group, control and low-authenticity group participants were less likely to complete a neurological assessment and administer IV fluids. This might suggest more realistic portrayal might predict the participants’ ability to complete a full assessment. Although this was not the primary aim of the study, exploring how mental models of assessment are developed may be worth investigating. To identify whether students do dismiss cues as a result of design flaws, moulage authenticity should be tested in a series of simulations to identify the correct level of moulage required to maximize the learning outcomes of simulation.

Perhaps another unconsidered impact of moulage is the potential effect it has on empathy. We see from the eye-tracking analysis that the high authenticity moulage lead to higher view counts of the face, whilst the low authenticity moulage lead to lower counts (Chapter 8). The eye-tracking scanpaths demonstrated a higher rate of visual searching across the control and low authenticity groups as compared to high authenticity. What does this mean in the context of clinical care, engagement and simulation? Perhaps it indicates that authentic portrayal of moulage persuasively convinces the participants of the humanity, evoking a greater sense of empathy, hence the higher rates of looking at the patients face. The literature on empathy in healthcare identifies that the time spent engaging with the patient is perceived as a trait of empathy [191]. Empathy is defined as the “action to place oneself in another’s position”; the action is to listen, attempt to understand and to respond to the patient’s cues [192]. For example, a clinician aligning their body language, vocal tones language to match the patients is perceive as empathy. Previous eye tracking work has demonstrated the link between eye-gaze patterns and empathy [193]; thus is it not unreasonable to hypothesise that the explanation for this might be that the more authentic stimuli provides a cue for participants to interact in a more empathetic way.

A counter point might be that the moulage is a distraction, hence the higher number of visit counts to the face. However, due to the participants noting that the moulage was not distracting (in the MARS results) and the high number of visits to the face in the control group, I would suggest this is not the case. If it was due to the high authenticity depiction, I would expect to see lower visit counts to the face in the control group and higher counts to the low authenticity group. This is a potential area of focus for future research.

Moulage and the Uncanny Valley

Extending the discussion on potential consequences of moulage, I now address the Theory of the Uncanny Valley. In the opening chapter, I suggested that moulage might contribute to the Uncanny Valley effect. This effect describes when something appears familiar, yet at the same time is strange; there’s a mismatch between features, both human and nonhuman. Moulage experts in Chapter 5 alluded to this concept by way of identifying “the moulage was not overdone” as a key component of moulage authenticity. Students agreed in the study that the moulage was not overdone and the issue of uncanny valley was not identified in the interviews or in any other observed measures. I would argue that the Uncanny Valley might impact participants more where the manikin creeps toward high-likeness to reality, yet is clearly not real, evoking disgust. The manikin used in the simulation, Laerdal SimMan 3G Essential, was clearly not real and the moulage itself blended well and matched the level of authenticity of the manikin.

Perceived Sense of Urgency Vs Actual Urgency

Students described feeling a sense of urgency to treat the patient quicker, however this did not align with their actual time to treat and decision making patterns. This suggests that participants' perceptions of performance may not align with actual performance. This phenomenon is not new – Eva et al (2004) demonstrate the correlation between self-assessment and actual performance in students is poor [194] - "*How can I know what I don't know?".* In a practical sense, authentic portrayal of moulage might provide more opportunities for students to bridge the gap between self-awareness and performance; moulage presents an opportunity to deliver feedback from objective measures. An alternative explanation to the mismatch between perceptions and performance might be that their patterns of thinking might be clearer, or they experience more clarity of thought when making decisions in a clinical scenario. In other words, they were clearer on the objective of patient management due to the portrayal of moulage. Sense of urgency, on the other hand, might be an indicator of engagement in simulation – this is worth exploring in future work. I touch on this concept in more detail a little further on in this chapter.

Eye Tracking As a Method of Measuring Engagement

Moving now to eye tracking and engagement, one of the central objectives that I set out to explore in this research. So far I have raised the potential of eye movements to indicate empathy and interaction with the patient. I will now briefly cover how eye tracking can provide us with objective measures of engagement for simulation. Eye tracking has a long history of being used to provide a window into cognitive processes. It can be used to deduce levels of engagement, areas of attention and within this we can make conclusions about thinking and cognitive processes. To date, there has been little exploration of eye-tracking as a measure of engagement. This work presents the potential of eye tracking to explore areas of attention and patterns of looking. The work was limited to Foveal Stabilisation and visits, however there is great potential to explore other measures such as comparing smooth pursuit patterns, or more detailed areas of interest (such as areas of the face). Regardless, the use of eye tracking is laborious and costly – each video required at least 10 hours of coding and the analysis phase lasts many months using specialist software. Perhaps the return on investment is not worthwhile when considering staff hours, hardware and software costs.

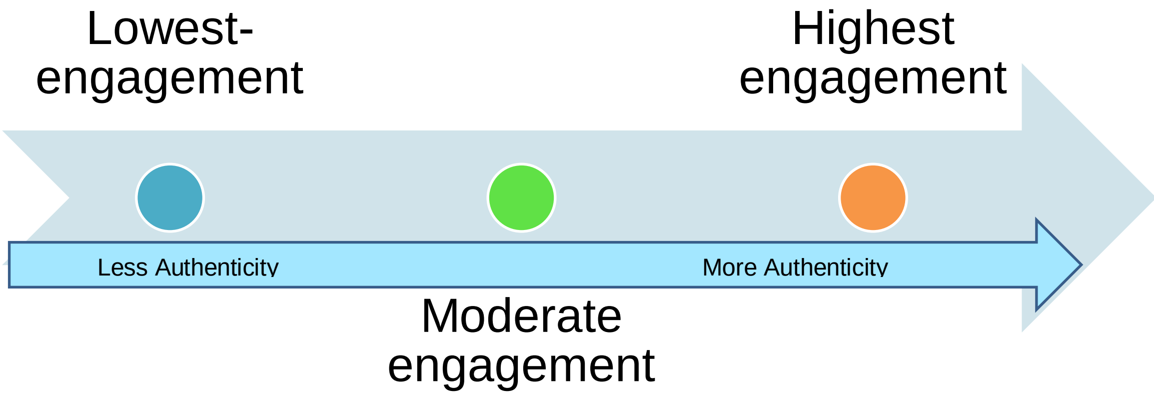
Authenticity and Engagement: Linking It All Together

In my view, linking the theoretical to the practical is a key feature of this research. I have sought to explore the underpinning theoretical concepts and outline practical implications in daily activities. As a result of the study in Chapter 7 and 8, I have conceptualised a model to assist the design of simulation. Including how authenticity interrelates. Firstly, I posit that missing cues and information, mismatching cues, personal knowledge and the previous experiences of simulation *hinder* engagement. This occurs by the need to verify the accuracy of portrayal and check the conditions of simulation. Previous experiences of simulation where confederates verbalise cues or direct the simulation direction, conditions participants to believe that there are hidden meanings in verbal cues (as opposed to believing what they are hearing and seeing). Due to an intrinsic motivation to learn, I believe students attempt to jump the hurdle of engagement, by attempting to convince themselves of the reality of the simulation, look for aspects to engage with and make assumptions of the simulation to facilitate reengagement. Based on the results of othis work, I present a conceptual idea for facilitating engagement. In the optimal zone of engagement, the following occurs:

- The simulation is free-flowing
- There is real-time feedback from the patient condition/s
- There is continual stimuli
- The patient’s appearance is dynamic (changing to reflect condition)
- There are visual cues of the patient’s condition
- There are tasks to complete
- There is realistic detail in the props
- There are real consequences to actions
- The moulage has 3D qualities
- The scenario is challenging
- The appearance is perceptually persuasive.

Secondly, when considering authenticity, I conceptualised the following: more authentic environments lead to more authentic behaviours. This is due to the fact that participants spend less time thinking about and rationalising the conditions of the simulation and more time *responding* to the simulation (ergo, they are more engaged).

Higher authenticity leads to accurately prioritising care and assessing the patient. It also forces independence and triggers action, and prepares for decision making in stressful situations. Less authenticity leads to dismissing importance, not taking the simulation seriously; participants begin shortcutting their clinical assessment and pretend to complete tasks. Finally, person-centeredness is lost with the lack of authenticity.



Despite the appearance that they might perform better (E.g. Quicker diagnosis in the Control group), students demonstrated a preference for authentic moulage replication. Making a recommendation to do no moulage instead of low-authenticity moulage may lead to lower student satisfaction in regards to training experiences.

Regardless, I believe that we need to take greater consideration of the cues presented – how they are presented, when they are presented and for whom they are presented.

Study Strengths and Limitations

This study sought to explore authentic moulage and engagement in simulation; contributing to the literature where there is little information elsewise. The use of Stimulated Recall Interviews and eye tracking measures provided great insight into the unique experiences of medical students interacting with simulation. The use of a single interviewer provided consistency when gathering this information. The interviews were not member-checked, as Stimulated Recall methods are considered to be a form of member-checking. Using a theoretical framework to design the study in the simulated context strengthens the capacity for specific suggestions for moulage use in simulation.

Participation in the latter two studies (Chapters 5, 7 and 8) was voluntary, which may have introduced bias – it may have attracted the more motivated participants who already had a particular view on moulage. The PhD candidate was not known to the participants, which reduced the risk of influencing results. The participants of the moulage experiment were randomized to groups by someone other than the PhD candidate, reducing the risk of bias and strengthening the results.

While there was a lack of diverse representation of participants in the Delphi study on authenticity (Chapter 5), sincere efforts were made to achieve otherwise. Despite extensive attempts to gain participants through purposive sampling, I was unable to recruit participants from the areas of Asia, the Middle East and South America. I would suggest that this also reflects the lack of prior research on moulage, making it difficult to identify the “right” people for the discussion.

The authenticity rating by experts did not consistently rate the more detailed moulage higher than the low authenticity moulage. This is likely due to the fact that this rating was carried out via electronic survey in cropped form (as opposed to *insitu*), possibly reducing the level of detail visible. Additionally, in comparison to other items (such as simulated patient injuries), moulage on a manikin rates less authentic. However, participants consistently rated the detailed moulage as more authentic (Chapter 7).

While the number of participants in the engagement study (Chapter 7 and 8) was underpowered, there are no other studies that explore varied levels of authentic moulage in simulation. There is one study exploring moulage versus no moulage [124], and one study that explores face and content validity of moulage [119]. The participant group was relatively homogenous – all participants were from a single institution. Despite this limitation, some of the results were significant and others were trending toward significant. The strength of this study is that it was mixed-methods; the interviews and eye-tracking provide previous unexplored insights as to how moulage contributes to engagement and other aspects of simulation, and provide sufficient level of participant numbers.

A second rater was not used to independently score the Immersion Rating Scale Instrument (ISRI), Times to Treat or code the eye tracking. When coding the Immersion Rating Scale and Times to Treat, I conducted the first few with the primary supervisor, verifying the approach used. Similarly, I consulted with all supervisors on the eye tracking codes, however multiple coders are not utilized in eye tracking coding due to the time intensive nature of the work [181].

The results could not be generalized to other health professions students, due to the nature of motivation that medical students might possess. Similarly, the results could not be generalized to post graduate participants – this is particularly relevant when exploring the participants versus experts rating of authenticity of moulage. The argument could be made that experienced clinicians might need less cues to be able to conceptually progress, however, counterpoint could be that because of their experiences they might need more detail.

Additionally, the setting of this study was with undergraduate medical students and was targeted as a learning activity. The importance of authenticity might be different for when the simulated activity is for the purpose of summative assessment. For example, if a hurdle exam was placed in the final year of the degree for students to complete as a demonstration of competence, the setting might need to be more authentic than a formative activity.

Conclusions

This study sought to understand how authentic moulage influences engagement in simulation. I achieved this by reviewing the literature, developing a theoretical system of classification of moulage and determining *how* moulage impacts on engagement in simulation. As the existing literature did not appear to explain how and why moulage contributes to simulation, it was imperative to explore this. The methodology followed allowed the formation of a framework for authenticity and suggestions for how and why authentic moulage contributes to engagement in simulation. The study uncovered additional information regarding what engagement in simulation means to participants of simulation.

The resulting evidence is suggestive that low levels of detail or a representative portrayal of moulage is not sufficient for participants to progress in a simulation; consequently the use of authentic moulage is preferable for conceptual realism and to minimise disruptions in engagement. High-authenticity moulage contributes to a more realistic approach to clinical prioritisation and assessment, despite the appearance that students arrive at diagnosis quicker with no moulage. While the moulage does not seem to impact the overall clinical outcome, there may be broader implications to empathetic care and biased care approaches.

Authentic moulage is a complex combination of physical and cognitive elements. Thus, interpretation of authenticity may differ due to previous experiences and the method in which it is presented (e.g. Screen based, augmented reality or *insitu*). Testing varied levels of authentic moulage with a stakeholder group prior to the deployment of the simulation would be a suitable approach to optimizing simulation conditions to achieve the desired learning outcomes. Finally, further work should be completed to consider moulage as a key component of simulation in its own right.

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APPENDICES

A- Conference publications to date

Does authenticity in moulage matter? Exploring Participant Engagement in Simulation

Research Question.

Simulation provides the opportunity for learners to deliberately practice skills, gaining experience in a realistic environment. It is impacted by the learners prior knowledge (constructivism); perception of the activity is impacted by personal and peer knowledge. Beyond perception, the learners interaction with the environment is influenced by pre-conceived thoughts and expectations. The success of simulation is dependent upon the degree of participant engagement and successful debrief strategies. Participant engagement is enhanced by fidelity, realism, authenticity and the presence of 'cues' in the simulation setting – such as moulage techniques. Moulage in medical teaching originated in the late 17th century with the use of wax replicas. Currently moulage is used to describe techniques in simulation used to add reality to the environment; it is presumed that moulage adds fidelity, realism and authenticity to simulation. Literature on moulage focuses on techniques and some practical application. There appear to be gaps in literature on the rationale for use in simulation and degree of authenticity required to create a meaningful learning experience.

Research in film/media discusses authenticity, proposing complete authenticity is not required; only first impressions contribute to engagement of the viewer. Other research suggests that no similarity at all is required to establish a relationship of resemblance; whilst others disagree stating that each generation expects a higher level of realism than the previous. In context of learning, authors identify that emotional impact of the experience is directly related to engagement, which is linked to learning. With these concepts in mind, one would then hypothesise that just as the apparent reality of artistic media directly impacts engagement, the apparent reality of moulage is vital to the engagement of learners in simulation.

Simulation literature on moulage and the degree of authenticity required is minimal. To assess the extent of impact moulage has on participant engagement, a theoretical classification of authenticity in moulage must be developed.

Methodology (proposed). Times New Roman, 10 pt.

Develop a theoretical system of classification in moulage to depict or reflect authenticity

A systematic review will be undertaken to attempt to analyse empirical evidence on the use of moulage. Outcomes of this review will guide development of the qualitative survey to develop a classification system of moulage. The outcomes of the literature review will guide the development of the qualitative survey to develop a system of classification of moulage. Using Rules' Framework of Authenticity (2006), I will hold individual interviews with a purposeful sample of simulation experts (including clinicians and educators). Interviews will be recorded and participants will receive verbatim copies of the interviews to verify their comments (member---check). Independent coders will use a thematic analysis approach to code and arrange the primary data. A draft model of the classification system will be circulated to all participants for validation.

Analysis (proposed). Times New Roman, 10 pt.

The fit of this theoretical model will be verified in a series of trials, whereby moulage items with a range of authentic and inauthentic features will be rated for authenticity by simulation experts, clinicians and students.

Results.

Systematic Review – Pending

Authenticity Rating Tool Draft – pending.

Questions for the Audience.

As key stakeholders in the simulation industry, I am seeking validation of the draft classification system.

1. As a moulage user, are the areas addressed in the rating tool relevant?

2. Is the tool user-friendly?

3. In your opinion, will it provide a realistic rating of authenticity?

References.

Cook, D.A., Hamstra, S.J., Brydges, R., Zendejas, B., Szostek, J.H., Wang, A.T., Erwin, P.J. & Hatala, R. (2013). Comparative effectiveness of instructional design features in simulation---based education: systematic review and meta---analysis. Medical Teacher, 35, 867---898.[223]

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SimART ™: Adding RealiTy to Simulation I

Jessica Stokes-Parish; Rebecca Marley; Janeice Roche

Introduction/Background

simART™ is one of the key tools utilised in suspending disbelief for those participating in a simulation scenario. Transforming manikins or simulated patients using simple effective techniques seem overwhelming.

This workshop will present moulage & special effects techniques including ageing, bruising and simple lacerations easily applicable without extensive time or equipment. This session is designed to be interactive and experiential. The participant will be able to identify and practice using makeup and equipment required to create these effects.

Purpose/Objectives

Upon completion of this session, participants will be able to:

1. Demonstrate ability to apply theoretical principles for using simART™ in teaching
2. Identify safe simART™ techniques using a variety of materials and methods to mimic patient states, wounds and pathologies
3. Design and create and implement a simART™ related to a simulated learning event.

Method or Issues for exploration/ideas for discussion

The session is divided into five main parts:

1. Provision of safe practice environment, learning objectives and session plan with relevant reference material.

2. Faculty demonstration and participant practical experience.
3. Session for participants to practice simART™ techniques with facilitator available.
4. Participant involvement through team work to develop, apply and showcase simART™ techniques
5. Evaluation of the session

Content

Part 1 – 5 minutes

WH&S considerations for use of simART™ materials will be addressed using printed material and basic safety precautions.

- With role play demonstrating effectiveness of simART™
- Mention safety & products (present booklet with safety & product info)

Part 2 – 10 minutes

Using the 'Teaching on the Run" pedagogy, the faculty will model the moulage techniques within a clinical scenario. Participants will be asked to direct the techniques and then practice.

Part 3 – 45 minutes

The practice session include three major stations, bruising, simple lacerations, ageing and other effects. All participants will have the opportunity to practice all stations. Facilitators will be assigned to each table for extra guidance.

- 3 tables set up to demonstrate skills
- Participants will rotate each 15 minutes

Timeline	Group 1	Group 2	Group 3
00:15	TABLE ONE *Bruising TECHNIQUES*	TABLE THREE *Simple lacerations*	TABLE TWO *Ageing*
00:30	TABLE TWO *Ageing*	TABLE ONE *Bruising TECHNIQUES*	TABLE THREE *Simple lacerations*
00:45	TABLE THREE *Simple lacerations*	TABLE TWO *Ageing*	TABLE ONE *Bruising TECHNIQUES*

Part 4 – 25 minutes

The “simART™ Olympics” is an opportunity for participants to consolidate their knowledge and skills through application. Each team will be presented a scenario and asked to apply simART™ to a volunteer.

This will be judged independently and an appropriate award presented.

Part 5 – 5 minutes

Participants will be asked to provide feedback at the conclusion of the workshop via mQlicker (electronic response via web). All responses will be anonymous and used to improve session validity and content.

Evaluation. The web-based response system mQlicker will be used to provide feedback from participant learning outcomes, the facilitators and equipment used. Using web based mobile devices the audience will be asked to participate in providing feedback.

SimART ™: Adding Reality to Simulation II

Jessica Stokes-Parish; Rebecca Marley; Janeice Roche

Introduction/Background

simART™ is one of the key tools utilised in suspending disbelief for those participating in a simulation scenario. Transforming manikins or simulated patients using simple effective techniques seem overwhelming.

This workshop will present moulage & special effects techniques including illness effects, large lacerations and first degree burns, easily applicable without extensive time or equipment.This session is designed to be interactive and experiential. The participant will be able to identify and practice using makeup and equipment required to create these effects.

Purpose/Objectives

Upon completion of this session, participants will be able to:

1. Demonstrate ability to apply theoretical principles for using simART™ in teaching
2. Identify safe simART™ techniques using a variety of materials and methods to mimic patient states, wounds and pathologies
3. Design and create and implement a simART™ related to a simulated learning event.

Method or Issues for exploration/ideas for discussion

The session is divided into five main parts:

1. Provision of safe practice environment, learning objectives and session plan with relevant reference material.
2. Faculty demonstration and participant practical experience.
3. Session for participants to practice simART™ techniques with facilitator available.
4. Participant involvement through team work to develop, apply and showcase simART™ techniques
5. Evaluation of the session

Content

Part 1 – 5 minutes

WH&S considerations for use of simART™ materials will be addressed using printed material and basic safety precautions.

- With role play demonstrating effectiveness of simART™
- Mention safety & products

Part 2 – 10 minutes

The faculty will model the moulage techniques within a clinical scenario. Participants will be asked to direct the techniques and then practice.

Part 3 – 45 minutes

The practice session include three major stations, illness effects, intermediate lacerations, beginner burns. All participants will have the opportunity to practice all stations. Facilitators will be assigned to each table for extra guidance.

- 3 tables set up to demonstrate skills
- Participants will rotate each 15 minutes

Timeline	Group 1	Group 2	Group 3
00:15	TABLE ONE *Illness effects* -Jaundice -Alcoholic	TABLE THREE *Intermediate Lacerations* Bullet wounds Facial laceration	TABLE TWO *Beginner Burns* Sunburn
00:30	TABLE TWO *Beginner Burns* Sunburn	TABLE ONE *Illness Effects* Jaundice Alcoholic	TABLE THREE *Intermediate Lacerations* Bullet Wounds Facial Laceration
00:45	TABLE THREE *Intermediate Lacerations* Bullet Wounds Facial Laceration	TABLE TWO *Beginner Burns* Sunburn	TABLE ONE *Illness Effects* Jaundice Alcoholic

Part 4 – 25 minutes

The “simART™ Olympics” is an opportunity for participants to consolidate their knowledge and skills through application. Each team will be presented a scenario and asked to apply simART™ to a volunteer.

This will be judged independently and an appropriate award presented.

Part 5 – 5 minutes

Participants will be asked to provide feedback at the conclusion of the workshop via mQlicker (electronic response via web). All responses will be anonymous and used to improve session validity and content.

Evaluation. The web-based response system mQlicker will be used to provide feedback from participant learning outcomes, the facilitators and equipment used. Using web based mobile devices the audience will be asked to participate in providing feedback.

SimART™ - Rapidly applicable simulation on a budget.

Workshop Overview:

Moulage is one of the key tools utilised in realism for those participating in a simulation scenario. Transforming manikins or simulated patients using simple effective techniques seem overwhelming.

This workshop will present moulage & special effects techniques (including traum, bruising and blood) that authentically represent reality in a time and cost-efficient manner. This session is designed to be interactive and experiential. The participant will be able to identify and practice using makeup and equipment required to create these effects.

The inaugural “simART™ Olympics” gives participants the opportunity to consolidate their knowledge in a fun and competitive environment.

Expected Outcomes:

Upon completion of this session, participants will be able to:

1. Demonstrate ability to apply theoretical principles for using moulage in teaching
2. Identify safe techniques using a variety of materials and methods to mimic patient states, wounds and pathologies
3. Design and create and implement moulage related to a simulated learning event.

Detailed Description

Part 1 – 5 minutes

WH&S considerations for use of moulage materials will be addressed using printed material and basic safety precautions.

- With role play demonstrating effectiveness of moulage
- Mention safety & products

Part 2 – 10 minutes

The faculty will model the moulage techniques within a clinical scenario. Using a teaching technique developed by the presenters, participants will be asked to describe the techniques and then practice.

Part 3 – 45 minutes

The practice session include three major stations - trauma, bruising and blood. All participants will have the opportunity to practice all stations. Facilitators will be assigned to each table for extra guidance.

Part 4 – 25 minutes

The “simART™ Olympics” is an opportunity for participants to consolidate their knowledge and skills through application. Each team will be presented a scenario and asked to apply moulage to a volunteer.

This will be judged independently and an appropriate award presented.

Part 5 – 5 minutes

Participants will be asked to provide feedback at the conclusion of the workshop via mQlicker (electronic response via web). All responses will be anonymous and used to improve session validity and content.

Does authenticity in moulage matter? Results of a systematic review.

Aims:

The aim of this research is to review current evidence on moulage authenticity and its impact on simulation.

Background:

Simulation is becoming commonplace due to its ability to closely resemble real-world situations, enable safety in practice and guide learning in stages. Research shows, regardless of level, the success of simulation is dependent on participant engagement and effective debriefing (Hayden et al, 2014; Hotchkiss et al, 2001; Roberts et al, 2011; Rodgers, 2007; Seropian et al, 2004). Participant engagement is enhanced by fidelity, realism, authenticity and the presence of salient 'cues' in the simulation setting – such as moulage techniques (the recreation of physical signs using makeup and/or prosthetics Diamond et al, 2011). Originally from Egypt and involved in the preservation of the deceased, moulage is currently used to add realism to the simulated environment.

Methods:

Ten databases (CINAHL Complete, ERIC, Embase, Medline, PsycINFO, SCOPUS, Web of Science, Proquest, Science Direct and SAGE) were initially searched using the search terms "moulage" "simulation" "authenticity" and then "moulage" with "realism" and later "fidelity" with Boolean combinations AND and OR, however this generated zero (0) results. Revised search terms of “moulage” and “simulation” still returned low (< 500 total articles) numbers of results. We explored other search terms, such as “makeup”, “art”, “special effects”, with no relevant documents found. To ensure all potential opportunities were explored, we broadened the search strategy again to use the single term “moulage” in abstract, title and keywords, resulting in a total of 1352 articles at 1 March 2015.

Inclusion criteria were set for English language, within 10 years of publication, peer-reviewed journal article and moulage-related empirical study. After revision (inclusion of non peer-reviewed articles) due to limited results and a snowballing search of reference lists, a total number of 9 articles were deemed appropriate for the study.

Results:

The resulting papers were assessed for quality using the Medical Education Research Study Quality Instrument (MERSQI). Two of the studies were unable to be scored with the MERSQI due to the nature of their report. All studies were single-site, with varied measures of reporting. Only one of the studies was a randomised controlled trial. Some studies (44%) included content validity, however none reported on internal structure.

Enrolled participants in the studies varied from 12 to 190, with two of the papers not reporting on participant numbers. The types of participants were varied, including both undergraduate and post-graduate learners. Study locations were mainly university-based (n=4), one hospital based, one at a conference and the remaining studies (n=3) were unspecified. Notably, five of the studies were on dermatology.

Three studies indicated that moulage influenced memory retention in learners (Garg et al 2010; Goulart et al, 2012; Jain et al, 2013), whilst another concluded in review of their study that moulage may have improved learner performance (Hernandez et al, 2013). Researchers noted their limitations were the authenticity of moulage. Specifically, that the moulage was not validated prior to use (Garge et al, 2010; Goulart et al, 2012; Jaine et al, 2013). Only one of the 9 papers (Langley et al, 2009) set out to assess the validity of moulage. Langley et al (2009) did not use the word authenticity, however used realism – which could be used to indicate levels of authenticity. Specialists rated the moulage as realistic, with Langley et al (2009) indicating they would assume transfer of learning would be increased as a result. However, the study did not include any research to achieve this. In some cases, there was no mention of validity of the prop at all, other than simply stating moulage was used (Foot, 2008; Atlas, 2005; Taylor, 2014 & Smith-Stoner, 2011).

Discussion:

It seems that using 3D moulage as opposed to 2D (images) could cause better retention of knowledge (Garg et al, 2010). Perhaps this is an indication of the impact of realism – decreasing the cognitive load, allowing the learner to engage. A number of assumptions could be made here. Firstly, that 3D moulage does indeed improve learning outcomes. Or was it that the lecture style was not learner-centred and therefore not engaging enough? Interestingly, Jain et al's (2013) research found that their students often dismissed the 3D moulage due to the high level of realism – students assumed it was a real melanoma. This begs more queries. Were the students briefed adequately? Was there a glitch in the instructional design – i.e. perhaps the learner was inadequately prepared as opposed to related to the representation of the melanoma. Does this mean that authenticity can inhibit learning? We were unable to draw meaningful conclusions from these papers due to the lack of detail included.

Conclusions:

Firstly, limited literature resulted in an inability to generalise or provide recommendations for practice - despite the broad search of literature. Secondly, the majority of research was poorly constructed; studies were small and limited, mostly with minimal comparison or quality data (e.g. Only post experiment surveys of participants were used). Thirdly, due to the poorly constructed design or reporting, the studies were not replicable.

Despite this, there is a clear assumption by authors of these studies that moulage is essential in simulation-based education for improved realism and therefore learner engagement (Foot, 2008; Atlas, 2005; Taylor, 2014 & Smith-Stoner, 2011). Due to the lack of evidence, it is apparent that research is warranted to explore the authenticity of moulage and its impact on learner engagement.

References

Atlas, R.M., et al., Recognizing biothreat diseases: realistic training using standardized patients and patient simulators. Journal of Public Health Management & Practice, 2005: p. S143-6.

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Diamond, S., A. Middleton, and R. Mather, A cross-faculty simulation model for authentic learning. Innovations in Education & Teaching International, 2011. 48(1): p. 25-35

Foot, C., et al., Moulage in high-fidelity simulation-a chest wall burn escharotomy model for visual realism and as an educational tool. Simulation in Healthcare, 2008. 3(3): p. 183-187.

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Hayden, J.K., Smiley, R.A., Alexander, M., Kardong-Edgren, S., & Jeffries, P.R., The NCSBN National Simulation Study: A Longitudinal, Randomized, Controlled Study

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Jain, N., et al., Melanoma Simulation Model Promoting Opportunistic Screening and Patient Counseling. Jama Dermatology, 2013. 149(6): p. 710-716.

Langley, R.G.B., et al., Temporary tattoos to simulate skin disease: Report and validation of a novel teaching tool. Academic Medicine, 2009. 84(7): p. 950-953

Roberts, D. and L. Greene, The theatre of high-fidelity simulation education. Nurse Education Today, 2011. 31(7): p. 694-698.

Rodgers, D.L., High-fidelity patient simulation: A descriptive white paper report. 2007, Healthcare Simulation Strategies: Charleston. p. 1-140.

Seropian, M.A., et al., Simulation: Not just a manikin. Journal of Nursing Education, 2004. 43(4): p. 164-169

Smith-Stoner, M., Using moulage to enhance educational instruction. Nurse Educator, 2011. 36(1): p. 21-24.

Taylor, S.R. and C.W.D. Chang, Novel Peritonsillar Abscess Task Simulator. Otolaryngology-Head and Neck Surgery, 2014. 151(1): p. 10-13.

Designing a scale for validation of moulage authenticity using the Delphi Method.

Background:

The success of simulation is dependent on instructional design and effective debrief strategies. Key elements of the former include cues and the level of realism provided. Realism might involve replica equipment, manikins, and the use of moulage. Moulage comprises special effects makeup techniques to apply wounds, bruises, simulated illness or lacerations and other signs of trauma.. Further research, beyond descriptive studies, is needed to explore the application of moulage in simulation – there is no clear imperative for moulage in simulation, nor is there an understanding of how its use influences engagement, learning and outcomes in simulation. To effectively assess moulage in simulation, the authenticity of moulage must be measureable.

Aim:

Develop a tool for measuring moulage authenticity in simulation. Method & Participants: Using Dieckmann's realism as a conceptual framework, the Delphi method was used to gain a consensus on the attributes of moulage authenticity. 18 participants were recruited to participate in sequential surveys and provide expert opinion on what contributes to moulage authenticity. The survey content included open-ended questions, statements of agreement, and opportunities to list, and then rank, elements of moulage.

Results:

This study is currently in Round 3 of surveys, and will be completed by round 5 at the most. The results and moulage authenticity rating tool will be presented at the conference. Participant will have an opportunity to critique the tool following its development. Recommendations: The Moulage Authenticity Rating Scale will enable comparative studies on moulage in simulation, thereby facilitating a better understanding of its use in simulation practice.

SimArt: Matching moulage to your learning objectives

Authors: Jessica Stokes-Parish, Jan Roche

Together, Jessica and Jan present the popular 'SimArt' moulage workshop series. Moulage is used to contribute to realism in simulation, by applying special effects makeup techniques to create simulated wounds, lacerations, bruises and many other illness effects. Jessica and Jan will interactively explore matching your moulage to the learning objectives to achieve better outcomes. This workshop is hands-on and will explore several moulage applications including lacerations and burns. To consolidate your newly-acquired skills you will have the opportunity to participate in the annual 'Moulage Olympics', working in teams to best represent a case presented to you. At the end of this workshop you will be: 1) equipped with confidence to better match your moulage application to learning objectives , and 2) safely apply moulage techniques 3) able to apply moulage techniques outlined in the workshop.

B – SSH Novice Researcher Grant 2017 Notice

SSH

Society for Simulation in Healthcare

January 25, 2017

Dear Jessica:

Congratulations! On behalf of the SSH Research Committee, we are pleased to notify you know that your application of "How does variation of moulage authenticity impact on engagement of participants in a simulation?" has been selected as a recipient of the 2017 SSH Novice Research Grant.

Amount of award: $10,000

We had an outstanding pool of applications that went through a rigorous peer review process, including the use of scoring criteria mirroring that of the National Institutes of Health (NIH). An independent review committee participated in the final deliberation process. The reviewers were unanimous in choosing your proposal for this award and commend you for the obvious effort you put into its development and the originality and quality of your approach. We look forward to being part of your success in the future.

More detailed feedback will be sent to you in the next month.

This award will be announced at the ***17th International Meeting on Simulation in Healthcare (IMSH 2017)*** in Orlando, Florida on Tuesday, January 31, 2017 at 8:30 AM. You, or a designate of your organization, are invited to join us on the Plenary Stage for this announcement and recognition.

Once again, congratulations!

Sincerely,

Dimitrios Stefanidis, MD, PhD, FACS
Chair, SSH Novice Research Grant Program

Aaron Calhoun, MD, FSSH
Chair, SSH Research Committee

2021 L St NW, Suite 400 | Washington, DC 20036 | Phone: 866-730-6127
www.ssih.org

C –Canada Research Trip Itinerary

Jessica Stokes-Parish - Simulation Coordinator
Chameleon Simulation Centre, School of Medicine & Public Health, University of Newcastle

Meetings at the Wilson Centre, Toronto General Hospital, 200 Elizabeth St., 1ES559
http://thewilsoncentre.ca/find-us

Monday April 25, 2016

10:00-11:00	Ryan Brydges [Wilson Centre Scientist] http://thewilsoncentre.ca/dr-ryan-brydges
11:00-12:00	Cathy Smith [independent SP consultant with an academic affiliation at the UofT]
12:00-1:00	**Wilson Centre RESEARCH ROUNDS (info to be provided). Welcome to attend but don't have to**
1:00-2:00	Nikki Woods [Wilson Centre Scientist] http://thewilsoncentre.ca/dr-nicole-woods

Tuesday April 26, 2016

10:00-11:00	Kinga Eliasz [Wilson Centre PhD Student] http://thewilsoncentre.ca/current-fellows#Kinga
11:00-12:00	Andrea Kirou-Mauro [[Wilson Centre MEd Student] http://thewilsoncentre.ca/current-fellows#Andrea
12:00-1:30	Fellows' Session: Cognitive and Social Dimensions of Education (Maria, Tina, Walter). **Welcome to attend first hour but don't have to**
1:00+	Timothy Willett MD, MMEd, Interim President, SIM-one - SIM-one.ca; 88 College Street, 2nd Floor; 647-448-7119 [very closed to the Wilson Centre]

Wed April 27, 2016

10:00-11:00	Catharine Walsh [former WC PhD Student.] [has expertise in reviews, simulation, and the delphi technique]
11:00-12:00	Jeffrey Cheung [Wilson Centre PhD Student] http://thewilsoncentre.ca/current-fellows#Jeffrey
1:00-2:30	Surgical Skills Centre http://sites.utoronto.ca/ssc/ running our neuro Lougheed course University of Toronto Surgical Skills Centre, Mount Sinai Hospital, 600 University Avenue, Level 2 - Room 250 skills.centre@utoronto.ca (416) 586-4800 x2611

Thurs April 28, 2016

10:00-12:00	Ryan Brydges
12:00-1:00	**PRESENTATION:** [Toronto General Hospital, 200 Elizabeth St., 1st floor Eaton North Room 441] **Does authenticity in moulage matter? A review of the literature** **Abstract:** The environment in which the simulation is situated plays a large role in the degree of engagement. Moulage techniques are used in current-day simulation to mimic illnesses and wounds, acting as visual and tactile cues for the learner. Against this background of the use of moulage in simulation, we investigated how the authenticity of moulage has an impact on participant engagement using a systematic review. The resulting nine papers clearly outline an assumption that moulage is essential in simulation-based education for improved realism and subsequent learner engagement. However, there is no clear evidence from the literature that this is the case, suggesting that further research to explore the impact of moulage on participant engagement is warranted.
2:00-3:00	Allan Waters Family Simulation Centre - St. Michael's Hospital Administrator: Krause, Kimberley - KrauseK@smh.ca Director: Khodadoust, Nazanin - KhodadoustN@smh.ca Directions. LKS East Basement (B129) – Skills Lab. Elevator access is card restricted. Options: 1. External entrance is from Victoria street, up the stairs to 2nd floor and across to the east end and down the stairs by the Shuter window to the basement. 2. Internal entrance is the 3rd floor bridge from Shuter wing, elevator down to the 1st floor, head for the stairs by the Shuter window and down to the basement. If elevator access is needed, please inform us and we'll make arrangements (x77431).

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

UNIVERSITY OF NORTHERN BRITISH COLUMBIA

University of Victoria

Centre for Health Education Scholarship
UBC Faculty of Medicine
JPPN 3300, 910 West 10th Avenue
Vancouver, BC V5Z 1M9

T: 604.875.4111 e. 67644
F: 604.875.8221
W: www.ches.med.ubc.ca

Ms. Jessica Stokes-Parish

Arriving: Friday, April 29, 2016 Departing: Wednesday, May 4, 2016

Friday, April 29

10:00 – 11:00am Meet with **Dr. Joanna Bates**, *Scientist, CHES*
- Location: IRC 429J

2:00 – 3:00pm Meet with **Dr. Anna Patten**, *Manager, Simulation Centre, Island Medical Program*
- Location: IRC 305 (videoconference)

Monday, May 2

9:00 – 10:00am Meet with **Dr. Surabhi Rawal**, *Clinical Educator Fellow, CHES*
- Location: IRC 429J

1:00 – 2:00pm Meet with **Dr. James Tessaro**, *Clinical Educator Fellow, CHES*
- Location: IRC 429J

Tuesday, May 3

10:15 – 11:15am Meet with **Dr. Heather Buckley**, *Clinical Educator Fellow, CHES*
- Location: IRC 429J

12:00 – 1:30pm CHES Community Rounds
- Location: IRC 324

3:00 – 4:00pm Meet with **Mr. Darin Abbey**, *Director, Centre for Interprofessional Clinical Simulation Learning*
Location: IRC 305 (videoconference)

D – University of Bern Research Trip

UNIVERSITÄT BERN

Medizinische Fakultät
Institut für Medizinische Lehre IML
Abteilung für Unterricht und Medien
AUM

Invitation to Berne

Dear Mrs. Stokes-Parish,

we are happy to invite you to Berne and are excited to receive as our guest an international expert on modern moulage in health professions education. We are looking forward to your presentation of your PhD project and an open and lively exchange of ideas and concepts on moulage and their role in simulation-based education during your stay from September 8th to 13th.

Thank you for making this possible on such short notice,

Kind regards

Dr. Daniel Bauer

swissuniversity.ch

Dr. med. Daniel Bauer, MME
Wissenschaftlicher Mitarbeiter
Mittelstrasse 43
CH-3012 Bern

Tel. +41 31 631 62 52
daniel.bauer@iml.unibe.ch
www.iml.unibe.ch

E – Ethics Approval Letters

HUMAN RESEARCH ETHICS COMMITTEE

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

Notification of Expedited Approval

To Chief Investigator or Project Supervisor:	**Professor Brian Jolly**
Cc Co-investigators / Research Students:	**Ms Jessica Stokes-Parish** **Doctor Robbert Duvivier**
Re Protocol:	**Developing a theoretical framework - Designing a scale for validation of moulage authenticity using a modified Delphi Method**
Date:	**21-Oct-2016**
Reference No:	**H-2016-0326**
Date of Initial Approval:	**21-Oct-2016**

Thank you for your **Response to Conditional Approval (minor amendments)** submission to the Human Research Ethics Committee (HREC) seeking approval in relation to the above protocol.

Your submission was considered under **Expedited** review by the Ethics Administrator.

I am pleased to advise that the decision on your submission is **Approved** effective **21-Oct-2016**.

In approving this protocol, the Human Research Ethics Committee (HREC) is of the opinion that the project complies with the provisions contained in the National Statement on Ethical Conduct in Human Research, 2007, and the requirements within this University relating to human research.

Approval will remain valid subject to the submission, and satisfactory assessment, of annual progress reports. *If the approval of an External HREC has been "noted" the approval period is as determined by that HREC.*

The full Committee will be asked to ratify this decision at its next scheduled meeting. A formal *Certificate of Approval* will be available upon request. Your approval number is **H-2016-0326**.

If the research requires the use of an Information Statement, ensure this number is inserted at the relevant point in the Complaints paragraph prior to distribution to potential participants You may then proceed with the research.

Conditions of Approval

This approval has been granted subject to you complying with the requirements for *Monitoring of Progress*, *Reporting of Adverse Events*, and *Variations to the Approved Protocol* as detailed below.

PLEASE NOTE:
In the case where the HREC has "noted" the approval of an External HREC, progress reports and reports of adverse events are to be submitted to the External HREC only. In the case of Variations to the approved protocol, or a Renewal of approval, you will apply to the External HREC for approval in the first instance and then Register that approval with the University's HREC.

- ***Monitoring of Progress***

HUMAN RESEARCH ETHICS COMMITTEE

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

Notification of Expedited Approval

To Chief Investigator or Project Supervisor:	**Professor Brian Jolly**
Cc Co-investigators / Research Students:	**Ms Jessica Stokes-Parish** **Doctor Robbert Duvivier**
Re Protocol:	**How does variation of moulage authenticity impact on engagement of participants in a simulation?**
Date:	**17-Aug-2017**
Reference No:	**H-2017-0214**
Date of Initial Approval:	**17-Aug-2017**

Thank you for your **Response to Conditional Approval (minor amendments)** submission to the Human Research Ethics Committee (HREC) seeking approval in relation to the above protocol.

Your submission was considered under **Expedited** review by the Ethics Administrator.

I am pleased to advise that the decision on your submission is **Approved** effective **17-Aug-2017**.

In approving this protocol, the Human Research Ethics Committee (HREC) is of the opinion that the project complies with the provisions contained in the National Statement on Ethical Conduct in Human Research, 2007, and the requirements within this University relating to human research.

Approval will remain valid subject to the submission, and satisfactory assessment, of annual progress reports. *If the approval of an External HREC has been "noted" the approval period is as determined by that HREC.*

The full Committee will be asked to ratify this decision at its next scheduled meeting. A formal *Certificate of Approval* will be available upon request. Your approval number is **H-2017-0214**.

If the research requires the use of an Information Statement, ensure this number is inserted at the relevant point in the Complaints paragraph prior to distribution to potential participants You may then proceed with the research.

For Noting

Please amend the HREC approval number at the start of the complaints statement in the recruitment flyer. The correct approval number is H-2017-0214.

Conditions of Approval

This approval has been granted subject to you complying with the requirements for *Monitoring of Progress*, *Reporting of Adverse Events*, and *Variations to the Approved Protocol* as detailed below.

PLEASE NOTE:
In the case where the HREC has "noted" the approval of an External HREC, progress reports and reports of adverse events are to be submitted to the External HREC only. In the case of Variations to the approved protocol, or a Renewal of approval, you will apply to the External HREC for approval in the first instance and then Register that approval with the University's HREC.

HUMAN RESEARCH ETHICS COMMITTEE

Notification of Expedited Approval

To Chief Investigator or Project Supervisor:	**Professor Brian Jolly**
Cc Co-investigators / Research Students:	**Ms Jessica Stokes-Parish** **Doctor Robbert Duvivier**
Re Protocol:	**How does variation of moulage authenticity impact on engagement of participants in a simulation?**
Date:	**18-Oct-2018**
Reference No:	**H-2017-0214**

Thank you for your **Variation** submission to the Human Research Ethics Committee (HREC) seeking approval in relation to a variation to the above protocol.

Variation to:

1. Undertake another round of recruitment to recruit sufficient participants.

2. Increase of the reimbursement for participants from $25 to $45.

Your submission was considered under **Expedited** review by the Ethics Administrator.

I am pleased to advise that the decision on your submission is **Approved** effective **18-Oct-2018**.

The full Committee will be asked to ratify this decision at its next scheduled meeting. A formal *Certificate of Approval* will be available upon request.

Associate Professor Helen Warren-Forward
Chair, Human Research Ethics Committee

For communications and enquiries:
Human Research Ethics Administration

Research & Innovation Services
Research Integrity Unit
The University of Newcastle
Callaghan NSW 2308
T +61 2 492 17894
Human-Ethics@newcastle.edu.au

RIMS website - https://RIMS.newcastle.edu.au/login.asp

Linked University of Newcastle administered funding:

Funding body	Funding project title	First named investigator	Grant Ref
Society for Simulation in Healthcare/Novice	Record corrupted, details removed and new record created	Jolly, Brian	G1701341

HUMAN RESEARCH ETHICS COMMITTEE

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

Notification of Expedited Approval

To Chief Investigator or Project Supervisor:	**Professor Brian Jolly**
Cc Co-investigators / Research Students:	**Doctor Robbert Duvivier** **Jessica Stokes-Parish**
Re Protocol:	**Developing a theoretical framework - Designing a scale for validation of moulage authenticity using a modified Delphi Method**
Date:	**16-Aug-2019**
Reference No:	**H-2016-0326**

Thank you for your **Variation** submission to the Human Research Ethics Committee (HREC) seeking approval in relation to a variation to the above protocol.

Variation to have Jessica Stokes-Parish staff number-plate account switched to student number-plate account.

Your submission was considered under **Expedited** review by the Ethics Administrator.

We are pleased to advise that the decision on your submission is **Approved** effective **16-Aug-2019**.

The full Committee will be asked to ratify this decision at its next scheduled meeting. A formal *Certificate of Approval* will be available upon request.

Human Research Ethics Committee

For communications and enquiries:
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