## 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 partcipant 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. 9 articles were targeted for review, following exclusion for English language and publication between 2005 and 2015.

**Results:** The resulting 9 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.


**Keywords:** Moulage, simulation, instructional design, realism, authenticity.

## 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 & 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 (Hayden, 2014; Ziv, Wolpe, Small, & Glick, 2006). 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 (J. Ker & 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 positive relationship between SBE and learning outcomes (Hayden, 2014), however the success of simulation depends largely on the degree of participant engagement and effective debrief/feedback strategies (Hayden, 2014; Hotchkiss & Mendoza, 2001; Jeffries, 2005; Roberts & Greene, 2011; Rodgers, 2007;

Seropian, Brown, Gavilanes, & Driggers, 2004). This paper will explore participant engagement with respect to one feature of SBE – moulage. Moulage is defined as the use of special effects makeup techniques to 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; Merica, 2013; Smith-Stoner, 2011).

## 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 dual 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, Benson, & Hennessy, 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 & Sjoblom (2012) identified disengagements in their case study of an anaesthesia simulation, finding that any 'glitches' in the representation of reality caused a disruption in the nurse's engagement (Rystedt & Sjoblom, 2012). This connects well to Dieckmann et al's realism hypothesis – the narrative and setting must be logical and believable. Dieckmann et al (2007) hypothesise that realism is composed of three parts: physical (physically believable), semantic (conceptually believable) and phenomenal (emotionally believable) realism (P. Dieckmann, D. Gaba, & M. Rall, 2007). 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 viewer/participant (Peter Dieckmann, David Gaba, & Marcus Rall, 2007; Herrington, Reeves, & Oliver, 2007; J. S. Ker, Hesketh, Anderson, & Johnston, 2006; Rodgers, 2007; Ross, 1988; Jenny W. Rudolph, Robert Simon, & Daniel B. Raemer, 2007). Realism is often interchanged with fidelity, 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) (J. Ker & 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; Norman, 2013b; Valkenburg & 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; Norman, 2013b; Valkenburg & 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, Middleton, & Mather, 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; J. W. Rudolph, R. Simon, &

D. B. Raemer, 2007). 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; Merica, 2013; Smith-Stoner, 2011). 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; Merica, 2013; Smith-Stoner, 2011).

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 15$^{th}$ or 16$^{th}$ century, the practice of moulage in museums commenced to aid training physicians knowledge of animal and human anatomy (Arnold, 1999; Mattatall & Rustige, 2001; Schnalke, 1995). 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 17$^{th}$ 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 (Mattatall & Rustige, 2001; Schnalke, 1995).What is left of the wax moulds is now held in various museum collections across the world (Cooke, 2010; Mattatall & Rustige, 2001; Schnalke, 1995). 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 tools and makeup to apply moulage in simulation (J. Ker & Bradley, 2010; Merica, 2013; Rodgers, 2007). 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. In the following paragraphs, we present our findings of current literature on moulage and its impact on participant engagement in simulation.

# 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?

## Search Strategy

We used a librarian-guided search strategy to conduct the literature review. Using the PRISMA Checklist for Systematic reviews (Moher, Liberati, Tetzlaff, & Altman, 2010) as a guide, we searched 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. 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).

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 9 articles were deemed appropriate for the purpose of this study as depicted in the PRISMA flowchart (Figure 1).

**Figure 1.**

Quality & nature of papers

Table 2 summarises the methodological quality of included studies. To objectively measure the quality of the papers the two reviewers 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 randomised controlled trial. Some studies included content validity (44%), however none reported on internal structure or relationships to other variables. All studies were single-site, with varied types of reporting (See Table 2). It was difficult to generalise results due to the varied quality and nature.

**Table 1.**

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 Figure 2.

**Table 2.**

## 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, Haley, & Hatem, 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, more effective learning is at a direct result of engagement – perhaps the 3D models were more engaging and contextual, decreasing the risk of glitches in the representation of reality and improved participant perception (Norman, 2013; Rystedt & Sjöblom, 2012).

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 (Hernandez, Mermelstein, Robinson, & Yudkowsky, 2013). However, Hernandez et al (2013) identified that only 29% (n=56) of students noticed the moulage, posing the question of whether a more comprehensive and engaging approach including 3D moulage prior to the interview could translate to an improved ability to perform in real life (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 with those who had more than 2D training (lecture based), highlighting "the clinical implication is that these are potential lives lost to melanoma that could have been prevented" (Goulart et al., 2012). Again, one might assume that the participant perception of reality was increased, and therefore engagement, leading to improved learning outcomes. What was interesting in Jain et al's (2013) study, was that students 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 authenticity of the moulage was so high that the learner was 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 & 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 as a result of lack of preparation for engagement, as opposed to directly related to the 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, Tyler,

Ornstein, Sutherland, & Mosher, 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" (Chang, 2010; 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 (2008), Atlas (2005), Taylor (2014) and Smith-Stoner (2011) did not discuss the authenticity of moulage (Atlas et al., 2005; Foot et al., 2008; Smith-Stoner, 2011; Taylor & Chang, 2014).

Limitations?

**Table 3.**

## 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. This was due to multiple factors.

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 (eg. 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 asessing 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 (eg. nursing versus medicine), level of learning (eg. first year student versus New Graduate) and types of specialties (eg. 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.

**Glossary Terms**
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

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