DEVELOPMENT OF THE PROP CHART, A NEW VISUAL MODEL TO EVALUATE THE EFFECTIVENESS OF TRAINING WITH COMPUTERISED MANIKINS

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Abstract: High-fidelity manikins and new computerised simulation methods play a key role in medical training. Despite the on-going developments in computer technologies and widespread use of computerised simulation methods, the most effective use of these technologies in medical training is still ambiguous. To give insight into the effectiveness of medical simulation training of health care professionals and to design more effective trainings, we created the Prop chart. This chart is initially developed for the training of multi professional teams using medical simulation. A literature search for evidence based features of effective medical simulation was combined with the opinion of experts in focus group discussions. Ten features of medical simulation that contribute to effective learning were identified and were used in the Prop chart. The experts agreed on the convenience of the Prop chart to evaluate and design medical simulation training programs. Future research will focus on the applicability of the Prop chart for fields outside the medical world and other new training methods like serious gaming.

1 INTRODUCTION

High morbidity and mortality rates, new technologies and the desire to assess medical professionals were main reasons to introduce medical simulation. Besides, the importance of medical team training using simulation is underscored in several health care reports to improve the number of preventable errors (Lewis and Drife, 2004); (CESDI, 1997); (Committee on Quality Health Care in America, 2001).

For these reasons, the last two decades medical simulation has had a growing interest and computerised manikins have been developed, revised and used for these purposes. This increase of interest in medical simulation has simultaneously brought simulator technology to a higher level and has resulted in the development of new methods in simulation. For example, one of the newest methods which is currently considered for medical education, is serious gaming. Serious gaming makes it possible to transfer training in hospitals or simulation centres to home settings. This in turns allows the adjustment of the training frequency and intensity to individual's learning curves, which is more likely to contribute to effective learning.

Beside simulation methods, new learning strategies are developed. Traditional learning strategies include large group lectures, tutorials, team training and individual training with or without instructor. A currently attractive medium for distance learning is e-learning. Issenberg et al underscored the importance of adaptability of simulation to several learning strategies (Issenberg et al., 2005). The chosen learning strategy or combination of strategies must be appropriate to achieve the training goals.

An important theory in education is the theory of deliberate practice. Deliberate practice is proven to be a very effective way to acquire skills. It comprises a set of principles which lead to effective learning and is based on learner's engagement in the accomplishment of learning goals (McGaghie et al., 2011); (Ericsson, 2004).

Unless growing evidence about medical simulation, development of new simulators and learning strategies, a guidance to construct an effective training design is lacking. Our objective was to provide more insight in the design and effectiveness of medical simulation training programs by creating a visual model. This visual model will represent the most important features in

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effective learning. The components of deliberate practice will be This model is initially developed for the training of multi professional medical teams.

2 METHODS

The visual model is based on evidence-based features of an effective medical simulation. To determine these features, we performed a literature search in MEDLINE and the Cochrane database, using the following search terms: medical simulation, team training, computer simulation, features, uses, effectiveness, effective learning.

From the literature, the most important features that contribute to effective medical simulation are chosen. These features are used in the visual model. After selecting these items, a final shape of the visual model was chosen.

The items can be applied in different manifestations to a training. For objective classification of these different forms of each item, the items will be described and divided into sub-items. Defining these sub-items was merely based on evidence, but conclusive evidence was not available for all items. Eventually we combined this evidence-based knowledge with expert opinions.

After identifying the evidence based items and potential sub-items, we incorporated expert opinions in the model. To attain opinions of experts in the field of both medical simulation and obstetrics, we organised two focus groups in London and Eindhoven (The Netherlands). Experts were invited to share their thoughts and ideas about effective features of medical simulation. The focus group sessions were led by a moderator. Each member completed an application form, identifying their occupation and experience in medical simulation. The defined, evidence-based, features of medical simulation that lead to effective learning, were presented. A group discussion was yielded by assigning ratings to the different sub-items.

3 RESULTS

The literature search resulted in 143 articles. The abstracts were used for selecting useful articles. Only one article gave an overview of the most important features of medical simulation that lead to effective learning. This Best Evidence in Medical Education (BEME) review by Issenberg et al. identified the 10 most important items in effective medical training (Figure 1) (Issenberg et al., 2005).

1. Providing feedback
2. Repetitive practice
3. Curriculum integration
4. Range of difficulty level
5. Multiple learning strategies
6. Capture clinical variation
7. Controlled environment
8. Individualized learning
9. Defined outcomes or benchmarks
10. Simulator validity

Figure 1: The 10 most important features and uses of high-fidelity medical simulation that lead to effective learning.

Because of the high quality and the perfect match with the addressed objectives of our model, these items were used for designing the model. As stated before, each item can be applied to training in different ways. For example, there are several ways of providing feedback, like self-evaluation, peer-assessment, feedback by instructor and feedback by video playback. The sub-items represent the different manifestations of one of the key-items. Since using any kind of training is better than no training at all, the first level of each item corresponds with a situation without any training.

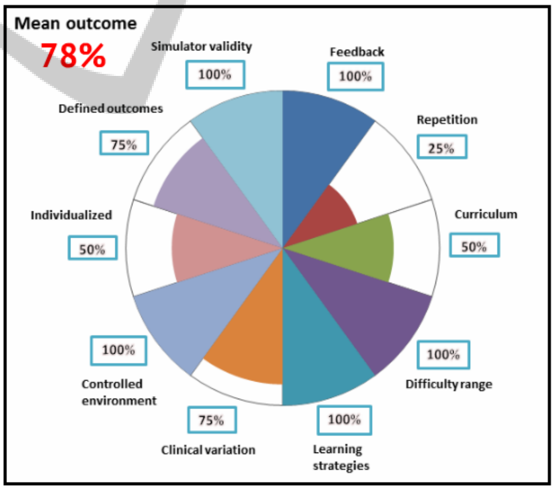

Figure 2: The prop chart.

Based on these evidence-based items and their sub-items, we created the Prop(eller) chart (Figure 2). The primary element is a circle which is divided in 10 similar pieces, corresponding to the identified features in effective training. Depending on the extent to which a feature (categorised in sub-items) will contribute to an effective learning, the piece will grow from the centre (0%) to the outside border of the circle (100%). A mean outcome of a design can be calculated by summation of the total surface area of all items. The border corresponds with the most optimal training design.

Table 1a: Item 1-5 defined by Issenberg et al. Each item is divided in sub-items. This will give a direction for rating to which extent the used item will contribute to an effective learning.

	Feedback[8]	Repetition[9]	Curriculum Integration	Difficulty Range	Learning Strategies
Level 1	-	-	-	-	-
Level 2	No feedback	Until level of novice	% of staff is trained in edu-cational program	1 difficulty level is trained	1 learning strategy
Level 3	Solely self-evaluation	Until level of advanced beginner	% of staff is trained	2 difficulty levels are trained	2 learning strategies
Level 4	Peer-assessment	Until level of competency	% of staff is trained	3 difficulty levels are trained	3 learning strategies
Level 5	Feedback by instructor	Until level of proficiency	% of staff is trained	4 difficulty levels are trained	4 learning strategy
Level 6	Feedback with video playback by instructor	Until level of expert	Total staff is trained	5 levels of difficulty, ranging from novice to expert level	>4 learning strategies

Table 1b: Item 6-10 defined by Issenberg et al. Each item is divided in sub-items. This will give a direction for rating to which extent the used item will contribute to an effective learning.

	Clinical Variation	Controlled Environment	Individualized learning	Pre-defined outcomes	Simulator validity
Level 1	-	-	-	-	-
Level 2	No variation within clinical scenario	During patient care	Passive observation	Not based on pre-defined goals	Very low simulator validity
Level 3	Very limited variation within scenario	% of capabilities of medical simulation centre	% of active participation in scenarios	% of training which is based on pre-defined goals	Low simulator validity
Level 4	Limited variation within scenario	% of capabilities of medical simulation centre	% of active participation in scenarios	% of training which is based on pre-defined goals	Medium simulator validity
Level 5	Plenty variation within scenario	% of capabilities of medical simulation centre	% of active participation in scenarios	% of training which is based on pre-defined goals	High simulator validity
Level 6	Unlimited variation within scenario	All capabilities of a medical simulation centre	Active participation in all scenarios	Completely based on pre-defined goals	Perfect simulator validity

For obtaining expert opinions, three interactive focus group sessions were kept. In total 20 experts participated (Table 2). In the end all items and sub-items were discussed. The experts agreed on the convenience of the PROP chart to evaluate and design a medical simulation training.

4 DISCUSSION & CONCLUSIONS

One of the advantages of medical simulation Is the adaptability of medical simulation to deliberate practice. Incorporation of this theory in the design of a medical simulation training will contribute to effective learning. Since the 10 items identified by Issenberg et al. cover all principles of deliberate practice, using these items for the design or evaluation of a training will logically lead to an effective training.

To overcome the shortcoming evidence for the classification of several items in sub-items, the use of expert opinion was an appropriate tool. Opinions of experts from different continents were included in the chart. Remarks on the different forms of the features were made. The next step in the classification of these sub-items will be the designation of percentages to each of them.

Table 2: Fields of interest of participating experts in focus groups.

Occupation & Experience in medical simulation	**N (n)**
Medical professional & medical trainer	13
Included medical professions:	
- Obstetrician	9
- Gynaecologist	2
- Anaesthesiologist	1
- Midwife	1
Residents using/studying medical simulation	2
Director of medical simulation centre	2
Medical engineer (developing physiological models for computerised simulation)	1
Simulation technician	2
Total	20

The experts, included in the focus groups, agreed on the convenience of this Prop chart for designing and evaluating medical simulation courses. Future plans for the Prop chart will be the application to new simulation methods, like serious gaming. In addition this chart could be used for designing medical simulation courses in different medical fields, like anaesthesiology, cardiology, paediatrics and surgery. But also using the Prop chart in non-medical fields could be a possibility. However, before establishing these goals, the Prop-chart will need additional investigation and validation of the sub-items.

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