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High-Fidelity in Urgency-Emergency Simulation: validation of a tool to determine the satisfaction of participants

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Abstract. *Background and aim of the work:* In literature there are some tools to measure the satisfaction level related to high-fidelity simulation experience. This paper reports the construction and validation of a specific unique questionnaire in Italian (SESAF - *Satisfaction of High-Fidelity Simulation Experience*). *Methods:* After having reviewed various tools available in literature, and conducted some focus groups with high-fidelity simulation experts, the authors produced the SESAF tool. It was administered to 237 Physicians and nurses participated in high-fidelity simulation of emergency codes. *Results:* The factorial solution included 7 factors explaining the 71.65% of the total variance. Cronbach Alpha, reported an excellent reliability (0.97). *Conclusions:* SESAF can make comparable the satisfaction levels of HFS trainees among various centers.

Key words: High-Fidelity Simulation, emergency, satisfaction, validation

Background

The term simulation refers to a model of reality that allows us to evaluate and predict the dynamic sequence of a series of subsequent events under the imposition of certain conditions by the analyst or user (1).

The full scale simulation is the possibility to reproduce an extremely realistic work environment that can classify fidelity as high (high fidelity) or low (low fidelity). The high fidelity human like mannequins are simulators that act as patients and can be positioned in a simulation center, or in work environments where training is performed (1).

Scientific literature has highlighted that participation in high fidelity simulation sessions is considered to be an invaluable training experience by the participants. Moreover, the simulation experience is associated with the understanding of improvements in knowledge and clinical expertise as well as an improvement in performance and self-confidence, remaining with the participants up to six months after the simulation training (2). When compared to other types of training interventions there is evidence of the high fidelity simulations' effectiveness in terms of a larger improvement in the learning curve (3).

The satisfaction of students who have experienced the simulation with high-fidelity mannequins seems to exert an influence on the training results. Some authors claim that it allows the participant to learn in a significant way and facilitates active learning during the training experience (4). Other studies suggest

a correlation between students' satisfaction and their performance (5).

Furthermore, satisfaction is featured by the different subjective perceptions referring to many aspects as well as to experienced emotions, which probably depend on some characteristics of the individuals. Validated tools in English are available in literature in order to determine the satisfaction related to the simulation experience. For example, two instruments developed by the National League for Nursing: *Student Satisfaction and Self Confidence In Learning Scale* (two sub-headings Satisfaction with Current Learning and Self-Confidence in Learning) and *Simulation Design Scale* (that examines the fields objective and information, support, problem solving, feedback/guided reflection, and fidelity/pragmatism). In addition, *Satisfaction with Simulation Experience Scale* (debrief and reflection, clinical reasoning and clinical learning) (6); *Kid-SIM Attitude Towards Teamwork in Training Undergoing Designed Educational Simulation* (communicative dimensions, interprofessional educational significance, the importance of simulation, role and responsibility, awareness of the situation) (7).

Usually the participant satisfaction questionnaires examine the following subjective perceptions:

- acquisition and knowledge transfer (8-11);
- development of clinical reasoning and critical thinking (6, 8, 12);
- self-effectiveness (13, 14);
- self confidence/trust in oneself (8, 10, 15-17);
- usefulness of the debriefing (6);
- realism and fidelity of the scenario (11, 18-21);
- stress (18);
- difficulties met (20);
- quality of the organization where the simulation occurs (19);
- perceptions on the team work during the simulation (6, 9, 7, 22);
- teachers (23).

In a review, Weaver highlighted the areas of interest and relative research in the high-fidelity simulations: knowledge, knowledge transfer, validity, realism of scenario, stress and self-confidence (24). The author underlined the need to conduct further studies about high-fidelity simulation (especially applied to nursing training). The main issues to be explored were: feedback and support given during the simulation, communication between the participants, and student satisfaction.

At present in Italy there are no studies about the validation of tools to determine participants' satisfaction and in addition, there is no one unique tool to collect systematically all the issues that can be assessed about the participants' satisfaction.

The aim of this work has been to produce and validate a specific unique tool in Italian represented by a new questionnaire.

Materials and methods

This study used a method design which captured quantitative data in order to develop a new tools to determine participants satisfaction in high fidelity simulation sessions .

The new tool is the *Satisfaction of High-Fidelity Simulation Experience* (SESAF).

Concerning to the construct validity the areas of interest were inserted in the SESAF with specific items:

- appreciation connected to emotions felt (fun, stress, discomfort)
- usefulness in clinical learning
- usefulness in the development of clinical ability
- usefulness in the development of clinical reasoning skills
- usefulness in the development of team work
- the facilitators competence
- usefulness of debriefing
- realism scenario (case, setting, materials)
- relapse in work performance.

Development of the SESAF

SESAF was developed in line with the following processes:

- The analysis of available literature in order to highlight the tools of satisfaction of the participants about their validity and completeness concerning the objective settings of research.
- Three focus groups created of doctors and nurses (who were simulation trainers) elaborate and

share the dimensions of the questionnaire, to formulate the items and to pinpoint further settings and variables to investigate.

- The new questionnaire was evaluated by a psychologist in order to improve the structure of contents and clarity.

For the SESAF answers we employed:

- Likert's scale, as like a lot of other published studies (10, 12, 15, 25-29);
- Numerical scales (30, 31).

Within the SESAF we included the *Satisfaction with Simulation Experience Scale* (SSES) (6). The SSES is composed of 18 items with 5 point Likert Scale as well as an open ended question. In the original study, the SSES was tested on second-year nursing students (268) and third-year nursing students (76) at an Australian University. The dimensions included in the SSES are "Debriefing and Reflection", "Clinical Reasoning" and "Clinical Learning". The choice to insert the SSES was connected to the specificity of the dimensions by this investigation.

In the original study the reliability of the Cronbach alpha coefficient and the internal coherence of the SSES were 0.776. The SSES also demonstrated to be valid and reliable for nursing students (6).

The SSES which was incorporated in the new tool was utilized as a parameter in order to determine the concurrent validity. The definitive version of the SSES tool in Italian was obtained through a preliminary translation phase and a reverse translation phase. Such a phase was possible thanks to the help of six English mother tongue speakers who independently translated it: three of whom translated from English into Italian (obtaining the first version) and the other three translated from Italian into English (the reverse version towards English). The consequent versions decisively appeared to be comparable and identical in substance. The translation from English to Italian was also done by an Italian native speaker who had no difficulty in translating it for the tool contained no typical American or English expressions.

The study was achieved through the steps listed below:

- Authorization requested to use the SSES to the authors
- Linguistic validation of the SSES
- Development of the SESAF questionnaire
- Administration to the SESAF.

The SESAF has been implemented for the data collection on the satisfaction of participants in the high-fidelity simulation sessions in the Simulation Centre of the Careggi Inter-Institutional Department of the University Hospital in Florence (CSC) and also in the Meyer Pediatric Hospital.

- Implementation of psychometric tests on the SESAF
  - Face validity
  - Internal consistency reliability (Cronbach's alpha)
  - Exploratory Factor Analyses
  - Concurrent validity
  - Reliability attributed to the stability of time (test-retest).

Context and participants

Concerning the implementation of other *psychometric tests* on the tool the sample enrolled for the administering of the questionnaire was represented by doctors and nurses who had participated in at least one simulation at CSC and at the Meyer Pediatric Hospital. The simulations were carried out starting from 2002 until 2012, and 900 doctors and nurses were involved.

The subjects involved in the validation study were 237 (doctors and nurses, 123 females - 51.9%). 88.6% performed their simulation experience at CSC, and 27 subjects at the Meyer Pediatric Hospital. The percentage of respondents was almost 30%.

The total sample was made up of 94 nurses and 143 doctors. The sample was sufficiently homogenous in reference to the gender (51.9%). The average age of the participants in the study was 41 (SD ± 10.7, range 23-62 years).

The CSC realistically reproduced the architectural and organizational characteristics of a real hospital room where doctors and nurses had the opportunity to deal with daily therapeutic-diagnostic and interventional occurrences on patient-simulators and thus dealing with diverse emergency clinical situations.

At the Pediatric Hospital Meyer the training program in urgency-emergency codes for professionals

provides the use of simulation on site that consists of the management of scenarios in the same rooms that are employed for real care.

In order to reduce biased ties to different training styles (that influence the number and type of scenarios faced by participants) everyone was asked to respond to the questionnaire referring to their simulation experience in which they dealt with cardiac arrest and applied the Basic Life Support early Defibrillation - BLSD protocols (32). It was the only common scenario carried out by all studied sample at least once.

The sample group were asked to complete the online questionnaire.

The choice to administer the questionnaire online was made according to the methodology utilized in Miloslavsky research (30).

The data were analysed using SPSS® Statistics 20- *Statistical Package for Social Science* (© Copyright IBM Corporation 1989, 2011).

The study was performed between February and July 2013.

Psychometric testing of the SESAF

The analysis of data was done in 3 main steps: pre-processing, descriptive calculation and inferential statistics, and implementation of psychometric characteristics of the tool (facade validation, internal consistency by means Cronbach alpha coefficient, exploratory factor analysis, concurrent validity, reported reliability on the time stability by means of test-retest).

The ***face validity*** of SESAF was performed administering the questionnaire to a convenient sample of 20 subjects (15 nurses and 5 medical doctors) using an on-line compilation mode anonymously. The subjects included in the convenient sample made no contribution to the draft of the initial questionnaire. They were asked to answer 4 questions concerning clarity, neutrality and completeness of the items in the questionnaire. They were also asked to evaluate the completeness in all the pertinent dimensions of the subject-matter of the survey. The answers predicted an inclusive value scale from 0 (Not at all) to 10 (A great deal). The possibility to express their thoughts and/or considerations was offered to the subjects. On these bases, some modifications such as graphic changes and the removal of repetitive items were generated.

Regarding the ***test-retest reliability***, the SESAF questionnaire was administered twice to 21 subjects (who were recruited according to convenience) at a distance of one month between the first administering and the second one.

Results

Regarding to ***face validity*** of the SESAF, the clarity of the answers that the participants produced were graded between the scale of 7 and 10. In other words their answers were considered between "good" and "excellent". The average value was 9. The neutrality of the of the answers that they produced the participants reached values between 8 and 10 or "very good" and "excellent". The average value was 9.45. The entirety of the answers was between 7 and 10 with an average of 9.2. Eighteen people reached a score between 9 and 10 with regards to the entirety of the questionnaire with an average of 9.2 (Table 1).

Table 1. Answers provided for the questionnaire facade validity of the new questionnaire

	The questions on the questionnaire are clear	The questions on the questionnaire are neutral (they are not biassed and they don't induce a reply towards a specific answer)	The answers of the questionnaire are complete (all possible answers have been inserted for every question)	The questionnaire is complete (all important aspects and dimensions of the topic in question are investigated)
N	20	20	20	20
Average	9.00	9.45	9.20	9.20
Median	9.00	9.50	10.00	10.00
Mode	10	10	10	10
Standard Deviation	0.97	0.60	1.05	1.36

The **test-retest reliability** of the factors was high (r-Average > 0.733), and significant (Table 2). These results indicate that the questions were not affected by time-dependent variations.

The subjects involved in the validation study were 237 (doctors and nurses, 123 females - 51.9%). 88.6% performed their simulation experience at CSC, and 27 subjects at the Meyer Pediatric Hospital. The percentage of respondents was almost 30%.

The total sample was made up of 94 nurses and 143 doctors. The sample was sufficiently homogenous in reference to the gender (51.9%). The average age of the participants in the study was 41 (SD ± 10.7, range 23-62 years).

An **exploratory factor analysis** to determine which variables could be fundamental in order to indicate the appreciation of the simulation experience conducted. The initial questionnaire consisted of 72 items (all closed types except for an open ended one) but 48 items were identified in the factorial solution including 7 factors and, were selected explaining the 71.65% of the total variance of the phenomenon. The solution was

Table 2. Test-retest correlation of factors. The diagonal line shows the correlation of interests between the initial time factor and the same score during the retest. Outside the diagonal line shows the correlation among diverse-time Factors

	Overall Satisfaction	Facilitator and Debriefing	Clinical Reasoning and Self-Effectiveness	Team Dynamics (Team Factor)	Professional Impact	Safeguards and Materials	Difficulty and Distress	Sum of the first six factors (Distress)
Overall Satisfaction (Post)								
Pearson correlation	0.921	0.903	0.924	0.715	0.799	0.505	-0.436	0.932
Sig. (2-tailed)	p.<0.01	p.<0.01	p.<0.01	p.<0.01	p.<0.01	p.<0.05	p.<0.05	p.<0.01
Facilitator and Debriefing (Post)								
Pearson correlation	0.879	0.895	0.859	0.721	0.702	0.533		0.894
Sig. (2-tailed)	p.<0.01	p.<0.01	p.<0.01	p.<0.01	p.<0.01	p.<0.05		p.<0.01
Clinical Reasoning and Self-Effectiveness (Post)								
Pearson correlation	0.831	0.854	0.897	0.656	0.711	0.485		0.860
Sig. (2-tailed)	p.<0.01	p.<0.01	p.<0.01	p.<0.01	p.<0.01	p.<0.05		p.<0.01
Team Dynamics (Team Factor) (Post)								
Pearson correlation	0.847	0.852	0.823	0.733	0.616	0.574		0.858
Sig. (2-tailed)	p.<0.01	p.<0.01	p.<0.01	p.<0.01	p.<0.01	p.<0.01		p.<0.01
Professional Impact (Post)								
Pearson correlation	0.833	0.741	0.799	0.712	0.870		-0.437	0.825
Sig. (2-tailed)	p.<0.01	p.<0.01	p.<0.01	p.<0.01	p.<0.01		p.<0.05	p.<0.01
Safeguards and Materials (Post)								
Pearson correlation	0.694	0.794	0.746	0.608	0.451	0.756		0.743
Sig. (2-tailed)	p.<0.01	p.<0.01	p.<0.01	p.<0.01	p.<0.05	p.<0.01		p.<0.01
Difficulty and Distress (Post)								
Pearson correlation	-0.505		-0.512	-0.464	0.482		0.783	-0.533
Sig. (2-tailed)	p.<0.05		p.<0.05	p.<0.05	p.<0.05		p.<0.01	p.<0.01
Sum of the first six factors (Distress) (Post)								
Pearson correlation	0.921	0.914	0.925	0.743	0.781	0.530	-0.445	0.938
(Sig. (2-tailed)	p.<0.01	p.<0.01	p.<0.01	p.<0.01	p.<0.05	p.<0.01	p.<0.05	p.<0.01

Table 3. Correlation Matrix among factorial scores

Factors	Overall Satisfaction	Facilitator and Debriefing	Clinical Reasoning and Self-Effectiveness	Team Dynamics (Team Factor)	Professional Impact	Safeguards and Materials
Overall Satisfaction	1					
Facilitator and Debriefing	0.71	1				
Clinical Reasoning and Self-Effectiveness	0.75	0.67	1			
Team Dynamics (Team Factor)	0.6	0.64	0.55	1		
Professional Impact	0.67	0.53	0.65	0.41	1	
Safeguards and Materials	0.43	0.38	0.28	0.4	0.15	1
Difficulty and Distress	0.09	0.25	0.15	0.24	0.05	-0.015

identified involving an extraction with the axis factorizing method by choosing to extract a fixed number of 7 factors. The rotation chosen was the Promax (Kappa 4) being the extracted factors both theoretically and experimentally correlated among themselves with the exclusion of listwise and choosing as an absolute value of cut off for the visualization of coefficients 0.25.

Correlation matrix among factorial scores is reported in Table 3. Factors 6 and 7 are barely correlated with the others. However, considering the explored areas of the study they enhance the measurement capacity of the tool, and they do not represent a limit. Table 4 shows the items associated with each dimension.

Concerning the **concurrent validity** a comparison analysis was carried out on SESAF tool with the SESS. The total factorial score shows a degree of agreement (i.e. concurrent/convergent predictability or validity) of r=0.9 equal to a common variance of about 80% (r^2=0.81).

The factors with the most correlation are "Facilitator/Debriefing (r=0.91) and "Clinical Reasoning and Self-Effectiveness"(r=0.9), while the factor "Difficulty and Distress"(r=0.22), and the factor "Safeguards and Materials" (r=0.37) show scant correlations.

The **internal consistency** measured by **Cronbach's alpha coefficient** of the entire SESAF and each subscale reported an excellent reliability (0.97). The maximum value of Cronbach's alpha was obtained by the factor 1 (0.949), and the minimum by the factor 7 (0.658).

Description of the final SESAF framework

Following the implementation of statistical analyses, the definitive version of SESAF is made up of 48 items (Table 4) with closed responses and one open ended question (in which the participants freely express their comments and reflections). The answers were graduated on the 5 points Likert Scale or with option choices among statements that cross-referenced the same values (1=Not at all, 2=a little, 3=Enough, 4=Very Much, 5=A great deal). Only 8 items had an attributable Score ranging from 1 to 10.

The total amount of the scores given to the answers provides an overall value for every single dimension and corresponds to a decisive level of satisfaction. It is necessary to subtract the score of the last dimension instead of adding, because the items are formulated in negative form (Table 5). The SESAF is available in both Italian and English versions from the authors, with specific scores for every single item.

Discussion

The choice of administering the questionnaire on-line was taken from other studies (19) and was mainly tied to the difficulty of reaching the targeted population with other modalities (people who were trained operators in the Florentine metropolitan area, who were operating in national territory, or abroad). Furthermore, the collection of data is more rapid and

Table 4. Items in each factors in the SESAF (Satisfaction of High-Fidelity Simulation Experience)

Factor	Items
Overall Satisfaction (14 items)	Fidelity/realism on simulation scenario
	Usefulness of simulation in work procedures
	The SIMULATOR allows learning through team work very effectively
	It was worth participating in the SIMULATION
	Satisfaction about the simulation experience
	The clinical case was realistic
	Develops clinical reasoning skills through the simulation experience
	Possibility of clinical learning through the simulation
	Degree of effectiveness of the simulator in re-creating the scenario (effectiveness as far as the proposed difficulties
	were similar to those of real cases experienced)
	Possibility of learning by efficiently working in a team
	The SIMULATOR permits you to learn the necessary procedures for patient management
	The simulation was a valuable learning experience
	The SIMULATION session has improved my level of professional training
	Usefulness of debriefing after the simulation
Facilitator and Debriefing (12 items)	I received feedback during the debriefing that helped me to learn
	The facilitator provided feedback during the debriefing that helped me to develop my clinical reasoning skills
	I had the opportunity to reflect on and discuss my performance during the debriefing
	The debriefing provided an opportunity to ask questions
	The facilitator provided constructive criticism during the debriefing
	The facilitator explained important things during the debriefing
	The facilitator made me feel comfortable and ease during the debriefing
	The facilitator's questions helped me to learn
	The facilitator was expert
	Degree of competence in the management of the debriefing by the facilitator
	Degree of competence in the management of the scenario by the facilitator
	Reflecting on and discussing the simulation enhanced my learning
Clinical Reasoning and Self-Effectiveness (8 items)	The simulation caused me to reflect on my clinical ability
	The simulation developed my clinical reasoning skills
	The simulation developed my clinical decision making ability
	The simulation tested my clinical ability
	The simulation helped me to recognize patient deterioration early
	The simulation enable me to demonstrate my clinical reasoning skills
	The simulation helped me to recognize my clinical strengths and weaknesses
	The simulation helped me to apply what I learned from the case study
Team Dynamics (Team Factor) (4 items)	My team were interested and paid attention during the debriefing
	My team were interested and paid attention during the SIMULATION
	Did you participate actively in the debriefing after the SIMULATION?
	Did your peers in the debriefing provided feedback on the performance expressed by the team as well as by individuals?
Professional Impact (4 items)	During the SIMULATION did the fundamentals learn as well as the experts were useful for work procedures?
	How much of what you learned during the SIMULATION have you applied to your daily work?
	The SIMULATION helped me understand what my role would be in a similar emergency situation
	If I had not participated in the simulation, my work performance would have been worse compared to what I actually had

(continued)

Table 4 ***(continued)*****.** Items in each factors in the SESAF (Satisfaction of High-Fidelity Simulation Experience)

Factor	Items
Safeguards and Materials (3 items)	The safeguards/materials were adequate in order to recreate the scenario The Health-system technology were adequate in recreating the scenario The setting was suitable in that it created the scenario
Difficulty and Distress (3 items)	During the SIMULATION I felt discomfort The SIMULATION was a stressful moment/a source of anxiety I found it difficult to face the clinical case during the SIMULATION
Comments and/or concerns about your simulation experience	

Table 5. Scores given to the answers provides an overall value for every single dimension in the SESAF (Satisfaction of High-Fidelity Simulation Experience)

Factor	Items
Overall Satisfaction (14 items)	Minimum 7 scores (absolute dissatisfaction) Intermediate 56 scores (adequate satisfaction) Maximum 105 scores (high satisfaction)
Facilitator and Debriefing (12 items)	Minimum 11 scores (absolute dissatisfaction) Intermediate 38 scores (adequate satisfaction) Maximum 65 scores (high satisfaction)
Clinical Reasoning and Self-Effectiveness (8 items)	Minimum 8 scores (absolute dissatisfaction) Intermediate 24 scores (adequate satisfaction) Maximum 40 scores (high satisfaction)
Team Dynamics (Team Factor) (4 items)	Minimum 4 scores (absolute dissatisfaction) Intermediate 12 scores (adequate satisfaction) Maximum 20 scores (high satisfaction)
Professional Impact (4 items)	Minimum 4 scores (absolute dissatisfaction) Intermediate 12 scores (adequate satisfaction) Maximum 20 scores (high satisfaction)
Safeguards and Materials (3 items)	Minimum 3 scores (absolute dissatisfaction) Intermediate 9 scores (adequate satisfaction) Maximum 15 scores (high satisfaction)
Difficulty and Distress (3 items)	Minimum 15 scores (absolute dissatisfaction) Intermediate 9 scores (adequate satisfaction) Maximum 3 scores (high satisfaction)
Total score - Minimum 22: Absolute dissatisfaction - Intermediate 142: Adequate satisfaction - Maximum 262: High satisfaction	
Comments and/or concerns about your simulation experience	

inexpensive despite the awareness of intrinsic limits of such a modality (less control on the interviewee).

The higher number of doctors as participants was due to the fact that more high fidelity simulation courses were organized for this professional category.

The exploratory factor analysis offered a solution with 7 factors: Overall Satisfaction; Facilitator and Debriefing; Clinical Reasoning and Self-Effectiveness;

Team Dynamics; Professional Impact; Safeguards and Materials; Difficulty and Distress. These factors were in line with the investigative dimensions in other studies on the satisfaction of simulation experiences but were found fragmented in other various tools available (6-23).

In opposition to the results of other studies (19) we chose not to insert items related to the organization of the simulation setting as such was an aspect that could be investigated by the didactic manager who would implement the simulation him/herself.

The *internal consistency* of the tool is good reporting an overall value of Cronbach's alpha at 0.97. The Cronbach's alpha was satisfactory even within every factor.

The *test retest* indicated a good time stability. The correlations of factors were high (>0.733) and they were all significant. There is a possibility that between the 1st and 2nd questionnaire administration, the subjects had participated in an additional high-fidelity simulation. However, it is worth mentioning that participants were always asked to respond about what they thought with their simulation experience with the cardiac arrest scenario.

As pertaining to the concurrent validity, the total factorial Score of the new tool showed a high degree of agreement concerning the SSES. The fact that the ultimate two factors (Safeguards and Materials and Difficulty and Distress) showed scarce correlations probably represents a strong point of the new tool, which appeared to measure dimensions not detected by the SSES.

It has been noted that there is a necessity to complete the validation procedure by carrying out a confirmative factorial analysis in the future that will be eventually able to contribute to further streamlining of the tool.

Conclusions

In Italy the implementation of SESAF could cover the gap related to the lack of standardized tools to determine the satisfaction levels of students who have had a high-fidelity simulation experience.

The SESAF can be implemented for the collection of data about participant satisfaction in the high-fidelity simulation experience with mannequins. It can be administered at a distance of at least a week after the end of the simulation sitting (a relative aspect of a simulation experience is to put in practice what was learned).

Its usefulness is mainly due to the possibility to homogenize the data gathering about satisfaction, and by rendering the obtained results comparable among Italian simulation centers and/or laboratories.

We hope that the didactic managers of training courses (Masters or other professional vocations) and professionals committed to the planning of simulation scenarios will adopt the SESAF tool in their training settings, and collaborate to its improvement.

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