N. Adding directions to simulation-based training

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Introduction

Current views on education emphasize that learning involves more than the transmission of knowledge from teacher to student. Students should actively engage in a learning environment that offers them the opportunity to really experience the learning task and the outcomes of certain choices or actions, preferably in teams (*1*). They do this by participating in functional and realistic learning tasks (*2,3,4,5,6*). Learning tasks should be designed in such a fashion that they systematically call upon all knowledge and skills formulated in the training objectives *(7)*. Moreover, these tasks need to be situated within a real and relevant context or environment. Scenario-based training (SBT) meets these requirements *(8)*. In SBT, trainees prepare, execute, and evaluate real tasks in a simulated environment. Training within simulated environments is beneficial over training in real situations, because it reduces the risks involved and because it offers the possibility to exhibit a certain amount of control over the training. Simulated environments may vary in their fidelity. They may be the real task environment, a high-fidelity simulation, but may very well be a highly symbolic representation of the real task. What they typically have in common is that they require the effort of other people besides the trainee, to deliver training. Staff or team members may for example be needed to play the people with whom the trainee has to interact. In addition, an instructor is needed to evaluate the performance of the trainee and to deliver feedback.

Recent developments in the gaming industry give rise to new opportunities to implement SBT in virtual environments in the form of *serious games*. The additional advantage of this medium is that, with the use of Artificial Intelligence techniques, the other players (e.g. team members, opponents, instructor) can be played by intelligent agents (also called *virtual characters*). Examples of such agent-based serious training games already exist (*9*). Combining agent technology and gaming will continue and become more advanced, yielding enormous benefits for training. Trainees can practice more often (and thus achieve higher competence levels), requiring no or fewer resources, which results in lower costs. However, in order to facilitate optimal progression of the trainee within the training, agent-based training needs to be (learning) goal-directed. A *director* is necessary to create learning opportunities within the game, thereby ensuring that the scenario develops in service of the learning goals. This director must be able to intervene in the events or agent-behaviours within the game in order to bring about the desired situations associated with those learning goals. The assumption here is that the quality of training improves by adding a director. Trainees should experience directed scenarios as more motivating and better adapted to their skill level. To investigate whether this is so, we conducted the present study.

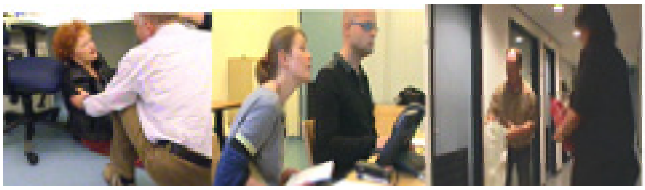

Figure 1. (left and right) Participant and actor in simulated environment. (middle) Director and 'emergency room operator' in central control room.

Method

We chose ‘bedrijfshulpverlening’ (BHV) as our training domain. BHV refers to company employees trained to apply first aid and to fight fires in case of emergency incidents at work until emergency services arrive. We created 4 BHV training scenarios (2 first aid incidents and 2 fire incidents) based upon predefined learning objectives. All scenarios were set in a regular office environment and involved a female getting into trouble and a male bystander, both of whom were played by actors. The scenarios described (A) a diabetic woman suffering from hypoglycemia, (B) a lady trapped within a room because of

a small fire in a trash can near the door, (C) an unconscious cleaning lady, who fainted because of an intoxicating gas and (D) a woman with a broken hip (as a result of fleeing in panic from a fire) lying near a fire hazard. Ten members of a company BHV-team individually participated in all scenarios. This type of training (simulation-based) was new to them. Participants were informed that the experiment was an exercise, but they were asked to act as if the incidents were real. They were instructed to act as if the only person around to help them handle the situation was the male actor. They were informed that they could use the telephone to contact the 'emergency room operator'.

The actors acted according to a predefined script, containing two versions of their parts for each scenario: a *difficult* and a *supportive* version. For example, in the supportive version of the 'burning trash can' incident, the victim-actor was able to climb out of the window, whereas in the difficult version the window proved to be stuck. In the difficult version of the 'diabetic patient' incident, the bystander-actor only provided the participant with relevant information *when asked upon*, whereas in the supportive version he spontaneously gave this information.

The scenarios were registered by three cameras and relayed to the adjacent director's control room. The director used a protocol to evaluate whether or not the script should be *shifted* during predefined events in the scenarios. A shift could either change the behavior of the relevant actor from acting in a supportive way to creating an extra difficulty or the other way around, depending upon the trainee's performance. If the director decided to order a shift, she gave the actors instructions according to the newly adopted version of the script through in-ear portophone speakers, so the trainees were oblivious of the intervention.

Design

All but one participant played all four scenarios. Five participants started according to the supportive version; the other five started according to the difficult version. Two scenarios were directed. This means that the script-shifts in the directors' protocol were executed. The other two were non-directed; even if the directors' evaluation indicated that a shift would be expedient, the shift was not executed. To be able to compare the directed and the non-directed scenarios *within* subjects, scenarios of the same type (first aid or fire) contained overlapping sets of learning objectives. In addition, the directed scenarios were either *A and B* or *C and D*, to make sure each participant took part in a directed and a non-directed scenario of each type. A counter-balanced design was used to rule out the effects of the order and start-off script of the scenarios, and of which scenarios were directed (A and B or C and D).

After completing a scenario, for each key decision during the scenario the participant was asked whether he would make the same decision again in a similar situation. Subsequently, we showed the participant parts of the recordings of the scenario. Each part referred to a learning goal. We asked the participant to rate his cognitive load, motivation, self-efficacy, and emotional state at the time of the recording on 11 7-point Likert-scale questions. After all scenarios were completed, the participant was asked about his experiences and opinions.

Results

A principal component analysis indicated that the questionnaire could be compressed into 3 subscales: Cognitive load (4 items, α=.752), Self efficacy (3 items, α=.793) and Motivation (2 items, α=.724). 2 questions were dropped, due to participants' misinterpretation. Table 1 shows the standardized mean and standard errors on the three subscales for all 4 scenarios.

Table 1. Standardized results of the three subscales for directed scenarios versus undirected scenarios.

	Directed	Undirected
Cognitive load	M=.0012, SE=.1553	M=-.0201, SE=.1038
Self efficacy	M=.0690, SE=.2068	M=-.0117, SE=.1561
Motivation	M=.0278, SE=.2174	M=-.0032, SE=.2446

The scenarios developed very differently, due to large differences in skill level of the participants and a high difficulty level of the scenarios. The participants did not perform all actions belonging to all scenes, resulting in large numbers of missing data. Therefore we were not able to perform a reliable repeated measures analysis.

Fortunately, the qualitative analysis was more successful. Interview results showed that all participants considered this type of training (simulation-based) to be very useful.

Especially the dynamics of the training context, such as having to deal with people in distress while executing certain checkups on a victim, was mentioned as a valuable addition to regular training. The participants felt the need to elaborate on their actions and choices with the other participants. Most of the participants mentioned that adding more realism, for instance smoke and smell, would improve the training even more. However, all participants agreed that the current scenarios were realistic enough to train awareness and decision making skills.

Discussion

In this study we investigated whether the quality of training can be improved by the addition of a director. We offered the participants directed scenarios, which could be adjusted by a director based upon the performance of the participant, and non-directed scenarios. Afterwards we asked the participants to rate the extent to which they thought the scenario was absorbing and instructive (motivation), and laborious (cognitive load) and how confident they were of their ability to handle the situation (self-efficacy).

Inspection of the raw data coming from the questionnaires showed no clear image, because of some problems we encountered during quantitative data analysis: a large amount of data was missing, the formulation of the questions caused difficulties during the interpretation of the data, and the execution of the interventions depended upon the performance of the participants. Some of these problems could have been overcome by formulating the questions differently and by selecting only those situations for analysis, in which an intervention was executed – or – in which an intervention was not executed, but would have been expedient.

However, the video recordings did show some interesting responses of the participants to certain events, actor behaviors and directors' interventions. Even though the scenarios showed some variability, the video recordings do seem to offer a possibility for comparison of directed scenes and non-directed scenes. In addition, the results coming from the qualitative data analysis show a positive attitude of the participants towards simulation-based training. They thought this type of training was instructive, motivating and they felt stimulated to refresh their knowledge, and to evaluate and analyze their performance with the rest of the team.

The question whether the addition of the director during training improves the quality of the learning situation cannot be resolved based upon these inconclusive results. We think it is presumable, that participants may not be capable of assessing the quality of training, because they are involved in their own performance during training. BHV instructors may better be suited to judge the quality of a learning situation. Therefore we have conducted a follow-up study in which BHV-instructors watched video recordings coming from this study. They were asked to judge the learning value of those recordings. This study is research in progress.

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