A PROCEDURE FOR THE EVALUATION OF INSTRUCTIONAL TECHNIQUES USED FOR THE INTEGRATION OF TEAMS

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ABSTRACT
A procedure for the evaluation of instructional techniques based on fictitious scenarios is described; it has been used to make the compared analysis of two strategies of cross-training applied as instructional techniques in the initiation of human groups that will be trained in tasks of sociotechnical nature. The training strategy uses two fictitious scenarios through which knowledge, abilities, and attitudes related to the domain selected for the training are promoted in a crossed way. A collaborative virtual environment is used as the medium to integrate and provide instruction to the group of trainees.

KEYWORDS
Collaborative Virtual Environments, Cross Training, Teamwork, Team Training.

1. INTRODUCTION
Training is an activity that promotes the learning of knowledge in the lower levels of the cognitive domain, as well as abilities in the psicomotor domain; nevertheless, when it is made with human groups (teams), the scope of the learning extends to the relational/social domain, and at upper levels of the cognitive domain. Consequently, the instructional system used in the training (Gagné & Medsker, 1996), as much in the integration of the group, as during its practice, is a fundamental factor for the development of shared cognitive schemes that can improve the teamwork.

In the scope of the investigation in teamwork assisted by computer, the interaction promoted within the team as a metric of the group cohesion, is a subject analyzed with approaches of diverse nature, like for example: the learning promoted through the environment (Dillenbourg, 1999), the activity generated with shared work spaces (Mühlenbrock, 2001), the type of knowledge that is shared when the used environment is intelligent (Soller, 2002), just to mention some. However, the instruction used in the process previous to the execution of a task, that is to say, during the integration of the group and their initiation in the task, is a not very discussed subject, but not less important for team training.

In this paper, a procedure for the evaluation of instructional techniques used for the integration of human teams assisted by collaborative virtual environments, is presented; specifically, a quasieperimental study (exploratory) that compares two cross-training strategies in the initiation of human groups.
2. AN EXPERIMENTAL STUDY

The goal of the study consisted of exploring the results in the performance of human teams that have been instructed by means of collaborative virtual environments, using different strategies for their training. Accordingly, an experiment was designed to try to answer the following research question:

*Are there differences in the observable performance of human teams that are initiated in a collaborative task, by means of the use of different instructional techniques?*

In order to evaluate the observable performance of the team, two factors were selected: efficiency and effectiveness. Also, two techniques used for cross-training of human teams were selected (Blickensderfer et al., 1998) known under the names: Positional Rotation (PR) and Positional Clarification (PC). As far as the activity on which the measurements were taken, it consisted of the design of a plan for the execution of a task in the domain selected for the training.

2.1 Goals

The goals of the experiment consisted of determining the differences in the efficiency and/or effectiveness in the design of an execution plan made by human groups that have been initiated in training activities using different instructional techniques.

2.2 Hypotheses

In agreement with the double objective, two hypotheses of investigation were considered:

H₁₀: The average time (efficiency) used for the planning task by the group that was initiated using the technique PR, is equal to the one used by the team initiated with the technique PC.

H₂₀: The quality of the plan (effectiveness) designed by the group that was initiated using the technique PR, is equal to that of the group that was initiated with the technique PC.

In that way, the alternative hypotheses would allow to demonstrate that the groups initiated with the technique PR are more efficient and/or more effective, than those that were initiated with the technique PC.

3. METHODOLOGY

The training strategy that serves as framework for this experiment (Aguilar y de Antonio, 2005) has been designed for specialized personnel required to execute sociotechnical tasks, such as: operation or maintenance of equipment, rescue operations, combat operations, etc.

Because the sample for the experiment was to be obtained from the students in the university of the research team, a domain familiar to this population was identified: spatial knowledge of the location of each of the campus buildings, as well as of the diverse routes that interconnect them. Based on this knowledge, a task related to the transport problem was designed, involving a problematic situation with certain human risk.

Considering the identified target population, and the designed fictitious task, an experiment was designed to evaluate the difference between means in two factors related to the accomplishment of a group task, using two independent samples.

3.1 Participants

A call was made, with which a sample of eighteen students was obtained which allowed to compose six teams of three different subjects each one.

In order to avoid that the personal characteristics of the members of different teams could influence the results of the experiment, the teams were composed as homogeneously as it was possible. The main characteristics that were controlled in the subjects of the sample were: the gender (men: 12, women: 6), the nationality (Spanish: 8, foreign: 10), and type of curricular program (undergraduate: 10, doctorate: 8). Additionally it was verified that members of each team had not worked together previously, and in the best of the cases, that they had not had contact before the experiment.
3.2 Experimental Design

With the six teams that were integrated, experimental sessions for two days were programmed, according to the design that is shown in table 1.

<table>
<thead>
<tr>
<th>Teams</th>
<th>Day</th>
<th>Instructional Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>I, II, III</td>
<td>1</td>
<td>Positional Clarification (PC)</td>
</tr>
<tr>
<td>IV, V, VI</td>
<td>2</td>
<td>Positional Rotation (PR)</td>
</tr>
</tbody>
</table>

3.3 Procedure

Each experimental session was organized in three stages:

1. *Virtual meeting (45'-50').* The human tutor, according to an instructional technique, used a collaborative virtual environment (Aguilar et al., 2005) to describe: the problem to be solved, the task to be carried out, the plan designed, as well as the roles assigned to each member of the team.

2. *Execution of the plan (20'-22').* The team executed the plan in a real environment (the university campus). Each team decided the coordination mechanism to be used during the execution.

3. *Design of plan (10'-40').* The team designed a new plan for the execution of a task in a situation similar to the one considered in the previous stages, using the mental scheme acquired in the first stage (initiation of the team in the task), and refined with the second stage (execution of the plan).

Some restrictions would have to be considered in the third stage of the experimental session for the design of the new plan, the same ones applied to the plan used in the first and second stage.

3.4 Fictitious Scenarios

In the fictitious situation that was designed, the group to be trained would have to play the role of a SWAT team (Special Weapons and Tactics) with the mission to rescue several radioactive units in a geographic area. The intention was to develop a shared mental model in the human team, which allowed them to reach a certain level of performance in the design of new plans for tasks similar to the proposed.

3.5 Data Analysis

The plans designed by the teams during the third stage, were evaluated with a quality function (1) that considered the goodness of the plans (2) as well as its deficiencies (3). The quality of the plan was considered inversely proportional to the value obtained from (2) and (3), that is to say, the plans of better quality were those of smaller resulting numerical value.

\[ \Theta(P) = \beta(P) + \mu(P) \tag{1} \]

The goodness function (2) is based on a restriction established for the design of the plans.

\[ \beta(P) = \sum_{i=1}^{n} \sum_{j=1}^{U_i} j^2 \tag{2} \]

Where \( n \) is equal to the total number of agents in the team, and \( U_i \) is the total number of units transported from one node to an adjacent one by the Agent \( i \) in the plan. The deficiency function (3) considers the type of committed errors, as well as the number of times that the team committed this type of error.

\[ \mu(P) = \sum_{i=1}^{4} x_i \tau_i \tag{3} \]

Where \( x_i \) represents the number of times the error of type \( i \) was committed, and \( \tau_i \) represents the penalty for the corresponding error. The values of the penalties for each of the errors were obtained from the maximum differences between the values of all the possible plans weighed in agreement with (2).
4. RESULTS

The means that were obtained for both evaluated factors, in agreement with the experimental design, are showed in table 2. With this information it is possible to deduce that, in general terms, the teams initiated with the technique PR used more time in planning, nevertheless, they generated plans of greater quality in comparison with the teams initiated with the technique PC.

<table>
<thead>
<tr>
<th>Instruction</th>
<th>$\Theta (P)$</th>
<th>$\bar{T}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>64</td>
<td>19'</td>
</tr>
<tr>
<td>PR</td>
<td>48</td>
<td>26'</td>
</tr>
</tbody>
</table>

A statistical analysis was made to determine the significance of the difference between the means of the two independent samples; the results were the following:

\[
\text{Efficiency} \quad t(4) = - .677; \quad p = .535 \quad \text{p > .05} \quad \text{H}_1 \text{ is accepted}
\]

There is not a significant difference between the means in time (efficiency) used during the plan design by the teams that were initiated using the technique PR, in comparison to the teams initiated with the technique PC.

\[
\text{Effectiveness} \quad t(4) = -.679; \quad p = .535 \quad \text{p > .05} \quad \text{H}_2 \text{ is accepted}
\]

There is not a significant difference in the quality of the plans designed (effectiveness) by the teams that were initiated using the technique PR, in comparison to the quality of the plans designed by the teams initiated with the technique PC.

5. CONCLUSIONS

The results of the experiment do not allow to infer significant differences in the factors chosen to measure the performance of the teams that were initiated with the technique PC, and with the technique PR. Maybe the used fictitious scenarios were not sufficiently complex so that the used techniques could promote differentiated effects in the learning and performance of the teams. Also, it is considered that the number of teams composed from the sample (6) was quite limited; for this reason, the sample could not have been a good representation of the population. On the other hand we believe that the factor “efficiency” would have to be controlled and used like stressor (time pressure) for the design task. With the lessons learnt from this exploratory study, we plan to design and conduct a new experiment. Although the results of this study are not conclusive, the authors consider that the greater contribution of the work described has been the design of an evaluation procedure based on fictitious scenarios, which can be used for the analysis of diverse aspects related to the instruction that is provided in virtual environments for training.

REFERENCES


