Precision Teaching to obtain motivation, learning and resistance to extinction in e-learning: methodological issues and applied researches in large railway companies in Italy

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ABSTRACT

The lecture is focused on the importance of scientific methodology in the e-learning design. Precision Teaching (PT) is presented from both a methodological and applied point of view. A particular light will be put on the use of PT as the most adequate measurement tool and the *state of the art* procedure for instruction and training via e-learning. Precision Teaching exclusive adequacy in achieving both accuracy (rate of response) and speed (frequency of response) will be discussed. The authors trace the evolution of procedures and findings associated with fluency, discuss on the folly of traditional e-learning without frequent, immediate and contingent feedback and analyze the need of an experimental analysis in developing and delivering effective e-learning in specific areas of complex behavior. An experimental research in a large railway company in Italy was made to compare the effect of precision teaching vs traditional learning methods. The

adoption of PT training in e-learning dramatically reduces training time and increases fluency (accuracy plus speed).

INTRODUCTION

This lecture concern about Science and learning paradigms for effective e-learning. In fact, most of e-learning methods and technologies are coming up without any awareness of the experimental, scientific research findings and most of the e-learning software strengths the importance of informatics and contents of learning without pay attention to instructional design rules and to learning biological laws. In the absence of a scientific, empirical point of view, teaching methodology is either neglected, or lay down from philosophy, sociology, pedagogy and other non-scientific discipline. Without evidence based rules and without scientific background, e-learning is often less effective, less cost-effective and more time consuming than traditional face-to-face training. Often e-learning is deliverable only in conjunction with via e-mail personal interactions, attending lessons or reading handbooks and so on; but this is not synchronous/asynchronous, or blended, e-learning: this is not e-learning at all. We want to demonstrate that it's possible to achieve in e-learning the same and even much more efficacy and efficiency than in traditional training, just adopting scientific paradigms like Lindsley's *Precision Teaching* (Lindsley, 1972). Precision Teaching is a learning paradigm, developed by Lindsley 40 years ago at Kansas University, in the field of Behavioral Sciences and specifically of Behavior Analysis. PT is a powerful tool for achieve learning in. The present study was initiated at the request of management in a large railway company in Italy (Ferrovie Nord Milano Group) to reduce both cost and time of training. The goal was to demonstrate that e-learning can do it at least without any loss in learning quality, or, if possible, improving the training efficacy. The experiment is a partial replication of a previous one developed in another main national railway company, Trenitalia.

The company's training problem

Training is crucial for train drivers. The problem involves both economic and safety issues: training of the new drivers is heavily time consuming (usually hundreds of full training days). Indeed, long lasting training is poorly related with the ability to quickly and accurately intervene in emergencies and dangerous situations. Skinner's main learning paradigm (Skinner, 1960) demonstrates that learning (= stable and generalized behavior's modification) is a function of the number of consequences gained by the learner in the allotted training time, not of the quantity of the allotted time by itself. Therefore, the duration of training, by itself, does not guarantees safety behavior activation in stressful and dangerous situations (McSween, 2004). A good lesson may be learned by some of the recent heartbreaking railway disasters.

Most of the actual e-learning platforms and training methods are neither useful for training time reduction, nor suitable for significantly better or faster behavior activation by the driver on the job.

The role of an e-learning scientific methodology and software

Our hypothesis is that training via e-learning with a built-in algorithm for very frequent feedback (up to 40 per minute or more) could be effective a) to reduce learning time in respect of the best traditional training actually in use and b) to produce an equal or better-quality learning. Two different parameters were adopted to measure learning achievement: 1) the accuracy (percent of correct answers) of response at a number of items and 2) the speed of the response itself.

Speed and accuracy are both crucial dimensions of work behavior, but the majority of the e-learning software and platforms neglect speed at all and is not suitable for a PT/e-learning training. Indeed, a software for e-learning must be projected with many built-in characteristics derived from learning psychology: training sessions shorter than 2' (two minutes), many opportunities for active responding (more then 30 x minute), immediate registration and instantaneous feedback, measurement of 2 parameters of learning and confluence in a Lindsley's "Standard Celeration Chart" (Pennypacker et al., 2003), self paced rhythm allowed, special comparative graphic system, absolutely poor desktop and absence of any button. Items must be delivered to the student in a "A-B-Cs / three contingency model"; all the sessions and all the items must be built with the principles of a shaping procedure, and so on. Such a software is quite impossible to find in Europe. In this experiment a software specifically projected for Precision Teaching was adopted, realized by Luca Caravita for ORSEC, Milano. The software is absolutely content free and largely platform independent; it allows a user screen in Italian and consists of three programs: 1) "Insegno", that is a curriculum and an exercises' builder (by a teacher), 2) "Imparo" for delilvery of lessons and modules to the trainees and a "Performance Analyzer" for trainees' management, extrinsic motivation and/or performance feedback or incentive programs and knowledge management. The analyzer is suitable for statistical and scientific analysis purposes and it was been the basic tool used by our researchers for data collection in on line and distance learning situations during the experimental phases.

Accuracy plus speed in e-learning design

Speed is quite never a training component and is misused as a learning dimension measure. But e-learning programs without speed as a target of training are ineffective (Binder et al., 1989). Indeed, they are quite always far-away from good performance in real work environment, This is the reason why so many e-learning managers take for granted that e-learning must be always mixed or blended with traditional face-to-face instruction. In the railway disaster prevention, speed is perhaps the most important parameter because a fast responder can act without loss of time (at a 120 km x hour an hesitation of three seconds in adopting the correct procedure means a loss of one hundred of meters). Thinking fast and being fast in response is also positively related with attention span (Binder et al., 1990): fast responders get more time for thinking and react better in new - not trained situations and in problem solving circumstances. Speed, finally, is highly related with retention and endurance; workers who become fast responders achieve much more resistance to extinction. The role of a fluent performance is evident in disaster prevention: the potentially dangerous events take place at a very, very low rate of occurrence in the worker's life and the ability achieved at a good accuracy level (e.g.: 100%) cannot resists to extinction in the absence of daily practice.

METHODOLOGY

Participants

21 participants, randomly distributed in experimental group (Precision Teaching, 10 participants) and in control group (Frontal Lesson, 11 participants),

Material

The didactic contents to learn during the training (railway signals, art. 41 of the Trenitalia handbook) have been arranged in advance with experienced trainers of the company. Not-electronic Pretest and Posttest were prepared (just paper and pensil) to avoid the risk of biases due to the confidence with PC by the experimental group trainees. The time employed in the compilation of the test was measured for each student through an electronic chronograph. The correctness (accuracy) of the execution was expressed by the percent of correct vs incorrect answers to 30 items. For further aims the same items have been administered through PC, too, at the end of the experiment, always recording the correctness and the speed of the execution. During the training, each participant of the experimental group worked on a workstation with the special software, "*Imparo*", the trainee version. The software doesn't require *any* specific knowledge neither for the execution of test, nor for the training phase. Indeed, participants were briefly trained to assure familiarity with the computer tool. The trainer of the control group utilized the usual tools of traditional training (e.g.: handbook, block notes, blackboard and video projector).

Procedure

Pretest: during the pretest, the conditions of layout have been the same for all participants. Training: the participants of each group attended to the "lessons" in separate classrooms. For structural and organizational reasons the training duration was much different for the two groups: PT group (experimental) was trained wholly for only 90 minutes distributed in 4 sessions. During the training the subjects must answer to a sequence of items, randomly presented by the computer, as fast as possible, but each at his own pace (e-learning must be individual). The control group attended to a traditional lesson with an expert teacher for wholly 270 minutes, divided in two sessions. Posttest: the posttest has been disbursed immediately after the end of the last training session, to avoid effects of forgetfulness or, on the contrary, of uncontrolled practice.

Instructions

In Pretest and in Posttest the trainees received the same prescription: "Hold closed this issue up to when the instructor will tell you to start. Hardly the <START!> cue will be given, you will begin to answer to questions that you will find in the following pages" and: "You must answer to all the questions, in a sequential way from first one to last one, do not correct them, try to answer as quickly as possible".

Parameters of measure

The dependent variables were: 1) accuracy, measured at pre and post test as the number of correct answers and 2) speed, measured at pre and post test as the time employed for completion of the test. Besides, the duration of training was recorded too.

Hypothesis

H0: No difference is found under the two conditions: e-learning with built-in Precision Teaching methodology seems to be equivalent in effects to traditional training.
H1: differences are revealed by the statistical test, comparing the groups. The training conditions affect the results. If the measures of accuracy or the measure of speed, or both, are significantly higher in the experimental group and the methodology of Precision Teaching seems to be more effective in comparison to traditional lesson. Obviously, if the difference is in favour of the control group, the traditional training conditions seem to be more effective.
Covariance: To test the real effects of the experimental conditions and to make decision about differences not biased by the impair duration of the training groups, (training time is ⅓ in duration for the PT/e-learning experimental group), an analysis of covariance (ANCOVA) were performed.

RESULTS

In Tab. N.1 and in Tab. N.2 are illustrated the mean (M) and the standard deviation (SD) of experimental group and of control group in Pretest and in Posttest.

Table 1: Correctness

Group	Control		Experimental	
Test	Pre-Test	Post-Test	Pre-Test	Post-Test
M	17,09	28,00	16,40	29,20
SD	3,1766	2,1448	3,9497	1,3166

Table 2: Speed of execution

Group	Control		Experimental	
Test	Pre-Test	Post-Test	Pre-Test	Post-Test
M	6,06	5,35	6,56	2,93
SD	1,9539	0,9462	1,0780	0,7396

By the statistic analysis of Pretest, emerges that the groups (experimental and control) are homogeneous either for speed of execution of the assignment (Mann-Whitney U = 36, z = -

1.340, p = .18 ns) either for correctness (Mann-Whitney U = 52.5, z = - .177, p = .86 ns). Comparing the data to Posttest, we found that the two groups differ in a high meaningful way if compared in the speed of execution (Mann-Whitney U = 1, z = - 3.804, p <.0001). In this case, the Effect Size points out a huge effect (Cohen's d = 2.82; 95% IC Effect Size = from 3.9 to 1.53). Always in Posttest, in relation to the correctness, we calculated the ANCOVA using the different duration of the training in the two groups as concomitant variable. Verified the fundamental requisite for the ANCOVA (little or no real evidences against the null hypothesis of the equality of the slopes), we got: Common slope = .000038; Intercept = 1.5399. The conclusion is in favour of a strong evidence against the null hypothesis (H0: The difference between the two means is about to given value M). In other words, the difference between the two means is quite different than it is claimed; it underlines that the means of the correct answers, weighted up the differences due to the duration of training, are meaningfully really different. Results are well explained at a glance in graphic form, keeping well in mind that the PT group good performances are obtained with a training duration that is ⅓ of the time allowed to the control group.

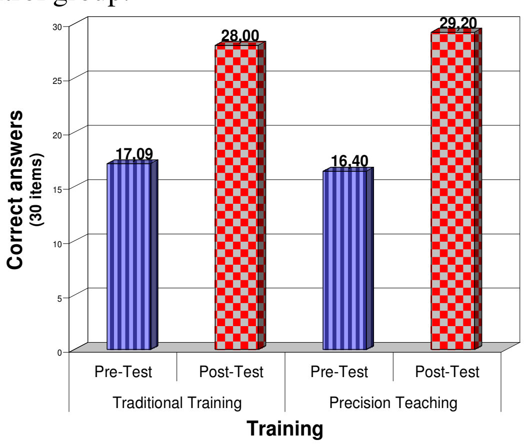

Figure 1: Correctness

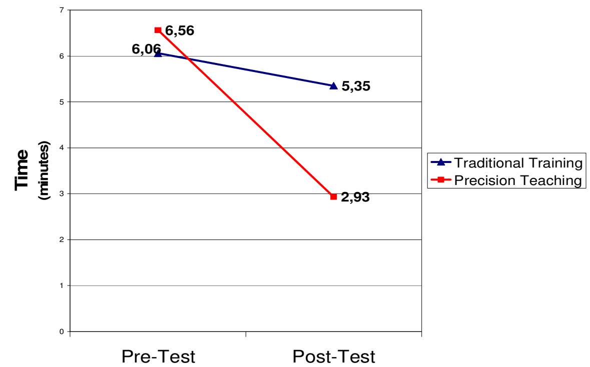

Figure 2: Speed of execution

DISCUSSION

The results fortify our hypothesis: the experimental group shows a great mastery of necessary abilities to resolve the assignment; besides, the methodology of Precision Teaching results much more effective and more efficient in comparison to traditional methodology. In fact, the PT/e-learning experimental group not only develops the assignment in a considerably faster way, but it arrives to the criterion of correctness with an extremely inferior duration of the training in comparison to control group.

It should be noted that analogue previous experiments in FNM and in our national main railway company Trenitalia (Tosolin, 2005) brought to strictly similar results for both the same (signals recognition and related procedures) and different tasks (e.g.: Ohm Law). Evidence in favor of the efficacy of PT/e-learning training, in absence of trainer and without any support of books, previous explanations, trainer's synchronous or asynchronous assistance is rapidly growing up. It must be considered, then, that other important experiments like the Errico's SMAU 2004 award winner (Errico, 2005), are demonstrating the high supremacy of PT/e-learning vs traditional, hypertext based e-learning.

At the end, we probably have to suspect that most of actual training via e-learning, delivered with poor, if any, built-in scientific and evidence based learning algorithms is at risk of failure. A naïve approach, based on business meeting and academic discussions, or founded on trials without research methodology is far to help in grabbing the great opportunity offered by the new technologies. Only further applied research is the matchless key to clarify that just a scientific approach, based on the behavior analytic learning principles can help in building effective and really highly competitive e-learning.

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