SIMPA: a training platform in work station including computing tutors

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Abstract. The know-how transmission becomes an essential condition of high technology companies continuity. In response, we propose a multimedia training platform in operators work station, called SIMPA. It was developed within the framework of a "Six Sigma" step, with a permanent concern of customers satisfaction (learners, formative persons in workshops, and managers). Its foundation is to leave a large place in the autonomous activity of the learner, by insuring him a permanent pedagogical accompaniment, thanks to two computing tutors (the professor and the companion); this answers the need of reduction in time of human tutoring. SIMPA integrates all the tools of follow-up necessary for the trainer to practise an indispensable debriefing at the end of each training session. We experimented SIMPA in situation at TED / TIV[1;] the results are convincing, as well in credibility of our computing tutors as in diversification of pedagogical courses.

1 Introduction

As many high technology companies, the Moirans site of Thales Electron Devices (TED/TIV[1]) is confronted today with the major stake of transmission of knowledge, condition for the company continuity. Four main reasons explain that:

- from 1998 the setting up of **work organization in autonomous teams,** characterized by training needs for the versatility in the workshops,
- a context of **reduction in working time**, with the setting up of a 35-hour working week,
- the **population pyramid evolution**, with the emergence of a young population mixing with an ageing one,
- the **temporary workers training,** more and more called for punctual work growth; it must be fast and effective.

In the operator's training domain on the Moirans site, we already provided a methodological response to these needs, through the contents structuring, the personalization of the pedagogical courses, and practises/theory alternation in the organization of our training activities [1]. With regard to the training evaluation, we developed a SEAMI[2]: System of Learner's Multimedia and Interactive Evaluation; its design benefited from recommendations resulting from a Principal Components Analysis made from a double experimentation from tool [2]. It appeared during these experiments the SEAMI could exceed its role of skill revealing corroborated; it is also a training tool in power, according to the model of pedagogy by the action. However, it preserved large gaps:

- its teaching structure was too rigid: single method of the illustrated textual QCM of videos;
- it wasn't possible to use it in self-tuition: no assistance or succeeded mediation;
- it didn't contain documentary space other only the 4 videos proposed;
- it didn't offer coherence with a personalized teaching course (pedagogical contract, formalized goals).

This article presents the step of design and the result of a model improved of SEAMI adapted to training; we called it **SIMPA[3]: Mediatized and Personalizable Interactive Support for Training.** Theoretical supportings and the practical application of our integrated computerized mediation model will be described on the simplified

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idea of the Intelligent Agents. We will copy our talk on the course of the project led according to the "Six Sigma" method that guided us in this step.

2 The "Six Sigma" Step

The development of SIMPA was treated from start to finish through a "Six Sigma"[4] project. This method relates to the development and the optimization of industrial process. It is a true methodology of implementation in project, that establishes the link between quality philosophy (to make well, first blow, for the customer), tools quality and statistical analyses. Focused on the measure, its permanent concern is the satisfaction of the customer need, taking into account all its requirements in the product or process specifications [3]. The successive stages of a project "Six Sigma" consisting in developing a new product are the followings:

- **"Define":** Need description; definition of the goals, the perimeter and the schedule of the project. *R0 review;*
- **"Measure":** Transcribe the voice of the customer in term of critical needs; hierarchisation and establishment of specifications for these needs; define means to measure them. *R1 review;*
- **"Analyse":** Total design of the product; estimate of its capability. *R2 review;*
- **"Design":** Realization of the tasks of detailed design; Analyze of failure risks; Test plan in situation. *R3 review;*
- **"Verify":** Check the robustness of the product; Plan of product transfer; lessons to be learnt from the project. *R4 review.*

All these stages give rise to reviews of validation (in the presence of the customers for the reviews R0, R2 and R4) for which a list of supplies is awaited. In our case, in the light of the gaps of SEAMI, the stage "Define" consisted in identifying the needs for a new multimedia training product. Let us detail our work according to stages of the "Six Sigma" steps.

3 Taking the Customers Needs into Account (stage "Measure")

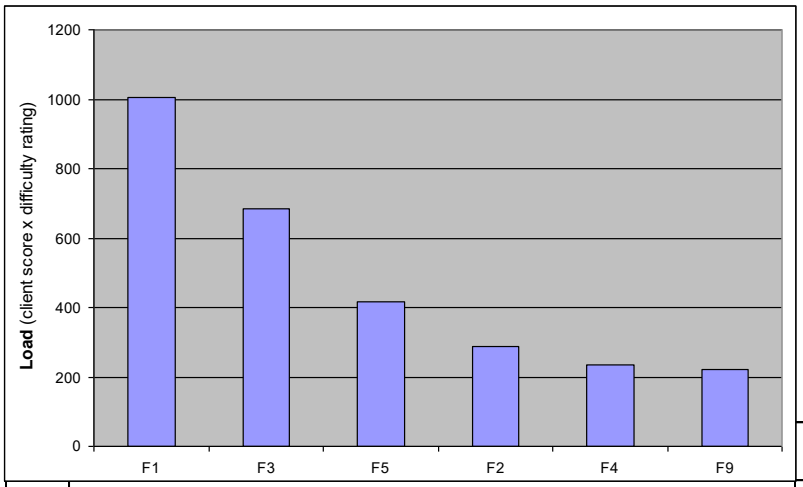
The project started on these 2 experienced needs:

- need for training supports on the work place with strong pedagogical contents intended to people in the field,
- need for competencies measuring instruments and traceability for training actions to manage the grids of versatility (card summarizing personal skills available in each workshop), within the framework of the system of Quality assurance ISO 9001.

3.1 Transcribe the Customer's Voice

We have 3 types of customers: the learners, trainers and managers, who are the pilots and the decision makers of our training activities. To identify their needs, the method requires to select and question a panel of them (we chose 10 interlocutors for each type of customer) and to gather and order their specific needs. So, we build for each type of customer a QFD matrix (Quality Function Deployment), also called **"House of Quality",** in which it is obligatory to define a feature for each critical need of the customer [4]. The features are classified in Pareto (classification by decreasing values; see fig. 1) according to their respective load, calculated by multiplying their total importance by an estimated index of realization difficulty (between 1 and 5). Thus, the exploitation of QFD matrix structures the design step by giving a table of functioning on the command of the operations. From our total analysis of the needs a dominating feature F1 results, which constitutes the base of SIMPA: the **computerized functions of mediation** (weight of 1005 for a total weight of 4170 per 21 features).

[4] The term "sigma" indicates a statistical measuring unit which is the reflection of the capability of a process. Ideally, a capability of 6 sigma ensures a level of conformity of 99.99966 %.



		clients's score	difficulty rating
F1	Computerized functions of mediation (companion / prof)	201	5
F3	Organisation and diversification of the course according to the target-competences	137	5
F5	Calculation of a confidence interval upon the score, thanks to behavioural data	104	4
F2	Procedure of application and follow -up of training actions	144	2
F4	Calculation of the score from the learner's answ ers	118	2
F9	Structure of the medium independent from the contents	55	4

Fig. 1. Pareto of the six priority features (on 21)

Thanks to the R1 review, one identifies on the one hand the difficulties of realization. In our case, we have to take account of 2 incompatible aspects (*a priori):*

- developing functions of mediation integrated by means of computer while guaranteeing a support structure independent of the content,
- diversifying the suggested teaching activities modes while authorizing a use of the product in autonomy by the learners.

On the other hand, we detect early in the phase of design the essential points of the customers future satisfaction, and thus the success of the project. That results naturally in the installation of customers satisfaction indicators, elaborated at the end of the stage.

3.2 Customers Satisfaction

Three mainlines of customers satisfaction appear:

- response to **s**pecific needs: we propose to each customer a questionnaire out of its 5 main needs;
- efficiency of the result: we organize an assessment meeting convened by automatic follow-up after a few weeks of practical application in the field; it results in a concerted skills validation by an evaluation between all the actors of the training session;
- reduction in working time of the trainer: we check his total time of presence does not exceed 50% of the duration of the training.

4 Theoretical Bases of SIMPA (stage "Analyse")

This stage gives rise to define the major choices which will guide the design of the product.

4.1 A Model of Framed Autonomy

One of the stakes of SIMPA is to reduce the attendance time of the trainers (their workload as a technical support being very strong) by adopting the **briefing–debriefing** tutorial model [5] described on fig. 2. Concretely the trainer leaves the training room after having presented the objectives and the day course; he carries out on his return an assessment adapted for each learner according to his traced activity during the autonomy phase. In our case the first session of training is devoted to discovering interface: it is **the run-up** [2].

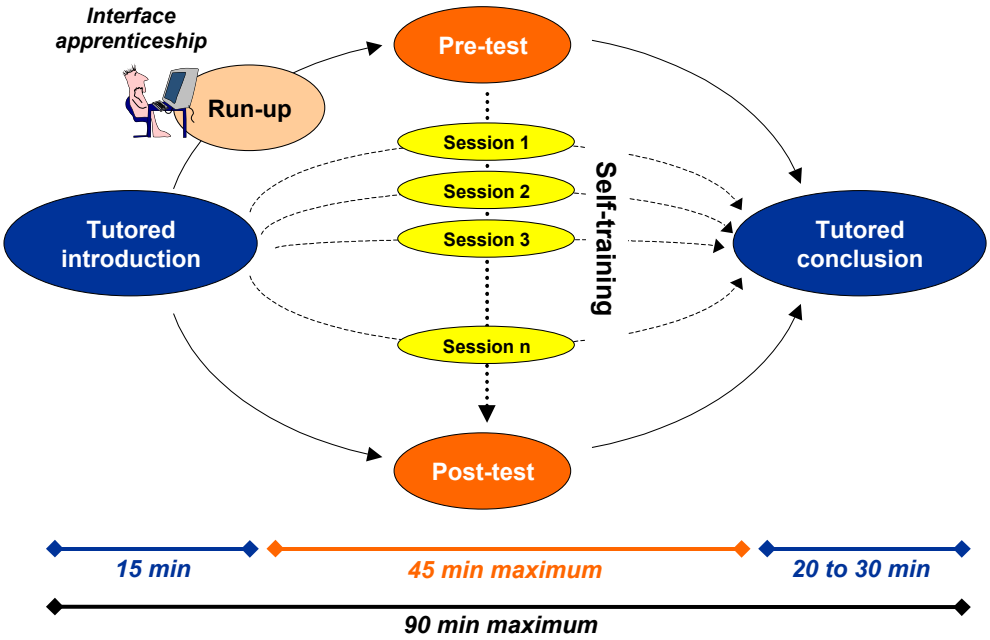


Fig. 2. The briefing–debriefing model

4.2 Structure of SIMPA

The heart of an application as SIMPA is composed of the **route book**, that is personal for each learner. His pedagogical contract is there drawn up (pedagogical objectives, course, possible specifications on the scores to obtain, methods of practical application, procedures of evaluation). This book grows rich by the follow-up of each training activity. From the route book, the learner navigate for each target-skill in the books dedicated to the **three types of knowledge** (theoretical and contextual knowledge, know-how in conformity, and be able to react in the event of risks) [1]. Lastly a book is dedicated to all the **documentary resources** in textual or multimedia form; these resources are worked out by the technical expert of the field in dialogue with the pedagogue. Fig. 3 shows the general architecture of the platform and its functioning.

4.3 Learning by Doing

We favour the autonomous activity of the learner; his course for each target-skill consists of a coherent series of exercises, called **teaching activities.** There is a balance to respect in the activities difficulty: if the difficulty is too weak, the learner answers by simple common sense without calling upon the documentary resources and thus without apprehending automatically the key concepts of the training. Conversely if the difficulty is too high the learner will be constantly in failure situation, and a feeling of discouragement will appear quickly. If one adds to these dangers the possible confusion of the learner within the environment from training or his possible incomprehension of the activities instructions, one admits without hesitation the need for **establishing a mediation in the absence of the human tutor.**

4.4 Mediation Criteria

To implement our feature F1, we proposed to exploit works of professor Reuven Feuerstein and his practice of the Instrumental Enrichment Program [6]. He defines cognitive functions (for example: "the need for precision in the data-gathering", "the need to plan one's control") to activate by the mediator during a training session. Our starting assumption is these cognitive functions are available for our learners, but little or badly invested because of the new situation or other parameters dependent on the environment or on the person's intentions. The goal of the mediation of the computing tutor is to request these cognitive functions so the suggested task can be accomplished successfully. One distinguishes 3 phases from the learner's mental activity [7] during the teaching activities which are proposed to him:

- **"I inform":** the learner takes note of the environment, the nature and the facts of the case posed,

- **"I elaborate":** the learner brings into play his cognitive mechanisms to solve the difficulty; this phase does not result inevitably in an observable behavioural activity,
- **"I act":** the learner declares his answer.

We wish to take as a starting point the **mediation criteria** [8], classified below according to 3 types of intervention to adapt them on computer:

- **Spotting interventions:**
  - on the pedagogical objectives,
  - on the significance of the training,
  - on the course and the used means.
- **Regulation interventions:**
  - impulsiveness control,
  - mediation of the concentration,
  - mediation of the implication,
  - mediation of planning (to split up the difficulty).
- **Recognition interventions:**
  - mediation of the competence feeling,
  - mediation of the search of innovation and complexity,
  - positive management of the errors.

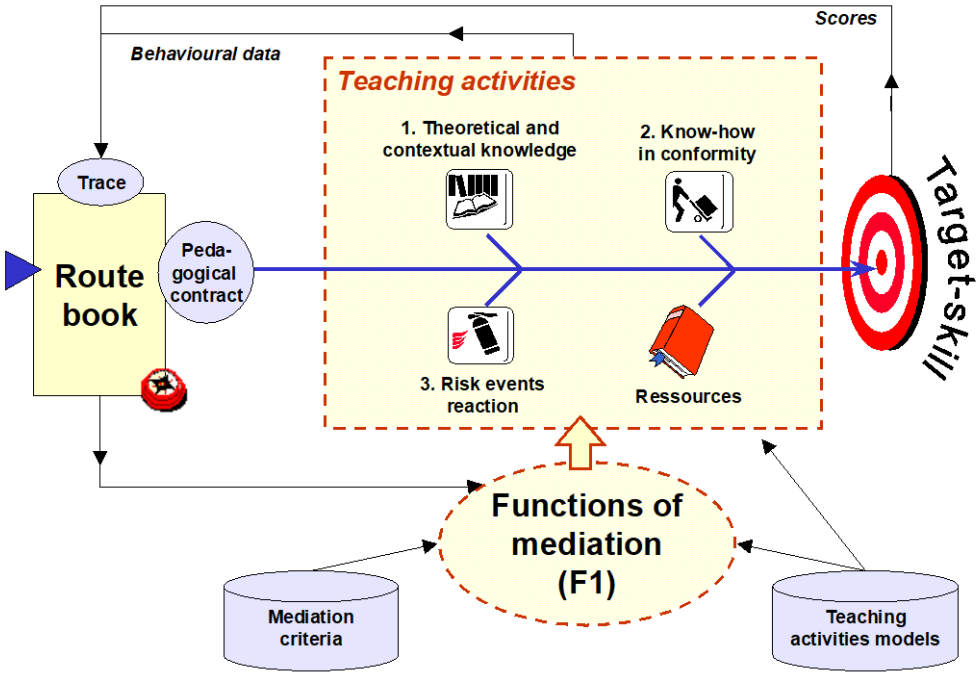


Fig. 3. General architecture of SIMPA

5 Detailed Design of SIMPA (Stage "Design")

5.1 A Library of Teaching Activities

SIMPA modules are designed around a fixed structure of decomposition of knowledge on which the pedagogue comes to graft, in dialogue with the technical expert a collection of adapted teaching activities. They are extracted from **a library of models,** until now composed of the following types**:**

- drag-and-drop labels (texts, photographs, videos or sounds), with 2 possible ways:
  - sequential (to respect a command of operations),
  - category index (all kinds of classifications in several categories),
- answer directly a Multiple Choice Questionnaire (MCQ),
- answer a MCQ launched by a keyword taped on keyboard,
- complete a phrase with holes,

- reconstruct a puzzle,
- complete a crossword grid,
- recognize active zones on an image,
- connect in pairs,
- validate or invalidate an assertion,
- extract the good elements from a given list.

This evolutionary list gives us a broad creation and field of application. Specific parameters, useful for the mediation mechanism, are dependant on each activity.

5.2 Actors of the Mediation

To mitigate the absence of human tutor during the training session, we developed 2 computing tutors: the professor and the companion. This binomial has a double function: on the one hand to instigate the interventions of the characters (who will intervene ? at which moments ?) by sparing possibilities of dialogue between them, and on the other hand to reveal fully **the duality of the ideal mediator:** at the same time to put oneself in the learner's place, and to guide him in his reflexion and his training course. As follows:

- **the professor** is based on the traditional guides developed in environments of interactive training or in the educational CD-Roms: he gives the instructions of each activity; as he knows the solutions, he expresses his joy in response of good answers of the learner;
- **the companion** is the regulator of the learner's behaviour: he is inspired by the pedagogical model of the "learning companion" [9]. He doesn't have the response to the exercises but his resources book is accessible permanently. Curiously, he doesn't fail to ask to the professor the utility of each new screen (pedagogical objectives).

These tutors share the mediation interventions. Because they don't manage any pedagogical adaptive strategy, we can't call them pedagogical agents as Claude Frasson defines them: reactive, instructable, adaptive and cognitive [10]. In fact, a pedagogical agent can be defined by three characteristics [11, 12]:

- adaptation: the agent is able to build a model of the learner;
- autonomy: the agent makes decisions on the basis of his knowledge;
- mobility: the agent can widen his space of search (on Internet for example), to dialogue with other agents to seek missing information.

Without developing complete "intelligent agents" [13], we gave to the tutors the following features, to approach a life-like behaviour [14]:

- **a permanent attention with the actions of the learner:** the eyes of the tutors follow the mouse movements, they bring pieces of advice and information about screen areas or the teaching activity in progress,
- **a diversity of the facial expressions:** the tutors are motionless (each one in a corner in bottom of the screen) but have a panel of about thirty different emotions. The animated elements are the eyes, the lashes, the eyebrows, the mouth and one hand. For the moment, they are not expressed directly by the word but by bubbles with the screen,
- **an interactivity with the results of the learner:** correction of the activities, evolution in the interventions of mediation given, automatic guidance control towards other screens of the course or documentary resources if the resolution of the current activity requires it (example on fig. 4).

In fact we counted on the **"persona" effect** described by James C. Lester and his team [15]: just the presence of a tutor animated in an environment of interactive training stimulates not only the intrinsic motivation of the learner but also their process of individual reflexion. Our goal is less to design an intelligent agent which adapts gradually to the learner's behaviour, than use the human adaptability confronted with a mediatized environment, since the conditions of interaction and credibility of the computing interlocutors are sufficient.

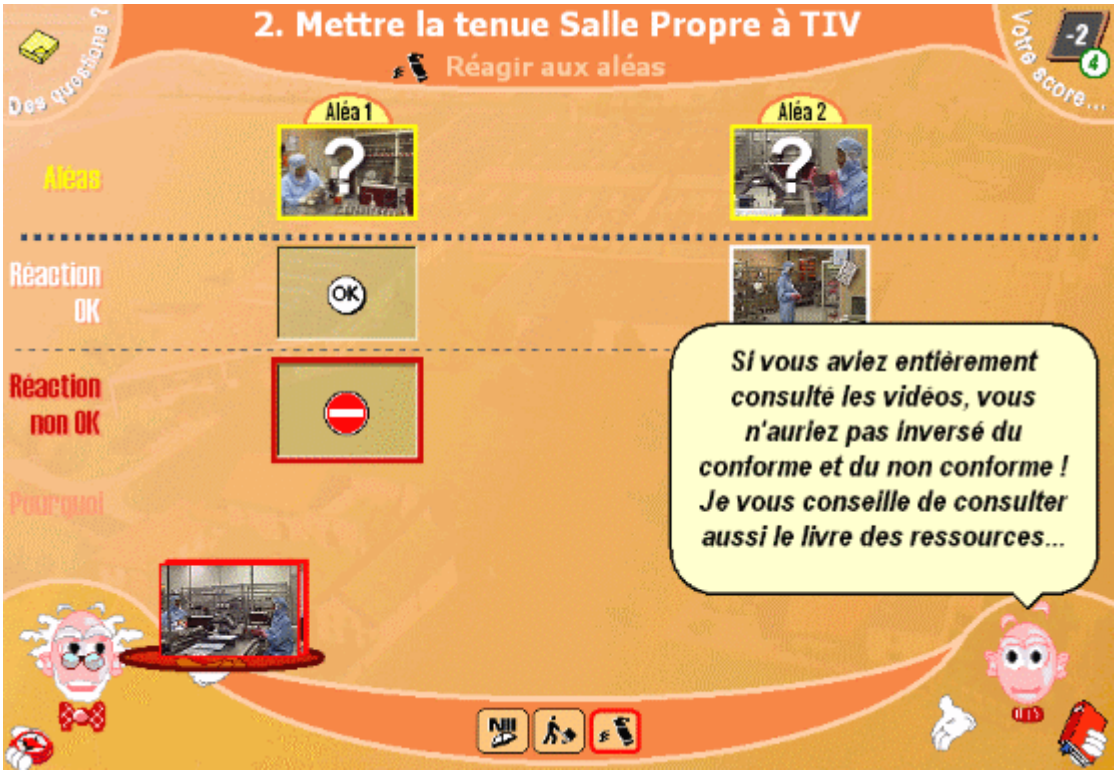


Fig. 4. Regulation intervention by the companion

5.3 The Mediation Mechanism

Without calling upon the techniques of the Artificial Intelligence (IA), we wanted to give to the computing tutors a credible talent for repartee. Thanks to the cyclic character of our training courses (a training action is divided into several target-skills, each one being a collection of teaching activities), we manage a limited number of teaching situations. So we built a mediation mechanism starting from a basic learner's behaviour, added by the processing of particular cases, as a function of the distance of the awaited behaviour. We identified these particular cases by a double series of tests on a panel of 25 learners in the company.

Concretely SIMPA modules are equipped with computer sensors which progressively generate **a training newspaper** with the activity of the learner (trace). One finds there the chronological order of his operations, devoted time, errors made as well as the obtained scores. This history is exploited by the tutors in order to clarify their interventions. One distinguishes the **thorough** (by the tutors) **and drawn** (by the learner) **interventions**. In the first case, the tutor interposes in the action by delivering his message on the screen; we reserve this type of intervention to defined cases: repetitions of the same mistakes, continuation of mistakes during the same activity. In the second case, the means to draw the attention of the learner are graduated from the most subtle (a wink of the tutor) to the most attractive (the tutor types with the pane). The tutor means his intention to intervene by a symbol representing the type of message which he wants to give. The drawing disappears since it is not any more topicality or when it is replaced by another message.

Except the spotting, these interventions are independent of the training contents. They are built according to the mediation criteria:

- **spotting:** at each arrival on a new screen, on request of the companion, the professor presents the teaching objectives. If the same page comprises several activities, he also gives a message of transition to present the activity that follows;
- **regulation:** interventions come from the tutors: if nothing occurs in an abnormally long time, in case of bad comprehension of the activities instructions (continuation of illogical actions), etc;
- **recognition:** with each click of the learner on the button *"I have finished"* (invariable means given to the learner to give his answer), the system generate an **internal bar code of the pedagogical situation**: well-ordered information upon the context and the behaviour (see details on fig. 5). The professor gives in case of good answer **a graduated recognition,** function of the difficulty of the exercise and number of tests to find the answer. On the contrary, the error is explicitly meant to the learner (in drag-and-drop

for example, the badly placed labels return to their initial position), and the companion advises him according to the bar code.

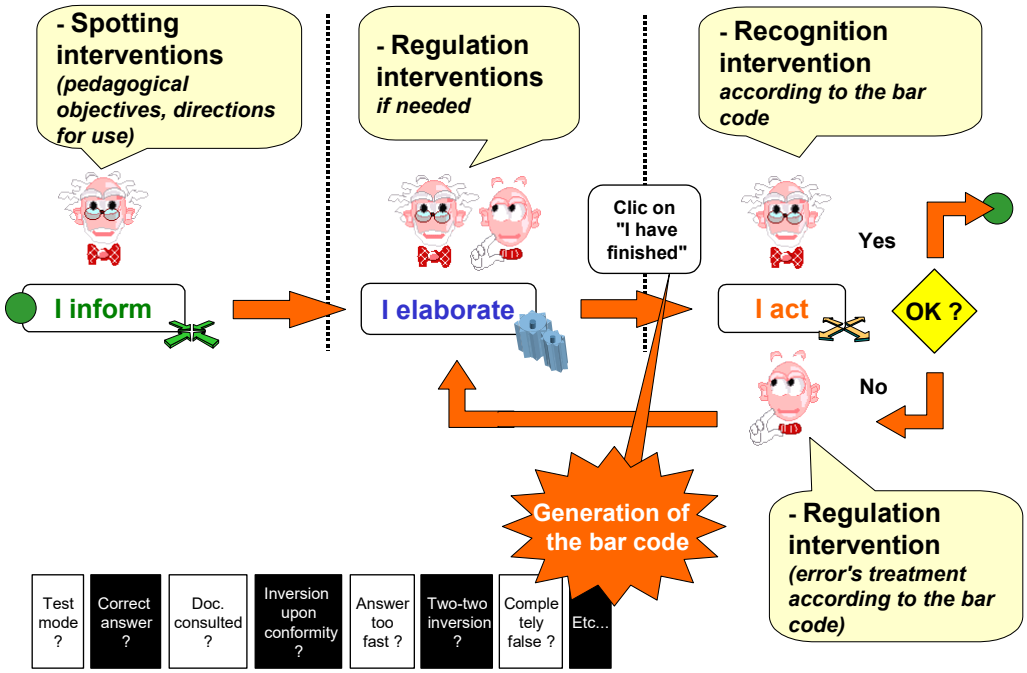


Fig. 5. Mediation mechanism in SIMPA

5.4 A Multi-users Platform

SIMPA modules were designed for triple use:

- **learning mode:** it's the greatest mode in term of mediation; the 2 tutors are present to accompany the learner, and the documentary resources are permanently accessible. Each activity suggested must be concluded so that one can declare complete the training course,
- **test mode:** the same activities are proposed, but the learner doesn't have any feedback on his actions: he has only one try to answer without knowing the accuracy of his answers. Only the professor is present (there is indeed no positive management of the errors to carry out) to manage navigation,
- **solution mode:** it is accessible at the end of the learning mode; all the activities are corrected, and the learner can freely come to re-examine the solutions of each screen, if it's results necessary during his later activity. This document constitutes a reference frame placed permanently at the disposal on the corporate network. There is no mediation for this using mode.

The platform recognizes two types of users: the learner and the trainer. The latter disposes of useful functions to control the learning session during his absence: management report of each target-skill, **uncertainty intervals on allotted scores** [1], **questions on computing post-it**. Let's also note that the trainer is the only one who is able to modify the pedagogical contract in the route book; in practice he draws up this contract in the presence of the learner.

6 Experiments and Estimate of the Mediation (stage "Verify")

6.1 Experimental Device

We developed a SIMPA prototype on target-skills *"Slip on the clean room overalls" and "Communicate in the clean room"* within the framework of clean concept[5] training. It was tested according to the following experimental protocol: 25 people of the company, of all ages, sectors and expertise levels used this module 2 times,

[5] The clean concept indicates the whole means implemented to protect our products sensitive to the particulate contamination, and in particular the behavioural work rules in clean room.

with an interval of 20 days. The purpose was to have a return of use on our mechanism of mediation: how the people react with the presence of the professor and the companion ? Do they have a credible and effective "behaviour" ? We thus proposed to our volunteers **an evaluation grid of the computing tutors.** In addition to the computer sensors which kept the trace of the actions, a human observer followed each test integrally, without intervening in the action, in order to identify the situations where the mediation proved to be insufficient.

6.2 Results Obtained

It appears that the companion is below the average for the first experiment (note obtained: 1.6 out of 4); his role was not marked enough, in particular with regard to the assistance which he should have brought thanks to his resources book. On the other hand, as the first experiment the professor obtained a note of 3.1 out of 4. His actions on the instructions of the activities suggested and on guidance within SIMPA were the most noticed and appreciated. In fact his role was dominating because of the intuitive character of the good answers to the activities suggested. The clean concept is often a matter of good sense and the scores were high from the first experiment (5.3 out of 7). There were few errors and thus few opportunities given to the companion to appear. The test would have been more instructive on tougher target-skills, but our industrial constraints pushed us to choose the clean concept as experimentation subject.

We carried out some adjustments between the two experiments:

- **on mediation:** possible intervention of the companion during an activity elaboration (before the learner's click on "I have finished"), solution of blocking situations met with the first experiment (reconstitution of the puzzle, clarification of activities instructions, etc), more shunting toward the companion's resources book;
- **on navigation:** erase of inopportune mouse clicks during animations, more ergonomic presentation of the dialog box with the learner, access facilitation to professor's spotting messages.

After the second experiment, the companion reaches 2.5 out of 4 and the professor preserves his popularity with 3.3 out of 4. The general appreciation of SIMPA passes from 2.6 out of 4 for the first experiment to 3.3 for the second. The principal roles of our tutors are identified as follows by the learners:

Professor:	- guidance during the course (21.5%),
	- activities Instructions (19.4%),
	- location in the course (16.1%).
Companion:	- invitation to use documentation (38.3%),
	- invitation to consult the professor (25.5%),
	- relevant errors management (21.3%).

These results validate our choice of a bicephalous mediation; the comments collected in margin of the investigation near the volunteers indicate their total satisfaction toward this environment of interactive training.

6.3 Deployment of SIMPA at TED/TIV

The two target-skills used for our test were supplemented by five others to form today a complete training module on behavioural rules in clean room. One of the announced advantages of SIMPA was **the platform reproducibility** on a new training subject **in a very reduced time** (advanced industrial times: 15 days). We tested and validated this feature by carrying out within the requested times an entirely new one-hour training module on the critical points of a manufactoring process which inherits of course all the mediation functions of SIMPA.

The last asset of SIMPA is related to its computer architecture: each module has its own contents but its "brain" is shared. All the mechanisms of decision concerning the tutors are gathered in a single application on the corporate network. The improvement process is not only continuous but also **with retroactive effect;** this contributes to the facility of deployment of SIMPA at TED/TIV.

7 Conclusion and Prospects

The first results as well experimental as in situation of real use show us that the principal objectives of our "Six Sigma" project in designing new training supports SIMPA are achieved. The conditions of interaction and credibility of our computing tutors are satisfactory and guaranteed whatever the training contents. Our industrial constraints require less the system efficiency on a given subject than its good reproducibility for future needs in

operator's training. The first training sessions carried out attest of a half-reduced time of human tutoring, and of a good satisfaction of the learners upon their computing tutors.

In term of pedagogy, the modular structure of the courses and the broad choice of teaching activities ensure the trainer a freedom and a great quality in the courses design. The objective is today for us to widen the equipment of SIMPA, at the same time in activities models and mediation capacity.

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