PREPARING AN OBSERVED PEDAGOGICAL EXPERIMENT

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ABSTRACT
The work reported here takes place in the educational domain and deals especially with observation of pedagogical activity. User behavior is observed through the raw traces (log files) of their activity from multiple sources. The main point of this paper deals with a very important stage, generally not described: the preparation of an observed experiment by selecting and structuring the relevant observable factors. A formalization based on regular expressions and languages for the different sources of observation is proposed as well as an example.

KEYWORDS
Observation, Pedagogical Experiment, Traces, Collect, Formalization.

1. INTRODUCTION
During the development and maintenance process of web systems, software designers' goal is to understand and to satisfy the user needs as much as possible. New trends consist in observing and analyzing user activity in order to understand better her/his behavior [Cooley, 99] [Burton, 01]. In the context of e-learning environments, such numerous and various web systems have been developed by designers and teachers. Many experiments are set up with students with these new Computer Supported Cooperative Learning systems [Corbières, 04] [Heraud, 05]. New usages thus appear in the educational world, where teachers tend to prepare a particular learning activity by constructing learning scenarios1.

In this context, teachers need to understand the on-going activity (especially in distance learning experiments); analysts need to take lessons from these experiments; students need awareness during the collaborative learning activity. The activity observation becomes a key issue in this approach.

First, the observation is useful to the activity regulation. In traditional teaching, namely in an environment with no computers, a teacher tries to be as aware as possible, to search for signs that allow him/her to understand the student comprehension status. The teacher then adapts her/his scenario, e.g. by adding further introductory explanations or by keeping an exercise for another session. In an educational platform, the activity observation allows the introduction of this kind of awareness in the platform, mainly for the teacher, allowing her/him to possibly adapt the remainder of the learning scenario.

Next, the observation yields much information useful to the analysis of a training session, for instance:
- when a teacher tries to understand why some learners succeeded in an activity while others failed;
- when a teacher wants to know how actual activities rely on the recommended scenarios or simply wants to know how long each activity took;
- when a learner wants to analyze her/his path; or
- when an analyst wants to know whether the learners followed a recommended learning scenario.

The tasks for introducing observation features in a given experiment are very different according to the diversity of objectives and roles mentioned above. That is why we need to describe precisely the expectations from observation for a given experiment. A good description of these expectations will result in a good configuration of the observation tools, making possible a very accurate observation of the collaborative activity. Finally, the observation is an important factor for the quality of the learning scenario [Marty, 04].

1 usually described according to the IMS-LD "standard" [Koper, 03].
Indeed, in the framework of reusing learning scenarios in different contexts, the quality of a learning scenario may be evaluated in the same manner as software processes, for instance with the CMM model [Paulk, 93]. The idea is to reconsider the scenario where some activities are systematically added or omitted by the users. To achieve such aims, students’ activity must be analyzed from several points of view and observed very accurately with correctly configured observation tools [France, 05][Heraud, 05].

In this article, we will first present what we call an observed experiment, giving a quick survey of each common stage allowing one to situate our work amongst others. We will next describe what must be prepared and give a formalism to achieve this step. This approach is applied to an example in a third part. Some perspectives and discussion are given in conclusion.

2. SETTING UP A NEW EXPERIMENT INCLUDING OBSERVATION ASPECTS

Setting up a new experiment with observation features is a difficult task. In addition to setting up an experiment as usual, we must consider the observation problem: when one sets up this kind of experiment, one knows the general observation goal one is trying to reach. According to this goal, we must define what to observe, how, at what level, for what period of time, etc.

To our knowledge, there is unfortunately no specific observation model allowing one to describe all the additional items to consider. However, people usually agree on several common steps to take [Cooley, 99] (although the names of these steps may differ) when one wants to set up such a kind of experiment.

2.1 Description of the Observed Experiment Process

From our point of view, we consider that an observed experiment can be described as shown in the following diagram (see figure 1).

**Collection phase:** In order to observe the learning activity process, it is obvious that we need to collect "hints" or traces of what is going on during the activity. Depending on the given experiment, only some traces are recordable. We call “observable factors” the set of all these recordable traces. The collection phase therefore consists in collecting these observable factors throughout the experiment. No interpretation is made of the collected data at this stage.

![Figure 1. Observed Experiment Process](image)

**Structuring phase:** The collection phase generally produces a huge amount of data. The understandability of this data is mandatory and good structuring is necessary. In this step, it is expected to group the collected data, to change its presentation, and possibly to annotate it.

**Analysis phase:** Most of the time this step is performed by the analyst and cannot be automated due to the high complexity of the analysis task. The more the structuring phase produces traces at the right level of comprehension, the easier the interpretation. Sometimes, specific tools to represent or visualize particularly some data are used at this stage.

The analysis stage is very difficult to formalize because in our context, it depends too much on changeable, moving criteria: the analysis may have various “shapes” depending on the analyst. However, every analysis is based on reliable elements of the experiment: the observable factors. The questions: “what can we observe?”,”what has to be observed?”, and “how to make these observable factors understandable by the analyst?”, in other words: “how to represent and structure what we have observed for a specific
analysis”? are methodological questions one must answer when setting up the experiment. These difficulties underline the necessity for a clear description of an observed experiment’s preparation. For this reason, we will focus in this paper on the initialization stage of the experiment (PRE-EXP).

### 2.2 An Informal View of the Preparation of an Observed Experiment

Let's specify informally the two major steps allowing "good" structuring of the traces. This structuring will be "good" if the analyst has all the information needed for her/his particular objective and if this information is comprehensible enough to interpret it with respect to the objective.

#### 2.2.1 Selection of the Observable Factors

As stated previously, we need to specify exactly which information can be observed. Technical features must be taken into account here, as well as ethical problems. Once this description has been obtained, we can consider that we have at our disposal for the experiment continuous streams of data (observable streams), one for each observable factor.

A particular observable stream can be useful for one particular objective, while completely useless for another [Marquardt, 04]. For instance, an eye tracking stream can be very useful if we have an objective of user interface validation, while completely useless if we want to check the degree of collaboration between students during a training session. It is thus absolutely necessary to "cut" some streams when they are not needed for a given experiment, avoiding unexpected traces acting as parasites [Zaïane, 01] during the analysis phase.

#### 2.2.2 Collected Data Structuring

Data collected may have various formats, may not be easily understandable [Heraud, 05] or even may not be in the right order, may be redundant and may be regrouped [Tanasa, 04]… For instance, we can find many clues in the logs about using the web mail. If the observation objective is based on the frequency of access to the web mail by the users, “connecting to webmail”, “retrieving email”, “opening a message”, “answering a message” are clues relevant to this objective but too precise for it. In this case, one can regroup all these clues into a singular “webmail_access” activity. The same holds for other granularity of information: web mail, instant messenger, VoIP or file sending in someone else’s pigeon hole² can be regrouped under the term “communication_tool”, more appropriate if we want to check the collaborative issues in a learning activity.

The collecting and structuring stages must also be prepared or configured, tuned in the PRE-EXP stage. Using a specific formalism to do so allows one to describe precisely the observation part of the experiment. This facilitates a clear separation between the experiment part and the observation part. Furthermore, the observation part can be reused for another experiment when an analyst has the same kind of objective.

We will propose in the next section a formalization proposition of this idea.

### 3. FORMALISATION

Most of the time, many experiments are set up concerning specific e-learning environments. The whole set of observable factors is thus generally the same for each experiment. [Champin, 04] proposes a use model that defines all observable elements of the system, but it is difficult and time consuming to model (or re-model) systems by specifying all observable elements and their relations. Therefore we propose to represent them via a language.

#### 3.1 Observable Factors

##### 3.1.1 Language of Observable Factors

The observable factor language $L_{obs}$ contains all the elements which can be observed during the experiment. Observable factors may have different levels of granularity according to the sources they come from. As stated previously, it is possible to obtain raw logs but also some higher level elements collected from a

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² service provided by our CSCW educational workspace
specific tool. An observable factor could be for instance the status of a proposed learning scenario. A specific tool can thus provide the user with explicit information, such as for example “exercise done”, directly interpretable at the pedagogical scenario level.

$L_{obs}$ may thus include several other languages dedicated to specific categories of observable factors helping to make a classification of these factors. We can identify the latter by sources, but also by level of abstraction, by subject:

For example, scenario element expressions (called $L_{sel}$) regroup pedagogical activities such as exercise done, help consultation, exercise assessment, etc.

It is up to the designer to specify such categories if necessary. The best way is to foresee and to include information about observation when a new component or tool is integrated in the e-learning environment.

$S_{obs}$, a subset of $L_{obs}$ describes the set of all observable factors that have to be collected for the current observed experience whatever their sources or their granularity are.

The observable factor set definition allows selection of the raw material to study. Thus the latter must be collected according to specific conditions and respecting certain rules. Now this selection amongst observable factors may be described.

### 3.1.2 Selection of Observable Factors

The selection of observable factors can be expressed in extension or in intension. The selection in extension is made by enumerating each element from $L_{obs}$ that has to be collected, whereas the selection in intension allows one to express some constraints on the observable factors in order to find the relevant ones.

If $L_{obs}$ is defined by the observable factors of the different sources of observation $S_1$, $S_2$ and $S_3$,

\[ L_{obs} = L_{S1} \cup L_{S2} \cup L_{S3} \]

More generally, with $n$ sources of observation: \[ L_{obs} = \cup_{i=1}^{n} L_{Si} \]

The set of “observed” elements is called: $S_{obs}$

As stated previously, the selected observable factors must be explained to become more comprehensible for the analyst. The set of observable factors must be rewritten in order to make them understandable: this “structuring phase” is realized by applying certain rules to the observable factors.

### 3.2 Structuring Observable Factors

Our rules are based on regular expression allowing the transformation of generally raw level observable factors (the left part of the rule) into a right part having a higher granularity, although every kind of transformation may be envisaged.

For example, a specific sequence of three observable factors (a, b, c) may be identified as performing a particular complex action for the student: reply to an e-mail. In this case, some observable factors may appear between the moment of the retrieval of the e-mail and the consultation and reply. It is thus possible to know if most of the students have communicated by e-mail during the exercise by applying such a rule to the set of “observed” elements.

- $a \cdot b \cdot c \rightarrow A$

Other rules have to be defined to rename observable factors, to reduce the redundancy or to change the level of granularity and to reach a meaning corresponding to the foreseen analysis axis.

- $a_1 \mid a_4 \rightarrow B$  
  renaming
- $a_2 \mid c \cdot 1 \cdot a_2 \cdot b_1 \rightarrow C$  
  reducing redundancy of $a_2$ if not $c_1$ between the two $a_2$
- $a_1 \mid b_2 \mid b_3 \rightarrow D$  
  changing the level of granularity
- ...

The result is a structured text that can be more easily analyzed because it is only based on relevant observable factors and it is expressed with a vocabulary adapted to the analysis. This vocabulary defines another language $L_{ana}$ corresponding to the actions searched for by the analyst.

It is well known in Artificial Intelligence and in Logic that such techniques have the disadvantage of giving different answers by changing the order of the rules. The result may thus not only be a sole “structured text” but also a tree of structured texts. Naturally this drawback could be avoided by the expertise of the analyst or exploited to find new behaviours as we will suggest in conclusion. Nevertheless, any exploitation of the results depends on the next phase (analysis) and is beyond the scope of this article.

Now, we will propose an example based on a real experiment where we were interested in studying the new usage of communication tools by students during practical work. How to prepare such an experiment?
4. EXAMPLE: USAGE OF COMMUNICATION TOOLS BY THE STUDENTS DURING A PEDAGOGICAL ACTIVITY

4.1 Description of the Experiment

Our experimentation proceeded with a public of third year students at the Graduate Business School of Chambéry in France. The object was practical work on the Adobe Photoshop software. The students were asked to perform a recommended learning scenario on a web-based learning platform. All necessary resources (courses, source images) as well as communication tools (webmail, forums) were available on this experiment platform. The students were forbidden to communicate, except via the computer. The teacher communicated with the students thanks to Instant Messenger, and validated completed work. A human observer was in charge of taking notes on the student and teacher behaviour, by using a note-taking grid.

4.2 Preparation of the Experiment

The aim of this experiment was to analyse the usage of communication tools to achieve a specific learning scenario. The preparation of the experiment consists in selecting the observable factors to collect. The full set of observable elements or factors available ($L_{obs}$) was known. The difficulty is to specify the elements which will be relevant. We choose $L_{scen}$ and extensively some specific elements from different sources concerning the communication to determine the selected observable factors ($S_{obs}$):

$$S_{obs} = L_{scen} \cup L_{forum} \cup L_{Instant_Messenger} \cup L_{Mail} \cup (L_{Dialogue} - \{technical\ problem\ conversation\})$$

Several sources may be selected but even in a specific stream, some information may be removed as shown in the last example: the “conversation about technical problem” factors of the external source “dialogue” are removed. In fact, it is important to have in mind the correlation between observable factors (see fig. 2 for the “leaves” in simplified format) and the aim of the analysis (here, communication tools) as shown in figure 2. This figure will also help us to determine the rules to elaborate for the structuring part.

To simplify the example, we will just try to translate the observed elements into the right level of abstraction. Thus we obtain:

- login | send | view | logout → FORUM
- open | IMsend | IMview | close → IM
- receive | eMsend | write | read → E-MAIL
- conversation → DIALOGUE
- FORUM | IM | E-MAIL | DIALOGUE → COM

![Figure 2. Structuring observable factors](image)

Naturally, the last rule brings us to the higher level of abstraction, making very easy the interpretation of the result but losing information which could offer a more precise description of the communication. It is always possible to adjust the configuration (files) of the PREEXP phase for a further experiment to refine the analysis.

4.3 A Few Words about the Result

The result is a set of structured texts (one for each student) similar to the following:

- READING_INSTRUCTIONS, EXERCISE1_DONE, EXERCISE2_FAILED, COM, READING_SUPPORT, HELP_ASKED FOR, COM, EXERCISE2_DONE, COM
Thanks to this transformation of the behavioural traces, the experiment has been exploited by non specialists in computer Science. Work in collaboration with researchers in Information, Communication and Cognitive Psychology (here the analysts) gave us some interesting results about the use of communication tools: their use seems to be correlated with difficulties (pedagogical analysis axis) or assessment needs (evaluation axis) or a validation tool (re-engineering axis). More generally, these results allowed us to show complementarities between mediated educative technologies and traditional pedagogical ones [Chabert, 05a].

5. CONCLUSION

In this article, the stage we are interested in consists in preparing an observed pedagogical experiment. A formalisation is proposed to collect and structure the observable elements. This phase is crucial for a further specific analysis. As stated previously, the activity observation also becomes a key issue for the teachers, the analysts or the students. We think that an observed experiment must be very accurately prepared in the phase we called “pre-exp”. The acquired experience of the precedent experiments may next become reused for the setting up of a following observed experiment. Future work consists in developing tools and models for indexing the pre-exp files and capitalizing this experience. Moreover the language for selecting observable factors has to be enriched in order to make it more powerful, allowing one to exhibit for example, specific conditions on observable factors or correlations between observable factors of different sources. It may thus be interesting to add time constraints in order to only collect specific information during a determined period.

More generally, our work consists in studying several parts of observation in a CSCW in order to develop an observation station dedicated to CSCW.

This work opens several perspectives in relation with hot subjects in this domain. We can explore this method in order to evaluate both students, experiments or even frameworks leading to a quality approach. More generally, our work shows that Observation is an activity in itself and also needs to be considered as a special step with preparation, possibility of reutilization, evaluation.

REFERENCES


