Design patterns for recording and analysing usage of learning systems: State of art of tracking and analysing usage

Jean-Pierre David, Jean-Michel Adam, Fatoumata Diagne, Anne Lejeune, Vanda Luengo, Jean-Philippe Pernin

D32.3.1 (Final)

State of art of tracking and analysing usage

Main author : Jean-Pierre David (UJF)

Nature of the deliverable : Report

Dissemination level : Restricted

Planned delivery date : April 2005

Prepared for the European Commission, DG INFSO, under contract N°. IST 507838
as a deliverable from WP32
Submitted on 07-05-2005

Summary

This document presents a state of art according to three aspects: use analysis in a wide point of view, tracking and analysing usages and what’s on Design Pattern.
The objective of this state of art is to synthetise actual works about tracking and analysing usages in order to isolate possibilities of patterns, that's the aim of DPULSE Jeirp.
The work on the state of art has been organised as a collaborative task of the DPLUS members. A lot of papers and projects on this topic have been studied. This document is the synthesis of this work, compiled and enriched by the Metah team.

History

Filename	Status	Release	Changes	Uploaded
D32-03-01-F.pdf	Final	1		07/05/2005

State of art about tracking and analysing usage and Design Pattern

1. Introduction

All the citizen are concerned with the use analysis of computer based learning. We propose in this paper a state of art on why and how analyse usage of technology-based learning environments.
Three aspects have been studied: use analysis in a large point of view, traking and analysing usages and what's on Design Pattern.
Today, in the field of technology-based learning environments, a research domain focuses on the concept of learning track in order to improve control and progress of computer-based learning situations. A learning track can be a production explicitly linked to the learning task (creation of a text, answering a question, etc.), or more implicit indices reflecting learner's behaviour or characteristics. An element of complexity is in collecting, filtering and structuring these raw tracks and to give them a so pertinent meaning to allow a human or artificial agent to observe, evaluate or regulate learning situations.
One main goal of the DPULS JEIRP is to isolate recurrent patterns in those different steps of digital processing of tracks.
The objective of this state of art is to present actual works about tracking in order to isolate possibilities of patterns.

2. Preliminary state of art on Use Analysis

The idea of the uses man makes of computer environments can be studied from technical and non-technical perspectives. The case studies for these purposes may span across many implementations, socio-technical settings and the literature generally studied does bridge over several disciplines; experimental psychology, Social Informatics, Sociology, Psychoanalysis, Philosophy and History. It would seem that Social Informatics is the field most concerned with ***usability*** issues in the sense of actually *using* environments. Studies from the core of psychology are losing ground in the literature, giving way to the increase of societal themes in the uses arena. Issues of ***utility*** are addressed quite directly in Sociology as well as ***acceptability***. On the fringes of the investigation into how and why people use computer environments and networks we find that philosophy has the role of addressing ***acceptability*** from a moral point of view.

In "Development of a Knowledge Base as a Tool for Contextual Learning", F. HENRI & G. PAQUETTE *et al* work on very large databases and point out the complexity of good pedagogical approaches. They say that one must realise that good teaching entails developing a multi-perspective view of the problems, notion and ideas being taught. Without this complexity in point of view of an object, the learner cannot develop his own proper opinion on the object treated since his very vision of it will have been biased from the beginning. The authors use of the notion of reference it crucial, as it is on the basis of this notion that one obtains the very idea of creating different points of view on an object. They limit their analysis to what they refer to as telelearning tutoring as well as to web-based content or information design.

They point out the fact that knowledge acquisition in traditional schooling is often abstract and out of context. They also make a very important separation between 1.the increase in competency level concerning specific tasks and 2.contextualised learning in action. Their conviction is that telelearning knowledge bases (TLKB) must also give access to the people (teaching staff) and not just the documents (inert representations of knowledge).

In "Hypermedia as an educational technology: a review of the quantitative research literature on learner comprehension, control, and style ", A. DILLON states that there exists much conflict in the literature that compares hypermedia and non-hypermedia learning environments. Much of this could be due to the fact that the field is not old in comparison to many scientific fields. One of the concepts that this author points out, without really defining it, is that of *learner style*. This is a predominant factor in calculating the efficiency of any pedagogical device or setting. It is more important than *presentation style*. He states that the technology used on the internet for learning is not a major breakthrough in education. "The value of hypermedia learning is limited...it is ultimately a form of information presentation...we should not pin undue hope on any technology of presentation".

In a Special Topic Issue on 'Human-Computer Interface' of the *Journal of the American Society for Information Science*, A. DILLON takes acceptability to be the most important factor for non-specialist user populations. His Social Informatics perspective is one that revolutionises to a certain extent past work in cognitive ergonomics; the focus in HCI here is less psychological and more socially-weighted. In this special issue proposed by Guest Editor A. Dillon, the shift in work on the uses people make of computers is taken to a historical perspective by B. SHACKEL and to a philosophical one by C. SCHMIDT. The other authors in this volume remain more or less in a Computer Science perspective except for C. Chen who puts forth the very interesting perspective of collaborative writing (socio-psychological). ELLIOT works with R. KLING, long-time editor of the *Information Society* journal, to produce a socio-organisational point of view in this special issue as well.

In the *Second Self* (1984), S. TURKLE carried out a well-known ethnographic study of socio-cultural groups born thanks to the coming of the computer age (400 individuals); some of the subjects were brilliant people being quite used to using computers, others were totally put-off by computers, many were children. Her findings tell us of the uses people make of computers —tremendously variant— and point out the fact that the user's relation with computers and technology in general is becoming very intimate. The fact the humans think with these machines demonstrates that they have integrated the machine as part of their identity. The people surveyed in her book expose how they think of the activity they are carrying out with the computer in their remarks; the author calls the domain explored the "Sociology of superficial knowledge", no doubt for its first-person access. The use people make of the computer is to think about their place in society in relation to artificial entities. Their remarks confirm that they investigate the human traits in computers and the machine in their person. And they explore the possibility that man thinks like a machine, that men are machines. In fact according to Turkle, peoples' use of computers is to carry out one's very own psychoanalyse during everyday life.

In the *"Computer Tribe"* [*La tribue informatique*], P. BRETON suggests that programming specialists use computers and networks to construct community belonging based on the concept of computer. Those that are less technologically-implicated in the pursuit of building mechanisms that can be compared to the human brain are held on the fringe of such communities; those that do not believe in the strengths of the computer or that are repulsed at the thought of their integration into society are forced out of their community. In *The Cult of the Internet, a Threat for Human Relations? [Le culte de l'Internet: Une menace pour le lien social?]*, this same author goes as far as saying that this community has a "religious" or rather sect-like character. The use of computers linked up through networks is being outrageously *overused*, to the point where the Internet is put to the user as a device that will bring about a better tomorrow, and suffocates local direct communication. People use it to disinform others on their very identity. Breton and Turkle are obviously ethically-oriented sociologists.

We shall now deal more specifically with the threes points of view of the phenomenon given above.

Utilisability

Usability is an important issue at the interface between the user and the tool and is one that goes beyond the framework of the Computer-Aided Learning Context. One may point out some distinctive approaches in the research (Senach 1990).

Use diagnostics of interfaces can be performed with clinical approaches (critical incidents), surveys, automatic data analysis.

1) Clinical approaches are used to highlight instances pointed out during the use of an interface. After interwiews or observations, the incidences are classified in a way that allows quick identification of dysfunctions. This research renders it possible to emphasise the inadequacy of tools *vis-à-vis* the practices of users. These approaches allow one to make a global diagnostic of the situation but cannot provide accurate answers for specific environments.
2) Surveys as diagnostics tools were experimentally studied by Root and Draper (1983). Their investigation was driven by the following question: are data collected in an *a posteriori* static fashion (pencil-and-paper) appropriate for analysing and explaining essentially dynamical situations? Researchers formulating surveys may miss out on aspects that other approaches would point out. But this technique does not allow for the identification of the organisation of the user's activity. The automated tracking and identification patterns of uses seem to be adapted to avoiding this problem.
3) The practice of tracking is common (Hanson *et al*., 1984, Neals and Simon, 1983, Apperley and Field, 1984). The main problem of this method is the significant amount of data recorded. Therefore, one has to formulate hypotheses in order to conduct anaysis, extract relevant information and link them. The relevance of this method was studied by Teubner and Vaske (1988). The method allows the extraction of data in a non-intrusive way without disturbing either the software or the man-machine interaction. In a non-experimental ecological context, the method allows for the collection of data through time, across vast corpuses as well as to distinguish groups of user according to their practices.

Utility

Mesuring the efficiency of educational technologies have strong behaviouristic tendancies. They mainly come from the States. Chaptal (2003) observes a genealogy of educational technologies that is in stride with pedagogical movements (behaviourist, cognitives et constructivistic) but does not exlude the reactualised persistence of the older models (behaviourist ones). In research focusing on efficiency, the models of evaluation sought are often competitive and not so distinct from one another; they are seen as being the best way of going about evaluating solutions. Consequently, contradictions are often encountered concerning the sameness of evaluation models and constructivist projects that rather imply complexity than linearity. For example, *Instructional System Design* studied by Briggs and Wager (1988) often expresses the strong persistence of behaviourist influence. The question is one of the interaction between the means and the goals sought. Any behaviouristic objectives that cannot be clearly observed are rejected as being non-scientific.

Saettler (1990) carried out a review of research on the efficiency of educational technology. Yarger and Smith (1990) identify five methodologies as the basis of American research in this area.

Qualitative:
- narrative studies
- case studies

Qualitative studies are powerful enough to thwart presuppositions and to discover original research vectors. The results of these studies have little scientific value in behaviourist terms.

Quantitative:
- surveys
- the study of correlations
- causal/experimental studies.

Quantitative studies were critiqued namely by Clark (1983), Lincoln & Guben (1985) because they went against the constructivistic turn in teaching.

In order to thwart this problem, other types of studies were carried out :
- reviews of research
- meta-analysis

The problem with the first type is rarely exempt from subjectivity. The latter type constists in a stastical analysis of a great number isolated studies in order to sum up there results. This partially reduces the obstacle of subjectivity (Liao & Bright, 1993).

Acceptability

In opposition to the research conducted on the effects of an environment, one can find a body of research about these issues as seen from the point of view of the relation between individuals and technical objects.
This research includes socio-cultural aspects. Amongst the people working in this area we must mention the work conducted by J. Perriault. He demonstrates the importance of the user's goals and the interaction between these goals and the designer's vision of them.

Ethnographical approaches must be noted. Light and Light call upon the practical anaysis to show just to what extent one must consider the sociological, cultural and microcultural ties as being determinant in the process of usage. They consider the installation of a new computing system in a cultural environment like a new piece of furniture. Several observations and analysis were carried out in the framework of the research programme entitled "Economic and Social Research Council", "virtual society ?" (Light, Crook and White, 2000). Different methods were employed: surveys interviews, discussion groups as well as analysis of logs concerning interactions during distance work activities (Light and Light, 1999; Light, Nesbitt and Harnad, 2000). Linked to this research programme, Woolgar (2002) proposes 5 rules of virtuality with which one can investigate the uses of Educational Technologies:

Five Rules of Virtuality

- Current rate of straightforward rapid expansion may not continue
- New technologies tend to supplement rather than substitute for existing practices and forms of organisation
- The more virtual the more real!
- Fears and risks associated with new technologies are unevenly socially distributed

Impact of new technologies depends crucially on their local social context

These rules show quite well the strength of this research on social and cultural over-determinism and the use of Information and Communication Technologies.

Other works have shown the importance of the role of the institution in the workplace where the learning takes place (Bliss, Saljö and Light, 1999; Crook and Light, 1999). Crook (2004) insists that students feel they do not have the capacity to organise their curriculum without pressure from the institution to structure such an activity as well as the rituals that go with it. Learning is also a cultural practice and like all cultural practice, the people that are confronted for the first time have to be able to rely on the structure of the institution as well as its rituals.

Other work namely from Ergonomics and Sciences Cognitive are interested in the design process for environments. They are bases on the failure in the acceptation by the public user of the system.

Research carried out in the States in the 1960s constitutes a response to this difficulty. This approach draws on the participation of users, Engineers and other actors in the process.
Participative design renews with the "concurrent engineering" methods. Granath (1991) puts the accent on all the actors involved and the user is not only a source of information put external experts, he is recognised as an expert.
The participative design is a means of expressing what is at stake in the identity games that individuals play. In this way, participative design is not only a design process, it is also a way of expressing the needs and representations of the users. The acceptability of the environment is the principal goal, the

focus of all questions (Mallein). In these processes, the scenario method is often used (Carrol, 1995, 2000). Various methods can be required in order to describe and narrate these scenarios (Greenbaum and Kyng 1991).

All in all, the aspects developed here be the authors mentioned, whether they be sociological, psychological, philosophical or historical in nature, represent the domain of use analysis as we see it.

References

APPERLEY M., FIELD G., (1984). "A comparative evaluation of menu based interactive human computer dialogues" in Shakel B. (Ed.): *Proceedings of the conference Interact 1984*, Vol. 1.

BLISS J., SALJÖ R., LIGHT P., (1999). *Learning Sites; Social and Technological resources for learning.* Amsterdam: Pergamon.

BRETON P. (2000). *Le culte de l'Internet: Une menace pour le lien social ?* Paris: La Découverte.

BRETON P. (1998). *La parole manipulée,* Paris: La Découverte.

BRETON P. & PROULX S. (1989). *L'explosion de la communication, naissance d'une nouvelle idéologie.* Paris: La Découverte.

CARROL J., M., (1995). *Scenario-Based Desingn. Envisoning Work and Technology in System Development*. Wiley and Sons Inc.

CARROL J., M., (2000). *Making Use. Scenario-Based Desingn of Human Computer Interactions.* Cambridge : The MIT Press.

CHAPTAL A. (2003). *L'eficacité des technologies éducatives dans l'enseignement secondaire.* Paris: L'Harmatant.

CHEN C. (1997). "Writing with Collaborative Hypertext: Analysis and Modelling", Special Topic Issue on 'Human-Computer Interface' of the *Journal of the American Society for Information Science*, Vol. 48, N° 11, New York: John Wiley & Sons, p. 1049-1066.

CHUI M. & DILLON A. (1997). "Who's Zooming Whom? Attunement to Animation in the Interface", Special Topic Issue on 'Human-Computer Interface' of the *Journal of the American Society for Information Science*, Vol. 48, N° 11, New York: John Wiley & Sons, p. 1067-1072.

CLARK R., (1983). "Reconsidering Research on Learning from Media", in *Review of Educational Research*, Winter 1983, Vol. 53, N° 4.

CROOK C., LIGHT P., (1999). "Information Technology and the Culture of Student Learning". In BLISS J., SALJÖ R., LIGHT P., (1999). *Learning Sites ;Social and Technological resources for learning.* Amsterdam: Pergamon.

CROOK C., (2004). "La formation en ligne mieux qu'un enseignement classique. Un paris hasardeux". In PERRIAULT J. (Dir.)Critique de la raison numérique, *Hermès*, n°39.

DILLON A., GABBARD R. B., (1998). *Hypermedia as an educational technology: a review of the quantitative research literature on learner comprehension, control, and style*. Review of Educational Research. 68(3).

DILLON A. (1997), "Introduction", Special Topic Issue on 'Human-Computer Interface' of the *Journal of the American Society for Information Science*, Vol. 48, N° 11, New York: John Wiley & Sons.

ELLIOTT M. & KLING R. (1997). "Organizational Usability of Digital Libraries: Case Study of Legal Research in Civil and Criminal Courts", Special Topic Issue on 'Human-Computer Interface' of the *Journal of the American Society for Information Science*, Vol. 48, N° 11, New York: John Wiley & Sons, p. 1023-1035.

GAGNÉ R., BRIGGS L., WAGER W., (1988). *Principles of Instructional Design* (2e édition). New York : Holt, Rinehart and Winston.

GAINES B. *et al* (1997). "Modelling and Human Factors of Scholarly Communities Supported through the Internet and World Wide Web", Special Topic Issue on 'Human-Computer Interface' of the *Journal of the American Society for Information Science*, Vol. 48, N° 11,

GRANATH J. A., (1991). *Architecture, Technology and Human Factors : Design ina Sociol-Technical Context*. Göteborg: Chalmers University of Technology, Architecture Workspace Design.

GREENBAUM J., Kyng M., (1991). *Design at Work : Cooperative Design of Computer Systems*. Chichester: Lawrence Erlbaum.

HANSON et al., (1984). Interface Design and Multi-variate Anylisis of Unix Command Uses. ACM Transactions on Information Systems (TOIS), Volume 2 , Issue 1 (January 1984). New York: ACM Press.
New York: John Wiley & Sons, p. 987-1003.

HENDRY D. & HARPER D. (1997). "An Informal Information-Seeking Environment", Special Topic Issue on 'Human-Computer Interface' of the *Journal of the American Society for Information Science*, Vol. 48, N° 11, New York: John Wiley & Sons, p. 1036-1048.

HENRI F. & LUNDGREN-CAYROL K. (2001). *Apprentissage collaboratif à distance. Pour comprendre et concevoir les environnements d'apprentissage virtuels*, Presses de l'université du Québec.

JOHN B. & MASHYNA M. C. (1997). "Evaluating a Multimedia Authoring Tool", Special Topic Issue on 'Human-Computer Interface' of the *Journal of the American Society for Information Science*, Vol. 48, N° 11, New York: John Wiley & Sons, p. 1004-1022.

LIAO Y., K., BRIGHT G., (1993), "Meta-analysis in Technology", in *Approaches to Research on Teacher Education and Technology.* Charlottesville, Association for advancement of Computing in Education.

LIGHT P., LIGHT V., (1999). "Analysing Asynchronous Learning Interactions : Computer-mediated Communication in Conventional Undergraduate Settings". In LITTLETON K., LIGHT P. (Dir.), *Learning with Computers :Analysing Productive Interactions*. London : Routledge.

LIGHT P., LIGHT V., NESBITT E., HARNAD S., (2000). "Up for Debate: CMC as a support for Collaborative Learning in a Campus University Setting". In JOINER R., LITTLETON K., FAULKNER D., MIELL D. (Dir.), *Rethinking Collaborative Learning*. London: Free Association Book.

LIGHT P., CROOK C., WHITE S., (2000).). "Learning Sites : Networked Ressources and the Learning Community", *The New Review of Information Networking*, n°6.

LIGHT P., LIGHT V., (2004). "Les TIC dans une université. Offre homogène, résultats contrastés". In Perriault J. (Dir.)Critique de la raison numérique, *Hermès*, n°39.

LINCOLN Y., GUBA E., (1985). *Naturalistic Enquiery*. Beverly Hills: Sage Publications.
NEALS A., SIMON R., (1983). "Playback : a Method for Evaluating the Usability of Softwar and Its Documentation". Proceedings of the SIGCHI conference on Human Factors in Computing Systems, December 12-15, Boston, Massachusetts.

MALLEIN P., TAROZZI S., (2002). "Des signaux d'usage pertinents pour la conception des objets communiquants". *Les Cahiers du Numérique*, vol. 3, n° 4.

PAQUETTE G., BOURDEAU J., HENRI F., BASQUE J., LEONARD M., MAINA M. (2003), "Construction d'une base de connaissances et d'une banque de ressources pour le domaine du téléapprentissage", *Sciences et Technologies de l'information et de la Communication pour l'Education et la Formation,* vol. 10.

PERRIAULT J., (1989). *La logique de l'usage*. Paris: Flammarion

ROOT R., W., DRAPER S., (1983). Questionnaires as a Software Evaluation Tool, Proceedings of the SIGCHI conference on Human Factors in Computing Systems, December 12-15, Boston, Massachusetts.

SAETTLER P., (1990). *The Evolution of Education Technology.* Englewood : Libraries unlimited .

SCHMIDT C. (1997). "The Systemics of Dialogism: On the Prevalence of the Self in HCI Design", Special Topic Issue on 'Human-Computer Interface' of the *Journal of the American Society for Information Science*, Vol. 48, N° 11, New York: John Wiley & Sons, p. 1073-1081.

SENACH B., (1990). *Evaluation ergonomique des interfaces homme-machine*, in Revue de la littérature, rapport de recherche INRIA n°1180.

SHACKLEL B. (1997). "Human-Computer Interaction—Whence and Whither", Special Topic Issue on 'Human-Computer Interface' of the *Journal of the American Society for Information Science*, Vol. 48, N° 11, New York: John Wiley & Sons, p. 970-986.

TEUBNER A., VASKE J., (1988). "Monitoring computer users' behaviour in office environments". Behaviour and Information Technology, n°7.

TURKLE S. (1984). *The Second Self. Computers and the Human Spirit*, New York: Simon & Schuster.

WOOLGAR S., (2002). "Five Rules of Virtuality" in Woolgar S. (Dir.), *Virtual Society ? Technology, Cyberdole, Reality*. Oxford: University Press

YARGER S., SMITH P., (1990). "Issues in Research on Teacher Education", in HOUSTON W., (ed.). *Handbook of Research in Teacher Education*. New York : Mac Millan.

3. State of Art on Tracking and Analysing usages

3.1. Methodology

A collaborative activity has been set up in this DPULS group for preparing the state of art on tracking and analysing usages. Arcade team has modelised an information system tacking in account the list of papers to be studied, the team of readers and the reading card to be filled in for collecting the readers opinions. This information system has been operationnalised by LIUM team, on a server with web form, with a data base for structuring and storing information and SQL for querying the collected data.
The results of this collaborative task is shown by 37 reading cards that have been collected in the data base.
This first reading card model was not very relevant for papers about Design Pattern. So a second one has been proposed by LIUM team and sent to the partner (annexe 4). We have collected 18 reading card for papers about Design Pattern.

First of all, we present vocabulary and taxonomy allowing classifying tracks with different criteria. Particularly, we identify three main kinds of goal in tracking: tracking for regulating learning situations, tracking for learners' assessment, and tracking for validating experimentations or research hypotheses.

- A synthetic table present tracking usage and their exploitation
- Then we present a synthetic compilation of the reading cards about
    - tracking for regulation of learning situations
    - tracking for assessment of learners

  - tracking for validation of research hypotheses
- Finally, we emphasis the proposals of some relevant author or group.

3.2. Basic definitions

As the question is complex, we propose to introduce a common vocabulary and a methodology to present the different points of view.
This proposed vocabulary is constituted from different documents concerning tracking. These documents are the following:

- deliverables coming from two previous Kaleidoscope JEIRP:
  - TRAILS Personalised and Collaborative Tracks of Digital and Non-Digital Learning Objects, [1][2]
  - ICALTS: State of the art of interaction and collaboration analysis [3]
- A frequently quoted research paper about organisation of trails in collaborative learning: Jermann, P., Soller, A., Muehlenbrock, M. "From Mirroring to Guiding: A Review of State of the Art Technology for Supporting Collaborative Learning". Proceedings of the First European Conference on Computer-Supported Collaborative Learning (2001)

A *learning track* is an index of actors activity, in an instrumented or not instrumented learning situation. A learning track can be either a result obtained during or at the end of an activity, either an event or a set of events related to ILE progress.
A learning track can be *fugacious* if it is directly observed and processed by an human being or *recorded* if it is collected and memorized with a technical device (paper-pencil, video camera, sound recorder, computer; etc.). After been collected, a recorded track is structured in a higher level information in order to be exploited to observe, evaluate or regulate learning situations by tutors, learners themselves in a reflexive approach, researchers or others less directly implicated actors (parents, institutions, etc.)

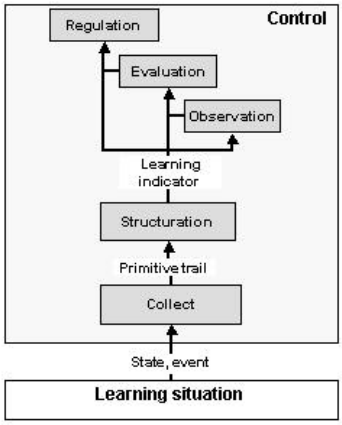


Fig. 1. Track's management general process

3.2.1. Step 1: Collecting tracks

Quality and nature of recorded tracks are closely linked to technical devices used to insure their collection. We can identify three main modes of collection:

- *Manual collection* is performed by an human observer, actor or not of the learning situation, with a paper-pencil device, eventually helped by a software tool (eg., a word processor).
- *audiovisual collection* is performed by a device able to create a visual or audio record of a learning situation
- *Digital collection* leads on the use of a computer environment recording learner activity. The result of a digital collect is a digital track.

Manual and audiovisual collecting modes can be completed by acquisition and digitalisation devices allowing creation of digitalized tracks.

Observation can be *direct*, if collected data deal with the progress of the learning situation or *indirect*, if data are collected before or after the learning experience, for example by mean of inquiries performed among learning situation's actors.

3.2.2. Step 2: Structuring tracks

Learning tracks are used by a teacher, a tutor, a learner, a researcher, etc., to observe, evaluate or regulate a learning situation. Those different kinds of use require the structuring of learning tracks in high level indicators, really pertinent to perform diagnoses and take appropriated decisions.

3.2.2.1. Primitive tracks

The term of raw data or raw track is also often used in literature (Jermann 2001, Champin),
This primitive track is the result of the initial collect of events, actions or results related to the learning situation. A primitive track can be a textual or audiovisual transcription, or represents information recorded by a digital device.

3.2.2.2. Learning indicator

A *learning indicator* results from the processing of one or more primitive tracks, in order to give sense to the collected raw data. This processing can be performed during the collect of primitive tracks or can be based on a set of indicators capitalized during previous observations.

The limited nature of data embedded within each type of track leads to simultaneously take care of different collecting mechanisms to get pertinent indicators. In this case, the different tracks must be merged in order to create *hybrid tracks*.

The processing of primitive tracks requires the adoption of an analytic precise point of view and can combine different modes: filtering data contained in primitive tracks, fusion of primitive or secondary tracks, interpretation and structuring. For example, for a sound recording, it is possible to extract the more significant sequences, to annotate them with a predefined analysing grid, then to build a document describing the sequence of pertinent events. In another register, it is possible to deduce automatically relevant information from low level digital tracks. For example, the simple list of mouse-click events can be considered in terms of links between concepts. In another more complex register, the raw answers to a questionnary can be processed to elaborate a learner profile.

3.2.3. Step 3: Exploiting tracks

After been structured and processed, primitive tracks and learning indicators can be exploited. The different data resulting from track processing are analysed to establish a diagnostic and to eventually take a decision. In function of his role within the learning situation, each actor will can (1) analyse and appropriate identified characteristics (observation activity), (2) establish a

diagnostic about the observed results and progress (*assessment* activity) and (3) act on the learning situation (regulation activity). We propose now to describe each of the three types of exploitation and related roles.

This first type of exploitation, the *observation*, deals with the need of several actors to make them learning indicators resulting from track processing. The appropriation leading upon a synthetic shaping of results, generally with textual or graphic means, can be enriched by mechanisms allowing the determination of best adapted parameters by the observer himself. For example, observation can be performed:

- By a tutor wanting to obtain a synoptic view of learner or group activity and results in order to regulate the learning situation;
- By a learner or a group wanting to analyse ILE own activity in a self-regulation approach;
- By a researcher wanting to obtain a synoptic view of learning indicators in order to analyse precisely the obtained results;
- By other actors, more peripheral to the learning process (institutions, parents, etc.) interested with the appropriation of learning tracks.

The second type of tracks exploitation concerns learning situations *assessment*. A wide range of goals can exist, in function of the different kinds of actors, such as:

- Computing of learner performances by a teacher from the observed indicators
- *assessment* by a tutor of observed results and behaviours in order to adapt planification of learning activities;
- *assessment* by a learner of ILE own results in order to orientate ILE learning in a self-regulation approach;
- *assessment* by a learning designer of effected learning tasks in order to compare them to prescription elaborated in a learning scenario [4,5];
- Analyse by a researcher of effected tasks in order to validate predefined hypothesis.

The last kind of exploitation or *regulation*, deals with the modification of conditions of progress of a learning situation by taking account of actors activity, perceived by means of observed and analysed indicators.

Modifications can be superficial and consist in providing an adapted set of feedbacks to the learners without deeply modifying the planification of activity. In this case, the mainly concerned actor is the tutor in charge of animating learning situation.

Another type of deeper regulation consists in redefining the planification in function of noted events (planification adaptation) or in delegating permanently the organization of learning tasks from the data collected in previous phases (dynamic planification).

3.3. Tracking usages and their exploitation

3.3.1. List of reviewed Papers

A CLIPS trainees has studied 30 papers on tracking and analysing usage,

Biuk-Aghai R., Simoff S., An Integrative Framework for Knowledge Extraction in Collaborative Virtual Environments. Proceedings of the ACM International Conference on Supporting Group Work Group2001, Boulder, CO, USA, October 2001

Branovic I., Giorgi R., Prete A., Web-based training on computer architecture : The case for JCachesim. IEEE Workshop on Computer Architecture Education (WCAE-02), Anchorage, AK, USA, May 2002.

Champin P-A, Prié Y., Mille A., MUSETTE : a Framework for Knowledge Capture from Experience. EGC'04, Clermont Ferrand, 2004.

Champin P-A, A model to represent design episodes for reuse assistance with interactive case-based reasoning. I. Vollrath, S. Schmitt, et U. Reimer, editors, GWCBR'2001, pp. 189-197, Baden-Baden, Germany, Mars 2001.

Croteau E., Heffernan N., Koedinger K., Why are Algebra word problems difficult ? Tutorial Log Files and the Power Law of Learning to Select the Best Fitting Cognitive Model.7th International Conference on Intelligent Tutoring Systems (ITS2004) , Maceio, Brasil, 2004.

Fiedler A., Gabsdil M., Horacek H., A Tool for Supporting Progressive Refinement of Wizard-of-Oz Experiments in Natural Language.7th International Conference on Intelligent Tutoring Systems (ITS2004) , Maceio, Brasil, 2004.

Furugori N., Sato H., Ogata H., Ochi Y., Yano Y., COALE: Collaborative and Adaptive Learning Environment.CSCL 2002, pp.493-494, Boulder CO, USA

Hardy J., Antonioletti M., Bates S., e-Learner Tracking : Tools for discovering Learner Behavior. The IASTED International Conference on Web-base Education, Innsbruk, Austria, February 2004.

Heller J., Levene M., Keenoy K, Hockemeyer C., Albert D., An e-Learning Perspective of Cognitive and Pedagogical Aspects of Trails. Document written for the Kaleidoscope Trails project, at http://www.dcs.bbk.ac.uk/trails/) 2004.

Heraud J-M., France L., Mille A., Pixed : An ITS that guides students with the help of learners' interaction logs. 7th International Conference on Intelligent Tutoring Systems, Maceio, Alagoas, Brazil, September 2004.

Jermann P., Soller A., Muehlenbrock M., From Mirroring to Guiding : A Review State of the Art Technologyfor supporting Collaborative Learning. Proceedings of the First European Conference on Computer-Supported Collaborative Learning, 2001.

Laflaquière J., Prié Y., Modélisation d'utilisation de système pour une assistance à base de trace: une application de MUSETTE à la tâche de veille documentaire. Workshop Traces, interactions, co-constructions collectives et relations à la cognition, AS CoMETE, Paris, Décembre 2003.

Mazza R., Dimitrova V., CourseVis : Externalising Student Information to Facilitate Instructors in Distance Learning. In U. Hoppe, F. Verdejo, J,. Kay (eds.) Proceedings of the International conference in Artificial Intelligence in Education (AIED 2003), pp. 279-286, Sydney, July 2003.

Mazza R., Dimitrova V., Visualising Student Tracking Data to Support Instructors in Web-based Distance Education. Proceedings of the 13th international World Wide Web on Alternate track papers & posters, New-York, NY, USA, May 2004.

Mbala Hikolo A., Reffay C., Tamo Tatiétsé T., Le paradigme d'agent dans le développement des plates-formes informatiques de formation à distance. "Technologies de l'Information et de la Communication et Formation à Distance", AUF - ENSP. Actes du Premier Séminaire National sur la Formation à Distance. Presses Universitaires de Yaoundé, pp. 60-66., Yaoundé, Cameroun, Avril 2002.

Mbala A., Reffay C., Chanier T., Integration of Automatic Tools for Displaying Interaction Data in Computer Environments for Distance Learning. Proceedings of Intelligent Tutoring System Conference (ITS'02), pp. 841-850, France, June 2002.

Mostow J., Some Useful design Tactics for Mining ITS Data. Proceedings of the ITS2004 Workshop on Analyzing Student-Tutor Interaction Logs to Improve Educational Outcome, August 2004.

Pernin J-P., Eyssautier C., Mini-survey academic state of the art.

Reffay C., Chanier T., Social Network Analysis Used for Modelling Collaboration in Distance Learning Groups. S.A. Cerri, G. Guardères, and F. Paraguaçu, editors, *Proceedings of Intelligent Tutoring System conference (ITS'02)*, pp.31-40, France, June 2002 .

Siebra S., Salgado A., Tedesco P., Analysing Partipant's Interaction in Collaborative Learning Environments.Conferência Latino-Americana de Informatica (CLEI 2004), pp.985-992, Arequipa, Peru, Setembro 2004.

Silva, D. R.; Vieira, M.T.P., Using Data Warehouse and Data Mining ressources for Ongoing Assessment of Distance Learning. The Second IEEE International Conference on Advanced Learning Technologies -ICALT, Setembro 2002

Steinke M., Huk T., Floto C., The Process of Learning with Hypermedia Systems: Linking Learner Characteristics, Software Design and Log Files.World Conference on Educational Multimedia, Hypermedia & Telecommunications, Honolulu, Hawaii, June 2003.

Vandebrouck F., Cazes C, Exploitation des journaux de traces (log) en mathématiques à l'université. "Technologies de l'Information et de la Connaissance dans l'Enseignement Supérieur et l'Industrie", pp 250-256, Octobre 2004.

Zaïane O., Luo J., Towards Evaluating Learners' Behaviour in a Web-Based Distance Learning Environment. Proceedings IEEE International Conference on Advanced Learning Technologies (ICALT 2001), Madison, WI, USA, August 2001.

Zapata-Rivera J-D., Greer J., Analysing Student Reflection in The Learning Game. AIED'03 workshop on Learner Modelling for Reflection, pp. 288-298, July 2003.

3.3.2. Synthetic table on taxonomy of tracks

This table presents synthetically the results using a taxonomy of tracks, indicating in which learning context they have been collected, if they provide qualitative of quantitative data, if the analyse provides information about behaviour or knowledge of the learner and which exploitation has been envisaged.

TYPE	TRAKS	Individual	Collective	Qualitative	Quantitative	Behaviour	Knowledge	Exploitation
INFORMATIONS	Personnal Information	++	+					actor identifying
	technical Information (IP, browser, SE,	++	+					Technical context identifying
RESOURCES accessed	reference of the resource used	++	+	+			+	log book
	Number of acces	++			++	+	+	frequency of activity
	Time spend/time of connexion	++			++	++	+	activity level evaluation
	navigation historic	++		++			++	learner profile
Learning activities	assessment	++		++			++	knowledge assessment
	time spend for responding to a question	++			++	+	+	Evaluation of ability
	tasks	++		+		+	+	Learner tutoring
COMMUNICATION ACTIVITIES	number of mails send/received		++		++	+		increasing group regulation
	Number of posted/read messages (forum)		++		++	+		Evaluation of Group interaction
	Addressee of messages		++					Evaluation of Group interaction
	Message content		++	+				Evaluation of quality of group interaction
	Demand for online help	++	+	+	+		+	Evaluation of resource adequation
	Contacting tutor	++	+	+	+		+	Regulation of situation

In this table, one "+" means that this characteristic has been found sometimes and two "++" means often in the 30 papers.

3.4. Compilation of reading cards on "tracking and analysing usage"

Using the reading cards produced by the DPULS partners, we try to synthesise their observations and their point of views. To perform this compilation of these reading cards, we propose the following grid.

The first criterion we retain is **the objective of tracking and analysing**.

Three objectives have been identified: **Learning regulation, Learner assessment, System Validation**.
Within these three identified classes we propose to isolate each theoretical or experimental approach by characterizing the following points:

- the kind of learning situations: individual or collective, distant or face to face learning
- The class of learning system: ITS, ELearning, microworld, collaborative tools, simulation, web site, specialised platforms, others.

Then, for each we propose to study:

- What are the primary tracks and how are they collected?
- How primary tracks are structured in more high level pedagogical indicators?
- (if relevant) how pedagogical indicators are analysed and what kind of diagnosis is made?
- (if relevant) how pedagogical indicators are visualised or presented to users

A synthetic table of studied papers, according to the three objectives chosen is given in annexe 1.

3.4.1. Tracking and regulation of learning situations

A meaningful tracking objective addresses supporting or managing individual learners or the group members during their learning activities. Traces gathered during learning may be mapped into models in order to diagnose what could be the best tutorial feedbacks or retroactions to the learners, else they can be stored to be further analysed.

Regulation may be either self-processed by learners provided with maps ore relevant feedbacks during learning, either led by systems like ITS or teachers enrolled into the learning situation. In the later case, row tracks are filtered and structured to build indicators that are in turn compared to ideal values.

Regulation may take different ways. One consists in proposing more suitable learning materials (i.e. learning objects, tools, services) to individual learners or groups, than those initially provided to them to reach learning objectives or competencies. Another deals with the learning scenario in which learners are enrolled in a particular learning situation. A serious effort is actually dispensed around adaptive learning scenarios (Alfanet). In collaborative situations, regulation may also target the group interactions, by supporting the learners to better work together and then better learn.

Learning situations: individual, collective, distant, face to face

Regulation isn't specifically linked to distant or more generally, instrumented learning. The traditional f2f education also cares of regulation, as far teachers take notes during or after a lesson, modify the number or the order of exercises to be done, divide the classroom into several groups and intervene into these groups if necessary.

. Individual and collaborative situations are equally considered by authors.

Learning situations and kind of learning systems: ITS, ELearning, microworld, collaborative tools, simulation, web site, specialised platforms, others

Most of the papers we studied deal with instrumented situations, nevertheless previous works related in TRAILS JEIRP focus on blended situations where students are visiting a museum and use digital interactive devices to get and provide information about their visit.

Data collection (Tracking)

Collection is in majority digital : log files, authors and recipients of interactions, number and contents of messages between actors using a chat or a forum, visited LOs, completed activities (when a formal scenario is used), time spent on a special task…

Data structuring and storage

Relational databases are mostly used to store and structure the row tracks collected during run time. Nevertheless some of the articles don't speak about the technical solutions they used.

Data analysis and diagnosis

Furugori & al. (Furugori et al. 2002 [a]) describe precisely an interesting set of indicators built from the row data collected:

- level of comprehension (LOC) with two sub indicators : level of comprehension of an explanation of a contents (LOCe) and level of comprehension of a learner to a category of contents (LOCc);
- level of difficulty (LOD);
- level of interest (LOI);
- distance between contents (DBC);
- busy level (BL).

In COALE system, the filtering criteria of collected data "have concerns to the progress and capacity of learners, the learning conditions and the didactic strategy". They developed an "action-status transition model" corresponding to the learners' action through the system window. Each indicator is filled with a value reflecting the data collected or performed from others indicators by a mathematic formula. They further build 3D graphs (contents recommendation space, Learning-mate recommendation space) to diagnose the preference plane of each learner.

Data visualisation

Maps are current ways to visualise analysed tracks in order to regulate (or to help learners in self regulation) the learning situation. We find graphical maps of routes (paths) to be followed by learners (Heraud & al. 2004), content awareness maps that advise learners about the more relevant contents to be study depending of their profile [a], Learning-mate Awareness map provided to guide learners to choose their best co-learners in collaborative situations [a], navigational maps that both mirror the different steps previously reached by a learner and reveal which path they may follow in order to improve their knowledge.

Analysing online collaborative dialogues, (Veira & Al., 2004) propose reports displayed to both instructors and learners and provided by an automatic dialogue classifier coupled to a chat tool.

Using IMS LD to formalize learning scenarios in adaptive learning, (Santos & al, 2004) don't need any visualisation tool since regulation consists in adapting on line the previous scenario. Learners playing the role they are linked to, are automatically guided to new activities or contents by the LMS.

3.4.2. Tracking and learners assessments

Assessment is defined like the process by which one attempts to measure the quality and quantity of learning using various techniques (definition of International dictionary of education). There are two kinds of assessment:

- the formative assessment: it is a part of the process of knowledge acquisition

- the sommative assessment: which closes an educational period and provide a mark which guarantees an experience and participates in the orientation of the student

According to [Doyon & al. 1991], the formative assessment allows the student to learn better and supplies him regularly the means to progress in his learnings as long on the cognitive plan (skill, knowledge) as on the socio-emotional plan. It is this type of assessment that is proposed in the learning systems studied.

Learning situations and Systems

The assessment is proposed to groups when the learning is collective or for an unique learner (individual learning). A group is assessed when the production concerns a set of individuals. In general, assessment is done for groups in distance learning on a Collaborative tool .Individual assessment is based on a face to face learning ([Mostow 04]) on an ITS .

Data collection (Tracking)

To assess learners, their tracks are collected. In majority of cases, data are automatically collected with Log files.

The Social Space Scale gathers data via a questionnaire, which is filled-in by the participants to online learning processes. Quantitative data relate (via the Lickert scale) to the perceived quality of various aspects of social interaction: participant's own behaviour in the group activity, feelings about other group members' behaviour, frequency of specific behaviours, etc. Probably, this system tracks automatically data from that questionnaire.

For learners'assessment, object tracked are:

- learners productions to know what they have done (Cool Mode ([McLauren & al. 04]), Reading Tutor ([Mostow 04]), [Jermann & al. 02]...)
- dialog to know if learners'speech are correct in the Reading tutor, [Jermann & al. 02]
- navigation, chronological event in others systems([Mostow 04])

Data structuring and storage

In half of the studied cases, tracks are structured. In ([Kreijns & al 04]) tracks result from a questionnaire, they are answers. The Cool Mode ([McLauren & al. 04]) system collects tracks structured in XML.

In ([Jermann & al. 02]) tracks collected by the systems are structured in indicators. These indicators are high-level tracks.

The studied systems are generally experimented on weak populations (on average a dozen). Thus, tracks are not important and stay in log files before their exploitation. In the project LISTEN, the Reading Tutor system is used by hundreds pupils. The collected tracks are stored in 22 Databases (DB). They need one DB for the tracks of an academic year. However this DB increases and reaches often more than 100 megabites.

Data analysis and diagnosis

The learners'assessment can be done for the researchers ([Kreijns & al 04]), certainly to reveal the lacks for a good learning and remedy them. Otherwise, the assessment allows learner himself to know the validity of its productions ([McLauren & al. 04]). ([Jermann & al. 02]) And ([Mostow 04]) present systems where the evaluation is made for a large part of the learning actors: learner, designer, researcher, tutor, teacher, …

The researchers analyze collected tracks with Statistics after the learning. In some cases, it is the system which takes care of the analysis or the task is shared by both (researcher and system).

Among its objectives, to assess learners, Reading Tutor uses requests SQL to exploit databases. SPSS and Excel (if we have less than 65000 lines) allow to analyze these data.

([McLauren & al. 04]) sets up a method called Bootstrapping Novice Data (BND) according to which a learner model is created from the learning tracks, the intelligent tutor is based on this model. The tutor assess learners productions

The learning task is the level of activity analyzed. Other grains of learning , like the sequence and the session, can also be analyzed.

Data visualisation

The analysis of tracks gives a result, a piece of information which is supplied to the actor addressed of the analysis. When this analysis is made by a system, an interface of visualisation is generally foreseen. In Cool Mode, the data are shown in the form of graphs that the experts annotated (according to the correction of these)

[Jermann & al. 02] presents systems where there is a visualisation of high-level indicators, graphs of knowledge, etc.

3.4.3. Tracking and validation of experimentations and research hypotheses

In this part we consider the papers in relation to a kind of validation. For us a validation is a procedure for checking and insuring the validity of an artefact, a theory, a model, a method or a hypothesis. In our domain we can distinguish several kind of validation in relation to the research domain and the type of results. For example, the analysis and validation about computer system artefact, models for interaction, student models (diagnosis, help, etc.), hypothesis about theories of learning, hypothesis about interaction or hypothesis about student learning.

In our case we can be interested by different points of view like usability of system, prove the effectiveness of the environment, examine how electronic environments encourage high-order cognitive and metacognitive processing, etc…

Learning situations: individual, collective, distant, face to face

All type of learning situation are used or studied in validation's papers. In the design patterns point of view we can identified more collaborative learning situations with collaborative environments, like for example the work from Lipponen et al. (2002) or Asensio et al. (2003).

Learning situations and kind of learning systems: ITS, ELearning, microworld, collaborative tools, simulation, web site, specialised platforms, others

There are a strong relationship between the kind of validation and the kind of learning system. For the validation of interaction models and hypothesis in human science we found more collaborative tools and e-learning systems (Jermann et al 2002, Kreijns 2004, Hara 2003). For the validation of computer models or computer systems we identified more "domain systems" like intelligent tutoring systems (Mostow 04, Heiner 04).

Data collection (Tracking)

In our case the majority collection is digital, in form of logs files like http log files, ip login, etc.. We identified also more semantic date identified by explicit meta-data, data and type of action, object manipulated or navigation description. We find less manually data, in this case we identified dialogs or research notes.

Data structuring and storage

The more significant data structuring is the relational Data Base. In the others case the data structuring is not specified or it is in relation of the data analysis, like for example the work from Mayo et al. (01), who propose a bayesien network for ITS system or McLauren et al (2004) who propose a graphs with learner's trails.

Data analysis and diagnosis

The data are presented and analysed in relation to the research hypothesis. Often the papers concerned present a statistical analyse. We found also analysis in relation to a human science model (Hara 2004), or computer model (Mayo et al. 2001,McLauren et al 2004). Another kind of analyse is made thanks to the tools from Data Base, like SQL queries or data mining. Mostow (1994) proposes a set of criteria for formulate ITS data as experimental trials and he take into account the kind of analyse, this proposition will be present afterwards.

Data visualisation

A small amount showed in the papers, we found: statistical graphs in the ITS papers and the visualization in relation to the model (bayesian graph, tree, etc.). In more of the cases, the visualization is produced for the paper but not in the learning system.

4. State of Art on Design Pattern

4.1. Methodology

A model of reading card has been designed by the LIUM team specifically for the state of art on Design Pattern. The compilation of the reading cards filled in by the partners has been made manually.

4.2. Compilation of reading cards on Design Pattern

Eighteen papers have been studied on the topic “Design Pattern”. Note that three of them have been referenced but not studied by the DPULS members by filling in a reading card.

We have classified these papers in two categories according to the objective given for the Design Pattern:

- those which are about LMS management or design problem (8 papers)
- those which addresses learning or teaching problem (7 papers)

For each category, we synthesize the reading cards according to the subjects which have been emphasized in the plan.

It seems to be complex to find a model which fixes a generic set of rules to process and structure the manipulated data. On the other hand, a certain class of users, confronted with a learning tracks management problem, can define a set of techniques dedicated to solve recurrent questions. The application into domain of learning tracks of design patterns requires to distinguish at less three different kinds of pattern:

- *Track collecting patterns* propose solutions to recuperate indices of actors’ activity. The main questions are linked with (a) the direct or indirect nature of tracks to be collected, (b) the digital or non-digital nature of collection mechanisms, (c), the

instrumented nature of learning situations, (d), the ability of software artefacts to set accessible manipulated indicators;

- *Tracks structuring patterns* propose solutions to process collected indices. This structuring is closely linked with the actors' goals and must answer to the following questions: how to define an homogenous frame of learning indicators in order to make a pertinent diagnose built from collected raw data? What are the associated filtering, merging and computing rules?
- *Tracks observation patterns* provide a certain class of actors with a set of solutions to visualize and manipulate primitive tracks and learning indicators. The related questions are linked with analysis of specific practices of the considered community.

What is a Design pattern?

In the majority of the cases, the meaning of "design pattern" is related to the Alexander' definition. The following definition issued from [Goodyear et al. 2004] contains it.

"Design patterns have a number of qualities which, in combination, give them the potential to be a useful way of sharing experience in the field of networked learning. A pattern is a solution to a recurrent problem in a context. In Alexander's own words, a pattern "describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice" (Alexander et al., 1977, p.x). Context is important in helping constrain and communicate the nature of both problem and solution. Describing the context for the problem and its solution avoids over-generalisation. In addition, patterns should also teach. They should be written in such a way that they help the reader understand enough about a problem and solution that they can adapt the problem description and solution to meet their own needs."

What is methodology for capturing and defining Design Pattern?

Usually, the method applied is the capitalization of knowledge and experience: a pattern is supposed to capture best practice in some domain. Pedagogical patterns try to capture expert knowledge of the practice of teaching. The intent is to capture the essence of practice in a compact form that can be easily communicated to those who need this knowledge.

An original method for pattern recognition has been proposed in the paper: "An exploration of technologies for the inductive analysis of learning design pattern", by Brouns F., Koper R; and all. They propose is to use LSA and I method (Latent Semantic Analysis and Indexing) to find similarity of concepts in the IMS-LD description of an unit of learning.

What is the Design Pattern format

The format is more or less the format proposed by Alexander.

Name	A unique name to distinguish the pattern and uniquely refer to it.
Problem	A brief description of the design problem at hand.
Context	An explanation of the origins of the problem, the context of the problem: the situations the in which the pattern apply or not.
Solution	A description of the solution proposed by this pattern that addresses the problem and the context. In addition, you can find an example of usage of the pattern
User Category	One of the three categories of LMS users defined above (learners, instructors and administrators).
Known uses	Examples of the pattern in real LMS. This is an important attribute of a pattern since it is claimed that a proposed pattern gets accepted by the corresponding pattern community, only if there have been two or three examples of its use by someone other than the one who

	suggested the pattern [Buschmann et al., 96].
Related Patterns	Other patterns that are related to this one in some way. It is noted that the patterns proposed in this paper, except for being related to each other, are also related to Hypermedia design patterns.

Set of Design Patterns

In the paper *"Toward a Pattern Language for learning Management system"*, Avgeriou P. and all propose a set of twenty Design Patterns on LMS problems. More often, between one and four examples are described.

Design patterns relationships

When a set of patterns is defined, distinct patterns can refer to each other. The patterns can also been classified, for instance in the domain of web-based instruction (WBI), the patterns proposed by [Frizell and Hübscher ??] are grouped into 3 sets :

- Learning Activity Patterns,
- Content patterns,
- Learning Support Patterns

What is pattern language?

According to Joseph Bergin [Bergin ??], *"A pattern language is a set of patterns that work together to generate complex behaviour and complex artefacts, while each pattern within the language is itself simple."*

This definition is completed by [Goodyear et al. 2004]: *"Ideally, the name of the pattern should crystallise a valued element of design experience and help relate it to other design elements such that we can create and use a pattern language. The use of patterns, then, can be seen as a way of bridging between theory, empirical evidence and experience (on the one hand) and the practical problems of design."*

What is the pattern language for?

In one reading card about "*Toward a Pattern Language for learning Management system"*, it is noticed that: Pattern language is merely to capture design expertise and present it in a comprehensible and usable format.

Another reader notices that *A pattern language enables software designers to talk about problems by the names of their pattern*.

Design patterns are usually drafted, shared, critiqued and refined through an extended process of collaboration. The pattern language allows the description of complex activities based on well known and improved patterns.

How to support the application of patterns?

In one reading card "Supporting the Application of Design Patterns in Web-Course Design", it noticed that : the support is composed by three main activities: *finding* and *selecting* the appropriate patterns, and the *application* of the selected patterns into the course's design.

• ***Finding Patterns****:* They utilize a hypertext rendition of their pattern language to support browsing and quickly navigating through the patterns in the language. Patterns are grouped into categories based on the type of problems they address with cross-referencing between related patterns. This allows quick access to the patterns.

• ***Selecting Patterns:*** To support course designers in selecting the appropriate pattern(s) to solve their design problems, they provide support for pattern selection in two ways. They provide a menu-based approach, which allows the designer to search for patterns based on their course goal or problem. They also use a decision support system to guide the designer through the process of designing a course using a standard instructional design process combined with the patterns that address problems within each phase.

• ***Applying Patterns:*** After the course designer chooses the patterns he wants to use in his course's design, a design specification for the web-course is developed based on these selected patterns. The course design specification acts as a bridge from design to implementation. It gives the instructor an idea of how the course is structured based on his particular design decisions.

5. Emergent ideas in papers or projects

5.1. JermanP. Proposals

Jermann [Jermann & al 2001] proposes a very useful classification framework built on a simple model of coaching. He distinguishes between mirroring systems, systems that monitor the state of interaction and systems that offer advice to users.

His framework addresses learning environments supporting collaboration. In his terms, collaboration management follows a simple homeostatic process that continuously compares the state of interaction with a configuration. The following figure describes this cycle.

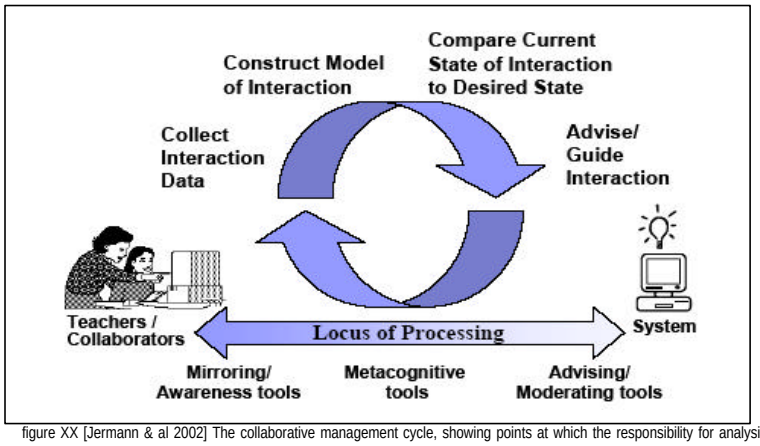


figure XX [Jermann & al 2002] The collaborative management cycle, showing points at which the responsibility for analysing and guiding the interaction might shift from the collaborators to the system.

He doesn't treat of systems that structure the learning situation in which the collaboration takes place (e.g. using learning scenarios). He focuses on situations where the collaboration itself is structured through coaching or self regulation. This approach involves gathering data along the whole learning phase.

The most important distinction is set by considering mirroring systems, that only record and reflect data, while monitoring and advising systems process input data to obtain a higher-level representation which may be displayed to the users or used by the system to provide advices or remedial actions in order to increase the learning process effectiveness.

Mirroring systems aim to make users aware of the participants' actions, like actions taken on shared resources, actions hidden to part of them because they intervene in private workspaces, number or kind of interactions in discussions… We may consider as « mirroring », systems that provide visual maps of navigation through learning objects [Kaleidoscope Trais WP]. Their main goal is to reflect users actions without any further analysis during run time.

Monitoring systems aggregate the interaction data in a set of high-level indicators that may either be displayed to users or hidden to them but compared to a model of ideal interaction to be further analysed (by teachers or researchers). Indicators may be quantitative (e.g. number of messages, number of problem-solving actions, number of help demands), or qualitative. COALE [N. Furugori & al 2002] may be ranged in monitoring systems while it delivers two kind of visual maps to users working in this environment. The first map is named « Contents Awareness Map » and aims to provide learners with informations about the most recommended contents they may study at the next step of learning. The second map, named « Learning-Mate Awareness Map) advises them about the good partner(s) to work or discuss with. The both maps are constructed from indicators collected during prior phases of learning (level of comprehension, level of interest, level of difficulty, distance between contents).

Advising systems are closely comparable with face to face situations where a teacher caoches a collaborative learning classroom. Jermann distinguishes systems by the nature of the information in their underlying models, and whether they focus on stryctly collaboration issues or both social and task-oriented issues. He tells us that systems which may advise the social aspects of interaction require indicators to qualify the dialog between group members (e.g. DEGREE [Barros & Verdejo 2000]). Several advising systems use finite state machines developped to monitor discussions. In many cases, systems that adress both social and task-oriented issues, use specialized computer agents. These agents use profiles of each user, and form beliefs about potential group learning opportunities.

Like Jermann, we consider that CSCL poses a real challenge: how to successfully make the transition from understanding how to mediate learning groups to understanding how to train a system to mediate groups. We assume that our work around patterns for tracking analysis participate to this goal.

Bibliographie:

[Kaleidoscope Trails WP] Deliverable D22.2.2, deliverable of the WP2 "trails within digital or not digital learning objects",

http://www.noe-kaleidoscope.org/intra/docs/full_deliverables/D22-02-02-F.pdf

[N. Furugori & al 2002] Fururogi N., Dato H., Ogata H., Occhi Y., Yano Y., COALE: Collaborative and Adaptive Learning Environment, *CSCL 2002*, http://newmedia.colorado.edu/cscl/35.html

[Barros & Verdejo 2000] Barros B., Verdejo M.F., Analysing student interactions processes in order to improve collaboration. The DEGREE approach. *International Journal of Artificial Intelligence in Education*, 11, 221-24

5.2. Mostow proposals.

[Mostow 04] (Mostow J.," Some Useful Design Tactics for Mining ITS Data", conference ITS 04

Mining data logged by intelligent tutoring systems has the potentiel to reveal valuable discoveries. What characteristics make such data conducive to mining? What variables are informative to compute? In the article, the author discusses how to collect machine-analyzable data and formulates it into experimental trails. The resulting concepts and tactics mark out a roadmap for the merging area of tutorial data mining, and may provide a useful vocabulary and framework for characterizing past, current, and future work in this area. The studied system is the Reading tutor from Project LISTEN.

At a low level, it is necessary to know which data to collect, how to modify the system to generate additional data, which variables to calculate in a raw dates to make of the analysis then the visualization to improve the results of the learning.

At a high level, it is necessary to determine the information to provide to the various actors of the e-learning to reach the same objective of improvement of the results. This information differs according to the actors.

The instrumentation of the Survey is a difficult and iterative task. For that purpose, Mostow proposes us tactics to facilitate it.

What makes ITS data exploitable?

The types of analyzable data depend on activities from which they are collected. The ITS allows to collect the tracks of any type of learning activity. But how to make them exploitable?

- Multiple grain size: To be exploitable, the granularity of tracks should correspond to the analysis wanted.
- Reifying Task: To be useful, the track must be understandable by the machine. The learning supplies many track which are not easily analyzable (ex: resolve mathematics on paper). The reification supplies processes machine-analyzable by reorganizing them so that they can use operations which are easy to instrument by machines.
- Timing: Some learning processes are not observable (as the reading on the screen). The "time spent» is relevant for that purpose.
- Writing: We can have difficulties to estimate the correspondence between the answer of the pupil and the expected answer. Some useful techniques are: latent rank of student essay questions semantic analysis to, Parsing and domain specific knowledge to analyze and critic self explanations' student of proof steps.
- Peer Communication: We can make a tracking of e-mails, chats, newsgroups to continue the survey on communications. These tracks could allow to determine patterns of communication (Who communicates with Whom).
- Student data: The particulars of learners can be used in the analysis of the ITS research versions.
- Manual Labelling: The manual analysis can sometime be useful.
- Adding probes: To measure the understanding of learning him (it) is not easy. For that purpose, questions of understanding can be inserted into the text (method " cloze ").
- Randomizing tutorial decisions: Allocating credit and blame over length sequence of ITS and student decisions leading to has given educational outcome is hard. One approach to making this problem somewhat more tractable is to embed randomized experiments in the ITS.

Formulating ITS data as experimental trials

The ITS generate quantities of tracks, we want to transform them in variables to analyze and show. To analyze the complex effects on possible results of learning, the rich interactions with the ITS, it is interesting to decompose this serial interaction of experimental tests defined by local decisions.

- Decision: Each test begins with a decision which arises from unexpected situations of learnings. We analyze the decisions which are on the base of the interactions.
- Context: Each test appears in a context. The characterization of the context is a basis to gather or not the tests and makes the link between the context and the results.
- Outcome: A trial finishes with a result. If the result is defined in advance, the ITS can note at same time the reached results. To note every test in a table as a set {context, decision, result} simplifies the analysis, but is not always feasible. Problems can result from the tests:
    - A test affects the result of the other one
    - Confounding the experimental manipulation with other influences one trial outcomes

These problems require statistical treatments to control them.

Emerging ideas treat with the transformation of the ITS data in a set of trials. It is a question of:

- Segmentation: The interaction can be segmented in episodes to be better analyzed
- Slicing: We abstract set / quantities of "relevant" data in a subset of interaction for a given task of learning. [Program slicing, Werser on 1984]
- Outcome Formulation: Another important stage in the exploitation of data is the definition of partial results. To define the results by basing itself on tracks, the method is unpredictable.
- Aggregation: The aggregation of various observations can give relevant information.

5.3. ICALT proposals

The framework introduced in kaleidoscope deliverable 26.1.1., from the JEIRP ICALTS, is discussed in a systematic way. It is a conceptual framework for interaction analysis that is usable to explain and understand the objectives, methods, and tools of interaction analysis defining the relevant concepts in the field of interaction and collaboration analysis and relating them to each other. The framework is also meant to classify interaction analysis methods, as well it can be used to design and develop indicators and analysis methods.

The document starts with the definition of key concepts as for example interaction. For interaction, they need a definition able to deal with actions and discourse, covering cognitive and participatory aspects of interaction, simple to process and able to deal with silence and inactivity. We can distinguish between human-human inter-actions and human computer interactions, that can be also be processed for analysis so taking this into account, it can be defined as

On a stand-alone mode of use*: "actions that affect the state of the system or of one of its components"*.

On a collaborative mode of use*: "an action that affects or can affect the collaborative process. The action itself or its effect should be perceived by at least a member of the group distinct of the one that performed the action*".

Afterwards a fine grained characterization and description of learning environment, analysis methods, and purposes of indicators is discussed, taking into account state of the art research references. For example for analysis method the following dimensions are proposed: input level (physical event, UI events, user actions) pragmatic aspect (to be used for task or solution quality aspects, communication, collaboration..), perspective (either action oriented or state oriented), viewpoint (summary or structural analysis), utilization of results (on the fly, afterwards), and type of techniques.

Finally, to show the feasibility of their presented framework, two practical exercises are developed. First two indicators, actions classification and SNA indicators, are fully discussed for a concrete example of analysis method developed in the partner's groups, then a set of learning systems are reviewed concerning the indicators defined in deliverable 1, to prove the general usefulness of the framework.

We studied also the second deliverable from ICALT JEIRP. This report aims at providing an outlook on future research directions in the domain of computer-supported interaction analysis. First section is a short overview of the domain of computer-supported interaction regulation. Then, section two discusses some research directions.

In the section 1, they propose that the goal of computer supported interaction regulation is to distribute the regulation process over humans and machines. Three possibilities arise when the computer is taking over some phases of the regulation

- Mirroring tools take over the collection and aggregation of raw data about the students' interaction, and show some visualization of this information to the user. These systems reflect student actions, for example, as a graphical visualization of chat contributions. The learners or the teacher have to compare this information with their own norms for desirable interaction and decide whether remedial actions are needed.
- Metacognitive tools display information about what the ideal interaction might look like alongside a visualization of the current state of interaction. These systems provide referents ("Norm") needed by the learners or human coaches to diagnose the interaction. It is then up to the students or teacher to decide what actions (if any) to take based on their diagnosis.
- Guiding systems perform the entire regulation process and propose remedial actions to help the learners. The desired model of interaction ("Norm") and the system's assessment of the current state ("Indicator") are hidden from the students. The system uses this information to make decisions about how to moderate the group's interaction.

Fundamentally, these three approaches rely on the same model of interaction regulation, in that first data is collected, then indicators are computed to build a model of interaction that represents the current state, and finally, some decisions are made about how to proceed based on a comparison of the current state with some desired state.

The research topics elaborated in part 2 are the following:

1. The first topic concerns the correspondence between indicators of learning and computational indicators. Simply put, they propose to work on the gap that sometimes exists between the two definitions of the term "indicator", the gap between what we can capture and process computationally ("Indicator") and what is important for learning ("What is important"). This topic also addresses the definition of norms ("Norm") and the related question of "What do we want to achieve".
2. The second research topic is about the use of Artificial Intelligence techniques in interaction analysis. Interaction traces from learning environments are usually very rich and contain complex information about the teachers' and learners' activities ("Raw Data"). AI techniques ("Analysis method") might enable to build models of the

interaction which also include semantic aspects the interaction, as well as information relevant to the task at hand.

3. The third research topic concerns the need to include contextual information in the design and usage of tools for interaction analysis. Human coaches and learners are for instance able to adapt their norms for judging interaction by taking into account the current context of interaction. Research is needed to explore methods that allow machines to be context-aware as well.
4. To foster the exchange of software components and to enable their usage in concrete learning environments, the fourth research topic consists of developing a common technical framework to describe Raw Data as well as the Analysis methods that are applied to obtain indicators. A first attempt was made in the first deliverable (D26.1) to describe indicators following a common description scheme. They propose to continue the effort of systematization to more technical aspects underlying interaction analysis.
5. The last research topic concerns the effects “of” and “with” computer support for interaction analysis. More empirical evidence is needed to demonstrate the efficiency of these approaches. This topic is dependent upon a clear definition of “What is important” (topic 1) as well as the possibility to implement tools that use indicators in concrete learning environments (topic 4).

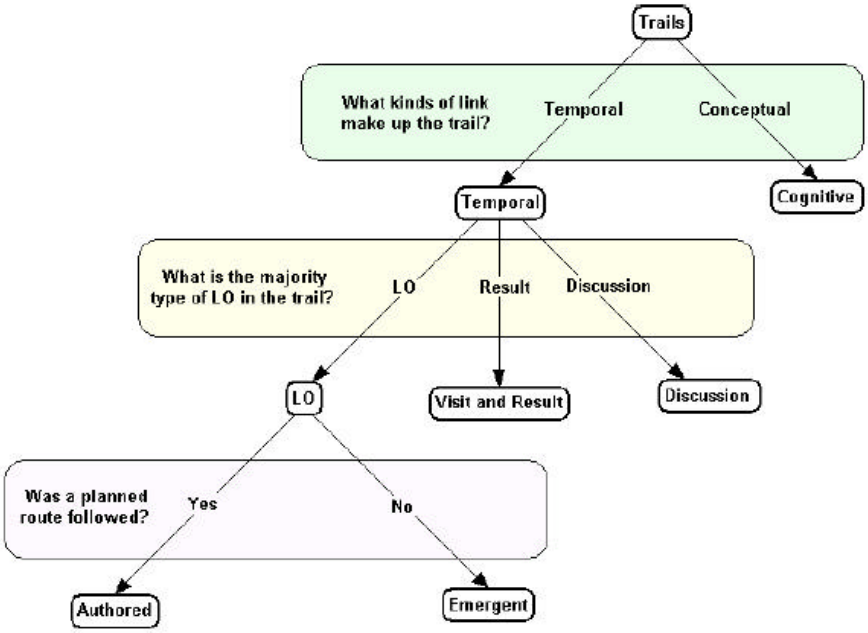
5.4. Trails JEIRP results.

The TRAILS project investigates the trails that learners follow and create as they navigate through a space of learning objects. Learners engage with LOs in the form of trails – time ordered sequences of LOs.
Examples of LO trails are: (i) a school-child navigating through course materials, (ii) a learner navigating through the literature on a subject, or (iii) a visitor navigating through a museum.
By following and creating trails, the learner navigates through a space of LOs creating a personal trail that can be evaluated and accessed in a structured manner. These directly observable LO trails are related to learners' non-observable cognitive trails.

5.4.1. Trails of Digital and Non-Digital LOs

Trails occur in various pedagogical approaches, namely **problem-based learning**, **inquiry learning**, **discovery learning**, **cognitive apprenticeship** and **classroom learning**.
Trails in mobile learning are described in several experiments using mobile technology to support museum visits. Mobile devices with additional digital information, which often includes but goes beyond an audio tour, accompany the visit to the usually non-digital museum objects. In some cases, learners have the possibility to make digital notes.
Trails in computer conferencing: It describes a method of analysing contributions to computer conferences, so that discussion participant can reflect on their contributions afterwards. This chapter shows a graphical technique that provides an overview of the discussion by displaying the contributions that individuals make to the various threads of the discussion.
Trails can be planned by teachers, using IMS Learning Design specification. These **planned trails** are seen as learning scenarios.
Data collection can be used both in individual and in collaborative situations or actions to help learners in tracking/understanding the followed trail, in building maps and in improving the learning strategies.
A provisional **taxonomy** of trails is defined. A first distinction is made between trails proper and graphs, which may contain several trails. Trails are linear sequences of LOs. Graphs contain possible trails, and can be divided into learning environments and mind maps

depending on the type of links between LOs. Trails can be further classified according to the majority type of LO within the trail. Here a distinction is made between LO trails, discussion trails and result trails.



A classification of trails

5.4.2. Personalised trails and learner profiling within an e-Learning environment.

Personal trails are trails that have been followed by an individual learner through some learning environment. In terms of our taxonomy of trails from D22.2.1 (Schoonenboom *et al.*,2004a) they are ***emergent LO trails***, as they emerge from the behaviour of an individual learner. For this reason they could be also be called *individual trails*. Personal learning trails manifest themselves in many ways – they can be short-term or long-term, and will vary greatly in the granularity of the events considered as single nodes along the trail. So, for example, one personal learning trail might be the list of LOs visited during an hour-long session working in an on-line e-learning environment, and another could be the list of qualifications gained between the ages of 15 and 25 on a *curriculum vitae*. The recording of personal trails can be a useful activity for learners – it allows reflection on what has been done, and perhaps the opportunity to re-visit sections of the trail that has been followed so far. Indeed, the "history" of web page accesses stored in a web browser is designed specifically to allow users to easily locate and revisit things they have already seen. The learner portfolio – a collection of representative pieces of work from over a period of time– is an important kind of personal trail. At present, portfolios of work are usually kept as "evidence" for some sort of assessment activity or to demonstrate to third parties (i.e. someone who is not the learner or instructor) that they have acquired skill at some competency, but the role of the portfolio can easily be modified or augmented to also act as a focus for reflection by the learner on what they have done. Techniques for visualisation of personal trails, such as those reported in D22.2.2 (Schoonenboom *et al.*, 2004b), can further serve to foster reflection in learners.

References

Lejeune A., Pernin J-P., A taxonomy for scenario-based engineering, Cognition and Exploratory Learning in Digital Age (CELDA 2004) Proceedings, Lisboa, Portugal, dec. 2004, p.249-256

Pernin J-P., Lejeune A., Dispositifs d'apprentissage instrumentes par les technologies: vers une ingénierie centrée sur les scénarios, actes du colloque TICE 2004, Compiègne, France, oct. 2004, p.407-414

JERMANN P., SOLLER A., MUEHLENBROCK M., From Mirroring to Guiding: A Review of State of the Art Technology for Supporting Collaborative Learning,Proceedings of ECSCL01, March 2001, Maastricht

ICALTS Deliverable 1: State of the art of interaction and collaboration analysis
Kaleidoscope JEIRP ICALTS, (2004) Interaction & Collaboration Analysis supporting Teachers & Students' Self-regulation, http://www.rhodes.aegean.gr/LTEE/KALEIDOSCOPE-ICALTS/

TRAILS Deliverable 2.1 - Trails of Digital and Non-Digital Learning Objects (14/7/2004)
Kaleidoscope JEIRP TRAILS, (2004) Personalised and Collaborative Trails of Digital and Non-Digital Learning Objects, http://www.dcs.bbk.ac.uk/trails/

TRAILS Deliverable 4.1 - Personalised Trails and Learner Profiling within e-Learning Environments (31/12/2004)
Kaleidoscope JEIRP TRAILS, (2004) Personalised and Collaborative Trails of Digital and Non-Digital Learning Objects, http://www.dcs.bbk.ac.uk/trails/

6. Annexe 1: Reading Card on tracking and analysing usages

Reviewer name:

Reviewer familiarity with subject matter:

? High ? Moderate ? Low

Your abstract of the article

Reader Opinion

Patterns

If the article talks about patterns can you precise what are the objective of their usage?

What are the patterns characteristics?

? Design Patterns ? Pedagogical Patterns

Do the authors generalise their experience in the article?

Tracking

Can you precise here the type of trail, the mode of tracking, the underlaying model, in complement of the indications provided on the right.

More precisely...What is tracked ?

? Dialog ? Learner production

? Object manipulated ? Chronological event

How are the trails collected?

Support?

? paper ? Audio record ? Video record

Are the trails formatted according to a model?

? Explicit metadata ? IMS-LD compliant

Analysing

Can you precise here the characteristics of the collected trails analysis

More precisely...

Is this analysis provided for:

? Learner ? Tutor ? Teacher

Who analyse?

? Manager ? Researcher

What is the objective of the analysis?

? Regulation ? Evaluation ? Observation

What kind of analysis?

? Statistics ? Data mining

Learning

Can you precise here the characteristics of the learning approach that has been described in this article?

Experimentation

If an experimentation is described can you precise its characteristics

When does the system analyse?

? During the Tunning ? During the regular use

More precisely...

Can you define the type of learning described?

? Individual or ? Collective

What kind of learners?

? Primary school ? Secondary school

What kind of learning system?

? e-learning Platform ? Collaborative tool ? ITS

? Microworld ? Simulation ? Web site

What is the learning domain ?

More Precisely

Objective

Public

Population size

results

7. Annexe 2: synthetic table of SOA on tracking and analysing usages

Paper	Raw Data	Data storage	Data analysis method	objectives		
				Experimentation and Validation	Assessment	Regulation
Lessons on Using ITS Data to Answer Educational Research Questions (Heiner et all 04)	logs	Data Base	statistics	Validation of tutor system and student model		
Some Useful Design Tactics for Mining ITS Data (Mostow 04)	All kind of data	Data Base	Statistics Data Mining	they propose a set of criteria for define the data to be recorded in relation to a set of constrains : Multiple grain size (in relation to the expected analyse), Reifying task, timing, writing, peer communication, student data, manual labelling, adding probes, randomizing tutorial decisions	Idem for the assessment. The objective of the analysis is to help improving educational outcomes. It's provided to all actors of the tutoring.	
Correlational analysis of student visibility and performance in online learning" (Wang M. 04)	Dialog, learner production	Not specified	Statistics	This study examines the relationship between student visibility and learning outcomes in a graduate-level online course. Visibility in this study refers to students' cognitive, social, and emotive presence. A visibility score is determined for each student, and the Spearman r correlational tests are used to detect any significant correlation between visibility and learning outcomes (grades). In addition, one of surveys distributed to the students at the end of the course concerns their self-Perception on Learning Experiences.		

From Mirroring to Guiding: A Review of State of the Art Technologyfor Supporting Collaborative Learning. (Jermann P., Soller A, and Muehlenbrock M. 02)	Dialog Shared and private workspace actions Web page access Student preferences	not specified	not specified		The collaboration progresses and the state of interaction are evaluated.	
Measuring perceived quality of social space in distributed learning groups. (Kreijns K., Kirschner P., Jochems W., van Buuren H., 2004)	Questionnaire in online session. Video Records	Files not specified	Statistics	the methodology used to experimentally validate the instrument (to measure a range of social climate/presence aspects that arise in online courses).	The paper presents the Social Space Scale, an instrument to measure a range of social climate/presence aspects that arise in online courses	
Content analysis of online discussion in an applied educational psychology cours. (HARA N., JAY BONK C., ANGELI C., 2003)	Dialog	Log files	Statistics. Henri's (1992) model for content analysis of computer-mediated communication was employed to qualitatively analyze the electronic discourse.	This study analyzed discussion in an online conference that supplemented class discussion.Using the Henri's model, five key variables were examined: (1) student participation rates; (2) electronic interaction patterns; (3) social cues within student messages; (4) cognitive and metacognitive components of student messages; and (5) depth of processing – surface or deep – within message posting		
Bootsrapping Novice Data: Semi-Automated Tutor Authoring Using Student Log Files", (McLauren B., Koedinger K., Schneider M., Harrer A., Bollen L 04)	Learner production	Log files	Behavior Recorder analyses by making graphs with learner's trails and experts manually decide what is correct or not in the graph		The authors propose an approach called bootstrapping navice data(BND) in wich a intelligent tutor is integrated to the tutoring system, with trails. The objective of the analysis is to create the intelligent tutor which will evaluate learners.	
Patterns of participation and discourse in elementary students' computer-support. (LipponenL., Rahikainen M., Lallimo J., Hakkarainen K. 2003)	Dialogs	Logs Files Video Records Data Base	social network analysis is applied to the quantitative data (retrieved from logfiles).	Patterns of participation and discourse mediated by Virtual Web School (VWS).		

			a qualitative content analysis is applied to the messages (contained in the system database).			
Viewing and Analyzing Multimodal Human-computer tutorial dialogue: a Database Approach (Mostow J., Beck J., Chalusani R., Cuneo R. and Jia P. 02)	Speech, mouse clicks, keyboard presses, graphical actions.	Logs Files formatted in a explicated metadata. Data Base	SQL queries and statisticals analisys.	Methods for extracting useful information from logs of 400 students which have read 2.4 million words.		
Collaborative Learning Patterns: Assisting the Development of Component-based CSCL Applications (Asensio J. I., Dimitriadis Y. A., Heredia M., Martínez A., Álvarez F. J., Blasco M. T., Osuna C. A. 03)	Not specified	Not specified	Not specified	The conceptualization of a part of Collaborative Learning domain for obtaining a component framework for the CSCL domain. This approach facilitates the identification, the study and the formalization of Collaborative Learning Patterns.		
Optimising ITS behaviour with Bayesian networks and decision theory (M. Mayo, A. Mitrovic. 01)	Chronological Event	files	Bayesian network	ITS based on Bayesian network		
Critical Inquiry in a text-based environment: computer conferencing in higher education (Garrison R., Anderson T., Archer W. 00)	Dialog Learner Production Video Record	Not specified	identify indicators of cognitive, social and teaching presence.	model of community inquiry that constitutes three elements essential to an educational transaction – cognitive presence, social presence, and teaching presenc		
Analyzing Online Collaborative Dialogues: the OXEnTCHê-Chat (Vieira A.C., Teixeira L., Timoteo A., Tedesco P., Barros F.)	Dialog	2 databases : Log which stores individual users'logs and the whole dialogi log ; Ontology which stores the ontology for various subject domains	The system classifier dialogs with Neural Network and Decision tree			In time feedback provided to both teachers and learners. Learners are informed of good links to visit, that may help them on the studied subject.
Pixed: An ITS that guides students with the help of learner's interaction logs (Héraud J.M., France L., Mille A.)	Navigation : learning episodes	database	Case-Based reasoning			The analysis is provided for learner and its result is an adapted path of learning. Analysis is done during runtime to propose concepts to learn (in the adapted path)
Authoring a collaborative task extending the IMS-LD to be performed in a standard-Based	User behaviour when using a learning	XML files	multi-agent architecture, which provides			learners working on the course materials are advised to consult

adaptive learning management system called ALFANET (Santos O., Boticario J.G., Barrera C.)	scenario (IMS LD compliant) : difficulties encountered, time spent on a special task, interactions ...		user modelling based on domain inde-pendent adaptive tasks			additional information if the system detects difficulties in completing a particular course activity ; adaptded routes between activities and course resources are provided to learners on runtime (from start to end) ; all adaptations made on initial scenarios are turned out to be profitable for similar learners in resembling situations.
COALE: Collaborative and Adaptive Learning Environment (Furugori N., Sato H., Ogata H., Occhi Y., Yano Y.)	navigation data, visited contents, dialog interactions (in CSCL)	Databases	Indicators built from row data : Level of comprehension, level of difficulty, level of interest, distance between contents)			Two maps are provided to learners : the former aims to help them to choose the most accurate resources (contents awareness map), the later to advise them of who in the learning group may be the best mates to collaborate (Learning-mate Awareness map)
Visualising Student Tracking Data to Support Instructors in Web-Based Distance Education (Mazza R., Dimitrova V.)	Web log data	???	The system uses graphical representation to visualize data from a java on-line distance course			The goal is to help teachers become aware of some social, behavioral and cognitive aspects and further identify tendencies in their classes or individuals that need special attention.

This paper presents a novel approach of using web log data generated by course management systems (CMS) to help instructors become aware of what is happening in distance learning classes. Specifically, techniques from Information Visualization are used to graphically render complex, multidimensional student tracking data collected by CMS. A system, called CourseVis, illustrates the proposed approach. Graphical representations from the use of CourseVis to visualise data from a java on-line distance course ran with WebCT are presented. Findings from the evaluation of CourseVis are presented, and it is argued that CourseVis can help teachers become aware of some social, behavioural, and cognitive aspects related to distance learners. Using graphical representations of student tracking data, instructors can identify tendencies in their classes, or quickly discover individuals that need special attention

8. Annexe 3: Reviewed papers for SOA on tracking and analysing usages

Here are listed the papers that have been described at least in one reading card by the DPULS partner.

Alexandra Cristea, Franca Garzotto, Designing Patterns for Adaptive or Adaptable Educational Hypermedia: a Taxonomy,

Ana Claudia Vieira, Lamartine Teixeira, Aline Timoteo, Patricia Tedesco and Flavia Barros, Analyzing Online Collaborative Dialogues: the OXEnTCHE-Chat,

Asensio J. I., Dimitriadis Y. A., Heredia M., Martínez A., Álvarez F. J., Blasco M. T., Osuna C. A., Collaborative Learning Patterns : Assisting the Development of Component-based CSCL Applications,

Avgeriou P., Papasalouros P., Retails S.,, Patterns for Designing Learning Management Systems, Design Patterns

"Brouns, Francis; Koper, Rob; Manderveld, Jocelyn; Bruggen van, Jan; Sloep, Peter; Rosmalen, Peter, van; Tattersall, Colin; Vogten, Hubert", An Exploration of Technologies for the Inductive Analysis of Learning Design Patterns, preprint

Bruce M. McLauren, Kenneth R. Koedinger, Mike Schneider, Andreas Harrer, Lars Bollen, Bootsrapping Novice Data: Semi-Automated Tutor Authoring Using Student Log Files, Workshop on Analyzing Student -Tutor Interaction Logs to improve educational outcomes

Chris DiGiano, Louise Yarnall, Charlie Patton, Jeremy Roschelle, Deborah Tatar, Matt Manley, Collaboration Design Patterns: Conceptual Tools for Planning for The Wireless Classroom,

Christine Steeples, Maria Zenios, Organizational Patterns for E-learning Centres,

Croteau & al , why are algebra word difficult? Using tutorial log files and the power law of Le, article

Davinia Hernández Leo, Juan I. Asensio Pérez, Yannis A. Dimitriadis, IMS Learning Design Support for the Formalization of Collaborative Learning Patterns, conference

Davinia Hernández-Leo, Juan I. Asensio-Pérez, Yannis Dimitriadis, Miguel L. Bote-Lorenzo, Iván M. Jorrín-Abellán, Eloy D. Villasclaras-Fernández, DESCRIBING EFFECTIVE COLLABORATIVE LEARNING FLOWS USING IMS LEARNING DESIGN, conference paper

Fusako Kusunoki, Masanori Sugimoto, Hiromichi Hashizume, COALE: Collaborative and Adaptive Learning Environment, short paper - CSCL 2002

Garrison R., Anderson T., Archer W., Critical Inquiry in a text-based environment: computer conferencing in higher ed,

Heiner C., Beck J., Mostow J., Lessons on Using ITS Data to Answer Educational Research Questions, WS conference ITS 2004

INABA, Akiko and MIZOGUCHI, Riichiro, Learning Design Palette: An Ontology-aware Authoring System for Learning Design, conference paper

Ivon Arroyo, Tom Murray, Beverly P. Woolf, Inferring unobservable learning variables from students's help seeking behavior, Workshop on Analyzing Student-Tutor interaction logs to improve educational outcomes

Jack Mostow, Joseph Beck, Raghu Chalusani, Andrew Cuneo and Peng Jia, Viewing and Analyzing Multimodal Human-computer tutorial dialogue: a Database Approach, Proceedings of the fourth IEEE International Conference on Multimodal Interfaces (Pittsburgh)

Jean-Mathias Heraud, Laure France, Alain Mille, Pixed: An ITS that guides students with the help of learner's interaction logs, Workshop on Analyzing Student-Tutor Interaction logs to improve educational outcomes

Karel Kreijns, Paul A. Kirschner, Wim Jochems, Hans van Buuren, Measuring perceived quality of social space in distributed learning groups,

Lasse Lipponen, Marjaana Rahikainen, Jiri Lallimo, Kai Hakkarainen, Patterns of participation and discourse in elementary students' computer-support,

Line Kolås, Arvid Staupe, Implementing delivery methods by using pedagogical design patterns,

Mia Lobel ,Michael Neubauer,Randy Swedburg , The eClassroom used as a Teacher's Training Laboratory to Measure the Impact of Group Facilitation on Attending, Participation, Interaction, and Involvement., International Review

Mostow J., Some Useful Design Tactics for Mining ITS Data, conference ITS 04

NORIKO HARA, CURTIS JAY BONK, CHAROULA ANGELI, Content analysis of online discussion in an applied educational psychology cours,

Olga C.Santos, Jesus G. Boticario, Carmen Barrera, Authoring a collaborative task extending the IMS-LD to be performed in a standard-Based adaptive learning management system called ALFANET,
Paris Avgeriou, Andreas Papasalouros, Symeon Retalis, Manolis Skordalakis, Towards a Pattern Language for Learning Management Systems,

"Peter, Goodyear; Paris, Avgeriou; Rune, Baggetun; Sonia, Bartoluzzi; Simeon, Retalis; Frans, Ronteltap; Ellen, Rusman", Towards a Pattern Language for Networked Learning, Conference paper

Rune Baggetun, Ellen Rusman, Caterina Poggi, Design Patterns For Collaborative Learning:From Practice To Theory And Back,

Sherri S. Frizell, Roland Hübscher, Patterns, pattern languages and educational design,

Wang M., Correlational analysis of student visibility and performance in online learning,

9. Annexe 4: reading card for SOA on DESIGN PATTERNS

Reviewer name	
Article reviewed	

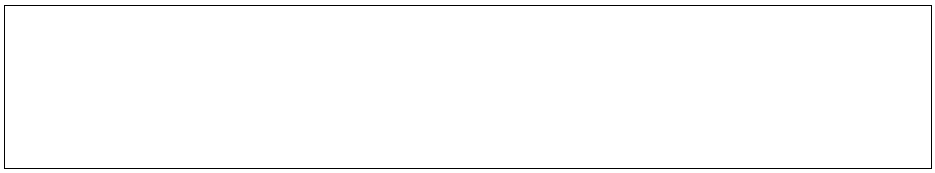
Authors	

Reviewer familiarity with subject matter

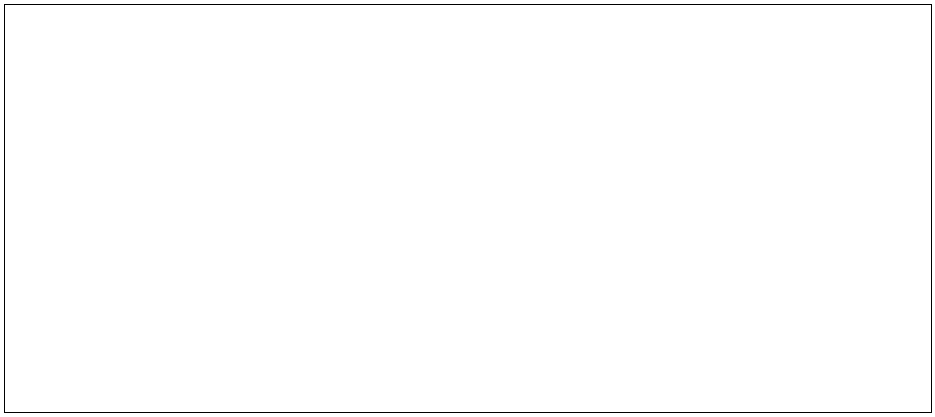
High	Moderate	Low

Abstract

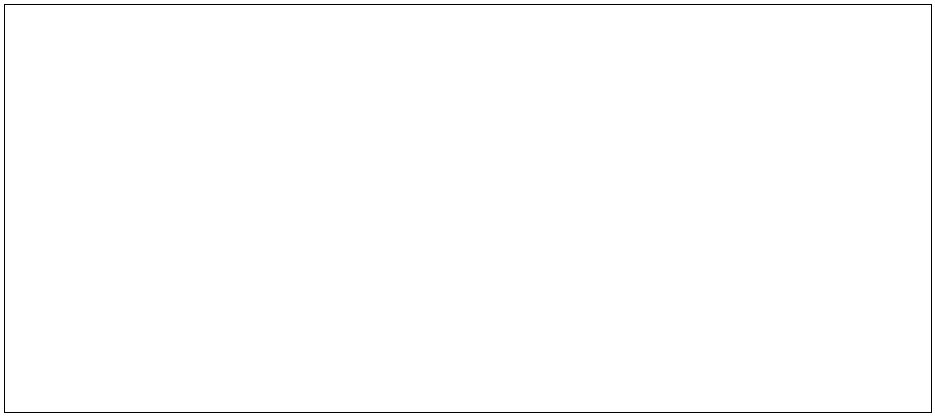
What is a Design pattern? (provide authors' definition)



What is methodology for capturing and defining Design Pattern?

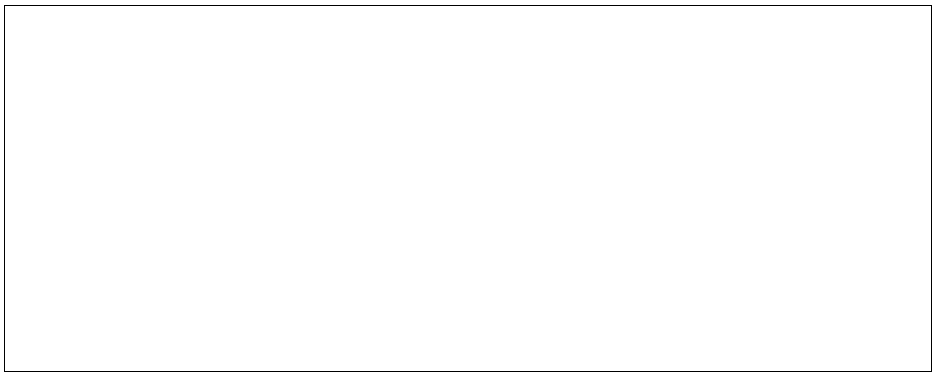


What is Design Pattern for?

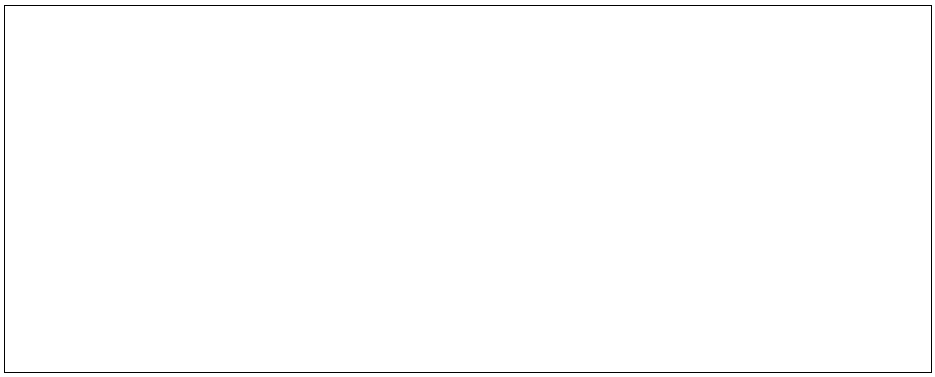


What is the Design Pattern format

(provide it in a table including a description of each field/attribute which characterize a DP**)**



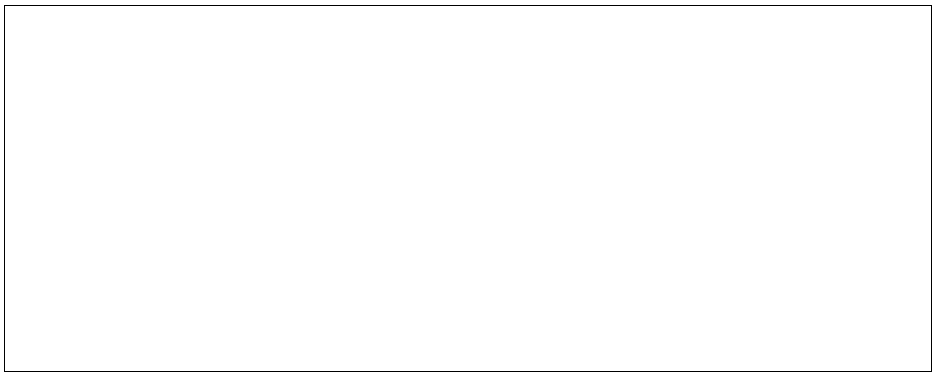
One example of Design Pattern (this example illustrates the Design Pattern format above)



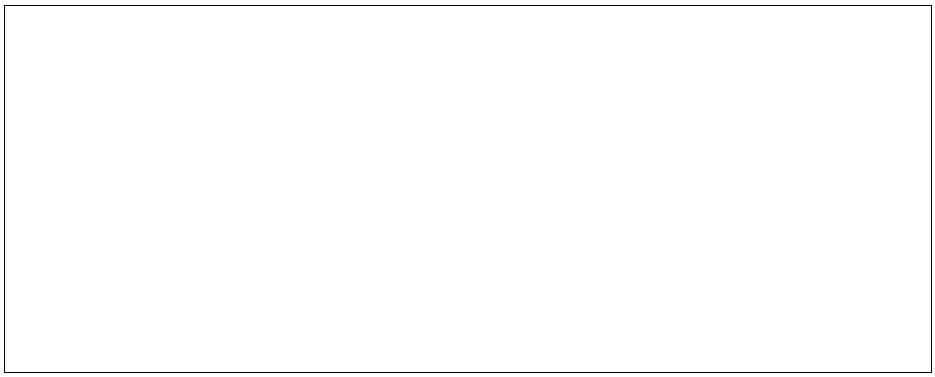
The set of Design Patterns (as a list of DP)

The Design patterns relationships

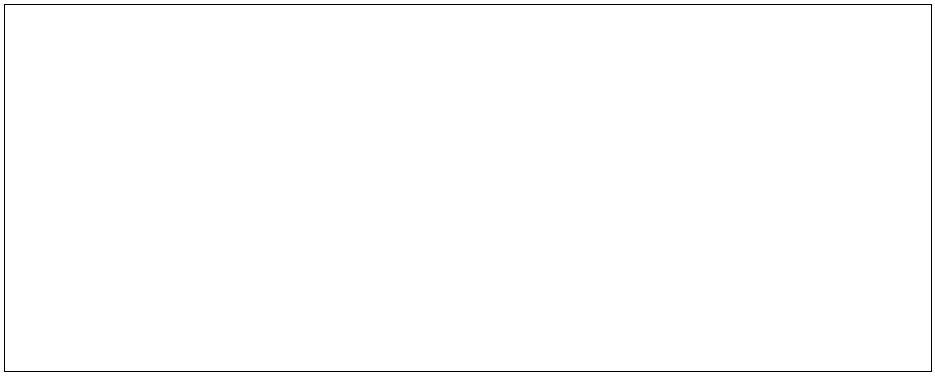
(A graph or map that shows how distinct patterns refer to each other and the nature of their relationships. For example with UML (Unified Modeling language) annotation)



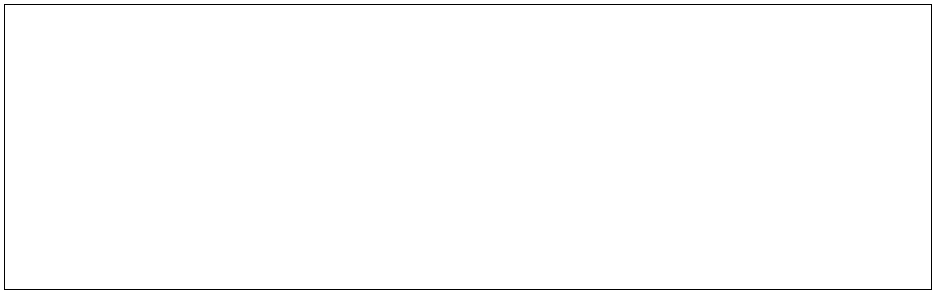
What is the pattern language? (if the article talks about a pattern language)



What is the pattern language for? (Note : if the article talks about a pattern language)



Reader opinion



10. Annexe 5: DPULS GLOSSARY (part of deliverable 32.4)

ACTOR

A human being that can assume one or more roles.

AGENT

An entity (human or artificial) that can assume one or more roles while interacting with other agents.

ASSESSMENT

The process by which one attempts to measure the quality and quantity of learning using various techniques.

Summative assessment aims to formulate a global (usually final) judgement, while formative assessment aims to identify strengths and weaknesses in order to improve both the process and the quality of learning. Usually, summative assessment is carried out at the end of the learning process, while formative assessment is carried out *during* the learning process.

Note: it is usually used in relation to a learner. See also definition of "evaluation".

DATA

Primary data = data that have not been processed; they may include:

- *Raw data*, i.e. recorded by the system.
- *Additional data*, i.e. linked to the activity, but not recorded by the system during sessions. They may include for example:
  - contextual data: description of the situation, concerning:
    - the LMS
    - the course content
    - the students' background
    - the goal of the course (lifelong learning, initial learning,...)
  - predictive data: data describing the predictive scenario, the learner profile (to be gathered before usage of the learning system)
- *Subjective data:* data that are not obtained by automatic calculation (example: answers to questions from a questionnaire, data obtained by textual analysis, etc.)

Derived data = data obtained from other data; they may include *calculated data* (data which do not exist at primary level and are obtained by processing raw data - examples: an average, a sum, etc.) and/or a*ggregated data* (data presented with semantic links; examples: tables joined by a relation, a matrix, etc.)

DESIGN PATTERN

[Taken from Alexander et al., 1977[1]] The description of a problem which occurs over and over again in an environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over.

DESIGN PATTERN LANGUAGE

Language for capturing design patterns and using them (how to retrieve, adapt, search for, etc. a design pattern). The language may consists of a syntactical structure and organisation, vocabulary, values for fields, types of links, pattern templates, etc.

A pattern language is used to provide:

- designers with workable solutions to all the problems that may arise while designing a course;
- people with new possible design patterns.

EVALUATION

Value judgements about quality of ideas, products, solutions and materials, that are based on observation, performance or any other data, directly measured or inferred. Evaluation is a general term, in relation to the learner it is more correct to say “assessment” (see definition).

INDICATOR

An indicator is a feature of a datum (usually of a derived datum). It highlights a relation between the datum and an envisaged event. *[Taken from ICALTS:]* In as far as they have value-oriented meaning, indicators can be considered variables. Indicators have to be interpreted, taking into account the learning activity, the profile and roles of the actors, as well as the interaction context.

Thus, they have a name and a descriptive definition. They may be represented by a symbol, have a ‘meaning’ in the frame of the context of use (*indicator concept*), and an operational definition. Each indicator may be calibrated by means of a norm to define semantics for the indicator values.

LOG FILE

A file containing a record of events (with timestamp) or actions (not necessarily with timestamp).

Note: Depending on the software generating the log file, you can find a description of the event/action and/or its contents, e.g. contents of chat messages are not usually recorded in the log file.

MONITORING

Regular collection, analysis and visualisation of information to assist timely decision making, ensure accountability and provide the basis for evaluation and learning.

REGULATION

The modification of the conditions of learning progress taking into account actors' activity.

Examples of regulation: mirroring, advising and monitoring.

Note: link between monitoring and regulation:

- monitoring is a part of regulation;
- monitoring implies that data are collected and analysed.

[1] Alexander, C., Ishikawa, S., & Silverstein, M. (1977). A pattern language : towns, buildings, construction. New York : Oxford University Press, 1977

ROLE

A set of tasks performed by one or more human or artificial agents according to specific needs and competences, e.g. designer, learner, teacher, scorer, tutor, mentor, etc.

SESSION

Period of time between two points in time.

Examples: course session, log session, etc.

STRUCTURED SET OF DESIGN PATTERNS

It corresponds to the historical definition of design pattern language: a set of patterns that work together to generate complex behaviour and artefacts.

TRACK (FILE) = TRAIL (FILE)

A file containing a record of a person's past performance. Log file (+ content file).

Note: in this definition, we consider that additional data are not trails.

USAGE PATTERN (= TRACKING PATTERN)

A pattern that describes a tracking problem.

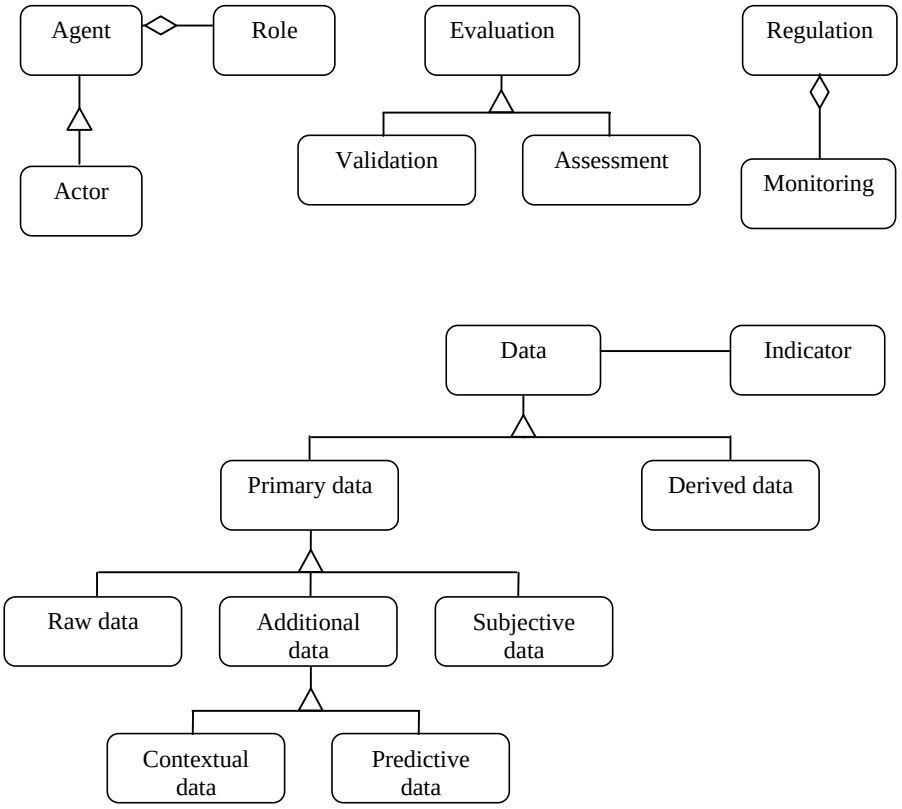
USAGE DESIGN PATTERN (= TRACKING DESIGN PATTERN)

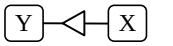
A design pattern to help designers solve tracking problems (described by a usage pattern): it describes how to collect, analyse and structure tracks.

VALIDATION

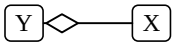
A procedure for checking and ensuring the validity of an artefact, a theory, a model, a method, or a hypothesis.

Example: to test whether a training program has succeeded in teaching what it set out to teach and whether this was a realistic training
need.

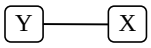




Generalization: X *is_a* Y



Aggregation: Y *has* X, X is *part_of* Y



Association (bidirectional)