Designing Competency Based e-Learning Initiatives

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Abstract: This paper deals with issues related to drowing up plans and putting into practice e-learning initiatives in complex and demanding businness environments such as organizations that require recurring training, to optimize their learning processes in terms of cost reduction and efficiency gains. We view the issue of initiating and executing such an e-learning initiative both by the "process" and "product" perspective.
Towards this end, our approach consists of conceptual tools and proposes a way of working supporting:

- Depicting and tracking personal competencies facilitating capturing of individuals' informal knowledge and implicit and explicit evaluation
- Providing dynamically optimal recommendations to learners for individual learning paths, learning content and learning programmes

We propose that in order to achieve competency based delivery of learning, solutions should imply a learner centric apprach taking under consideration the formal and informal knowledge that learrners posses. Going a step further, we present a first attempt of modeling the whole evaluation cycle from the initial set up of required proffesional profiles and how this is tied to a given work position, to the final optimal recommendations that a solution should provide/deliver based on personalised evaluation of the competencies that learner has achieved or he/she wants to obtain.

Keywords: Personalised learning, e-learning process, learning delivery

1. Introduction

This paper aims at providing an approach for facilitating the design process of mainly large-scale e-learning acts with the purpose of serving the requirements and needs of organizations with geographically distributed employees and short learning curves, for enhanced learning delivery based on the competencies that their employees posses as well as on the anticipated training level they need to obtain. Customized and track learning on individual participant basis, and flexibility greater than the one offered in traditional Learning is one of the major goals of our research.

We present a framework for supporting large scale e-learning initiatives in big distributed and highly demanding organisations by viewing the issue from two different perspectives:

- the "process" perspective: the initiative set-up and execution i.e. the way of working towards an e-learning initiative lifecycle (goal setting, requirements elicitation, analysis and design, implementation, feedback and so on)
- and the "product": the learning delivery to the final-users i.e. the final outcome of the process and its quality (personalized learning, quality of learning etc.)

The proposed framework will entail from the process viewpoint

- a set of well documented conceptual tools for the analysis of the professional knowledge and skills and of the production of professional profiles in the working environment for identified specialties.
- A consistent methodology for the evaluation and the professional improvement through educational processes, on the basis of the knowledge and skills of each employee, as well as
- A way of working for applying the proposed conceptual tools in real life projects,

while form the product viewpoint it tackles issues of personalised learning improved in quality.

Personalised learning will be achieved by enabling *efficient evaluation* of the employees using "traditional" evaluation techniques (on-line evaluation) as well as knowledge management techniques (tracing of learning behaviour patterns and informal knowledge) [Leo 1997], [Jimes 2003] This evaluation leads to the *definition of workers' basic deficiencies, as regards skills and knowledge* (*gap analysis*) in relation to a required professional profile for a given job-position. *The coverage of the detected deviations* will be supported by dynamic recommendations for the subsequent learning process progress [Petropoulos, Xini 2003]. Domain specific and language

independent taxonomies are defined and employed in order to map the training subject to the required job profiles that need to be obtained through the training sessions as well as for the appropriate recommendations, which will be dynamically directed to the learner.

The rest of the paper is organised as follows:
Section 3 presents the background of this research and the motivation we had for tackling competency based e-learning delivery.

In Section 4 we describe the learner centric approach for competency based learning delivery by defining the coresponding processes

Section 5 deals with the appropriate evaluation methodological framework for the evaluation of the knowledge and skills of the employees, adapted to the frame of individual companies' requirements.

Then section 6 goes in detail describing and sketching a conceptual architecture for the "product" perspective

Finally section 7 presents the conclusions drawn from the work presented and proposes topics and steps for remaining and future work.

2. Background

The motivation for the work described in this paper and the methodology that was developed came as a straightforward requirement from research and development projects in different market sectors that our company is involved in. The approach followed by many of our customers, medium or larger organizations, with respect to e-learning services targeted to their personnel is rather technology oriented, focused primarily on providing the necessary technology platform and ensuring participation of their employees - trainees. They rely heavily on the functionality and evaluation characteristics that proprietary solutions offer. This in turn yields a misconception of the derived training results as well as a lack of methodological tools in order to measure efficiency gains, cost savings, individual professional improvement, groups' performance enhancement, and organization advancement [Davenport, Prusak 1998].

Retroactive analysis of the different cases led us to establish a set of criteria for measuring the level of achievement of the objectives of a total competency based learning delivery solution from the perspective of personalized delivery of knowledge, human resources continuous evaluation, evolution tracking and improvement. This analysis was mainly based on the study of the deficiencies as well as the strong points of a variety of project cases.
The criteria set were:

- *Personalisation*: If the systems offer services of personalized learning, access to knowledge and the degree that the system offers these services. We also examine whether the system is in position to construct, maintain and update a personal learning profile in a formal way, which is going to be consulted every time a knowledge intensive task is performed.
- *Evaluation*: Whether the system offers explicit or implicit evaluation mechanisms (on line tests, quizzes versus tracking of behavior, intelligent mechanisms).
- *Evolution tracking*: With this criterion we examine whether the solution under consideration captures and measures the progress of the individual learner within the learning environment using a formal way.
- *Human Resources (HR) support*: This criterion is highly interconnected with the previous one, and it is defined for examining whether the e-learning solution is in position to provide valuable and exploitable information concerning the trainees (e.g. evaluation) as well as useful directions for HR development (identified gaps of the staff, suggestions for knowledge provisions-training, knowledge assets etc.)

3. Competency based learning delivery

We propose a learner centric environment as schematically represented in **Figure 1** below.:

In order to achieve dynamic evaluation of the employ's learning paths according to the skills he/she possesses and the required ones that are the actual target of the training, a learner centric approach is proposed comprising as building blocks four main elements:

1. *The existing profile of the learner:* It describes the employees' skills and current employment tasks
2. *The Required Profile:* It describes formally the skills that should be developed, enhanced or updated according to the training plan
3. *Explicit Evaluation Results:* These are the actual results that the employee

achieves through normal evaluation of tests and learning exercises

4. *Learning Behaviour Patterns:* These are the patterns that the employee generates in the learning process involved.

These four elements represent the corresponding conceptual entities that are captured and then processed in the proposed environment.

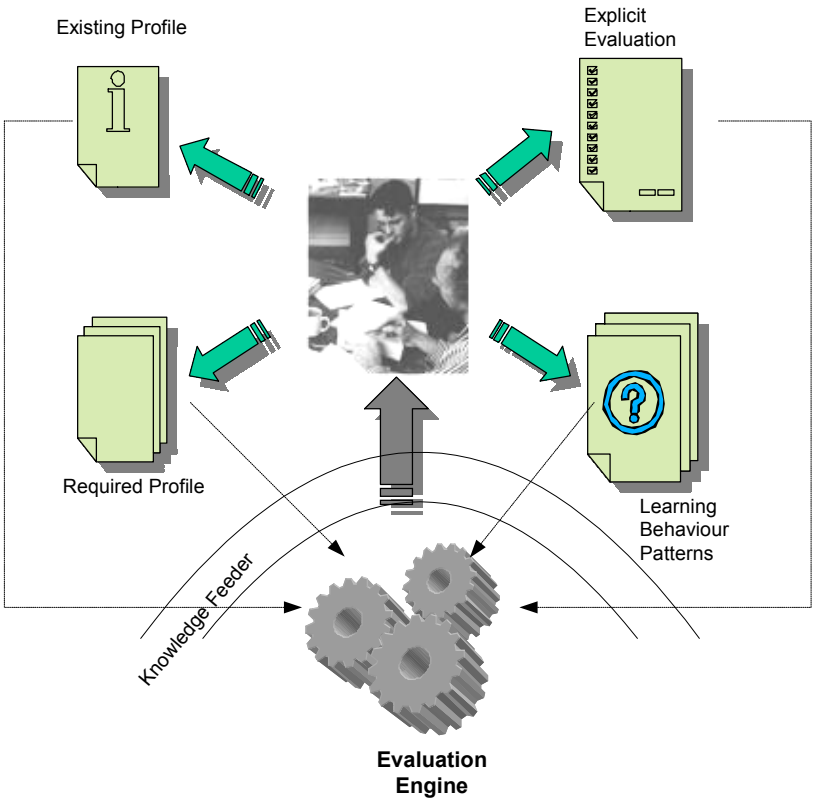

Figure 1: Learner centric approach

3.1 Process definition

Inititally, a sampling research is suggested with structured questionnaires and processing of the filled questionnaires for example through the use of multi-criteria analysis, in order to define the professional profiles [Siskos et.al. 2000].

The sampling research (apart from the general nature data) shall focus into two basic sectors:

- To the definition of general professional profiles, and
- To the evaluation and modeling of the human force on the basis of objective criteria

Collected data constitute the initial input and thet are then processed using the methodological approach of multi-criteria analysis for the assesment of criteria and indicators [Mendoza et.al. 1999]. This analysis supports the definition of the satisfaction indicators of the employees regarding their professional role, as well as their objective evaluation on the part of their companies.
With the aid of these indicators, the degree (grade) of overall satisfaction, and the satisfaction indicator of the individual factors are evaluated.

Given that the most important criteria for the placement and choice of personnel for the employers today are the “competence of knowledge”, and the “professional experience”, these elements should be verified, along with the degree of response to the market needs.

The collected and analysed data should be modeled to form the conceptual basis for susequent use. Several approaches may be employeed for the modelling task such as Enterprise Knowledge Development tools [Loucopoulos et.al. 1997].

Among the general professional profiles that are generated, some will be selected and adapted to the needs of the company in order to define the degree of compatibility with the

requirements of the market. These profiles are categorised based on the specialties that the learning initiative aims to train. In this way two different models for the selected categories of profiles are generated, consisting of characteristics, knowledge and skills for each selected professional specialty. These, we conventionally call «ideal professional profile» and «required professional profile» in contrast to the real professional profile of each employee and are both compliant with IMS Reusable Definition of Competency or Educational Objective RDCEO information model [IMS-RCDEO(a)2002]

The evaluation cycle starts on the basis of the detection of knowledge and skills of each employee (definition of the real professional profile) in relation to the required profile of its category. This evaluation constitutes the basic pre-evaluation for the classification of the employee in some professional profile. The procedure of the evaluation is implemented and ends up whether in the detection and certification of a gap between the required and real professional profile, or in the interruption of the procedure. The interuption occurs either in the case that the employee is considered insufficient in relation to the characteristics of his role and must be placed in another position, or in case the evaluation results show that the employee is under-employed in relation to his qualifications and possibly he must be granted a higher level of work.

The definition and analysis of the gap should be implemented continuously through electronic applications for evaluation, specialized data (positions requirements – position owners), processing of the data, informal knowledge tracing mechanisms (learners behaviour patterns, taxonomies, reasoning), classification of the data, grouping of the personnel according to the differences, representation of the results of processing and other similar techniques so as to produce utilizable and valid results.

The management of the differences that may occur, being positive or negative, will be conducted on the basis of the required professional role or the future professional improvement of the employee through the provision of training programmes. This training will aim to provide to the learner supplementary knowledge and skills in order to approach the required professional profile tailored for the respective job position.

The whole procedure should be manageable by a sufficient toolset, that does not only evaluate the present knowledge level of the employees, but also use knowledge management techniques in order to chose the most appropriate among the available training sources for the implementation of the required professional profile.

In this way a dynamic planning of an ad-hoc «personalized» program for the development of the human resources is generated. In turn, this leads to overall management of knowledge and skills, at the organisation level as well as at the level of the knowledge background of the employees, resulting to the faster and more effective coverage of the existing working positions, the rapid management of human resources and the more effective management of the professional evolution of the employees.

The overall procedure «closes» with the final evaluation, that will lead whether to the planning of future required professional characteristics of the employee, in case of success, or to the re-introduction of the employee in the process in case that the deviation between required and real professional profile persists.

In the frame of the previous analysis of the evaluation system, the following are involved accumulatively:

- Management of the data related to working position (role, tasks, actions, communications, demands, etc.).
- Management of the CV data and profiling data of the personnel (education, training, experience, skills) [EURES 2003].
- Definition of the gap between the present situation and the required one (as regards knowledge, experience and skills of human resources).
- Monitoring of the evolution / development of the human resources.

At the same time, the evaluation focuses also to the dynamic and effective management of parameters like:

- Classification of the training into categories and levels
- Training resources availability.
- Creation of training improvement programs by combining existing training units.
- Indicators of personal and professional satisfaction of employees and companies.

Having in mind the abovementioned data and in order to be able to implement the IT tools that can support the overall approach, the proposed actions are the following:

- Analysis of knowledge and skills according to the professional profiles selected
- Classification of knowledge in distinct parts of the knowledge subject
- Connection of skills with particular measurable results that the employee must achieve whether during the training or during work
- Creation of data collections with categories of questions, exercises, case studies and papers that will be presented or assigned to the employee according to the evolution of the training, during training
- Evaluation of the answers to the questions– exercises or the results achieved in case studies and work assignments
- Focusing on several questions categories, exercises categories, case studies and work assignments.
- Tracing and analysis of informal knowledge, i.e. knowledge not declared in the employees' formal CV.

The deducing mechanism of the proposed evaluation information tools will have input data derived from the training process of the employee, as well as data derived from his professional evolution and working and learning behaviour. Thus with the proper combinations it is feasible to define the level of knowledge and skills of the employee as compared to the required professional profile.

4. Evaluation methodology

4.1 Personnel' skills

The proposed approach uses a consistent methodological framework for the evaluation of the knowledge and skills of the employees-learners, adapted to the frame of individual companies' requirements. The framework provides the mechanisms enabling evaluation of the employees knowledge, and individualised paths for upgrading the knowledge and skills of the employees, according to the defined requirements of their professional role.

4.2 Gap analysis

An integral part of the methodology is based on the evaluation of the gap between the requirements of the role of the working positions and the competencies (knowledge, training, experience, skills) in workers occupying these working positions. This Gap Analysis leads to the following:

- Estimation of the degree of knowledge, experience and skills (competency analysis) of the workers in relation to the requirements of their role - job description and their objectives for personal evolution (within the working settings)
- Definition of the required education / training
- Monitoring of the learning process and the "behaviour" of the learner

4.3 Evaluation cycle

This information provides the specified approach of a dynamic adaptation of the employees to the requirements of their professional role and consequently of the more general management of learners' knowledge.

The described procedure is recursive, aiming, on the one hand, to the better utilization of the human resources on the part of the company and, on the other, to the global satisfaction of the employees purposes regarding their continuous professional improvement.

Finally, the total evaluation is conducted on the basis of three distinct but fully supplementary levels, i.e.: the employability of the employee, the satisfaction of the employee's goals in connection with his professional evolution derived from the attendance of the training program, as well as from the total evaluation of the employee and his professional evolution by the employer company.

Evaluation is divided in two categories:

Explicit Evaluation: These are the actual results that the employee achieves through normal evaluation of tests and learning exercises (LMS Evaluation tests, exercises, formal trainees' evaluation results etc.)

Implicit Evaluation based on the *informal* knowledge traced from his learning behavior and on-the job processes that he/she is carrying out, strictly related to the training subject (Learning Behaviour Patterns*)*.

Diagrammatically, the frame of Estimation and Evaluation of the Employees Knowledge and Skills is presented in **Figure 2**.

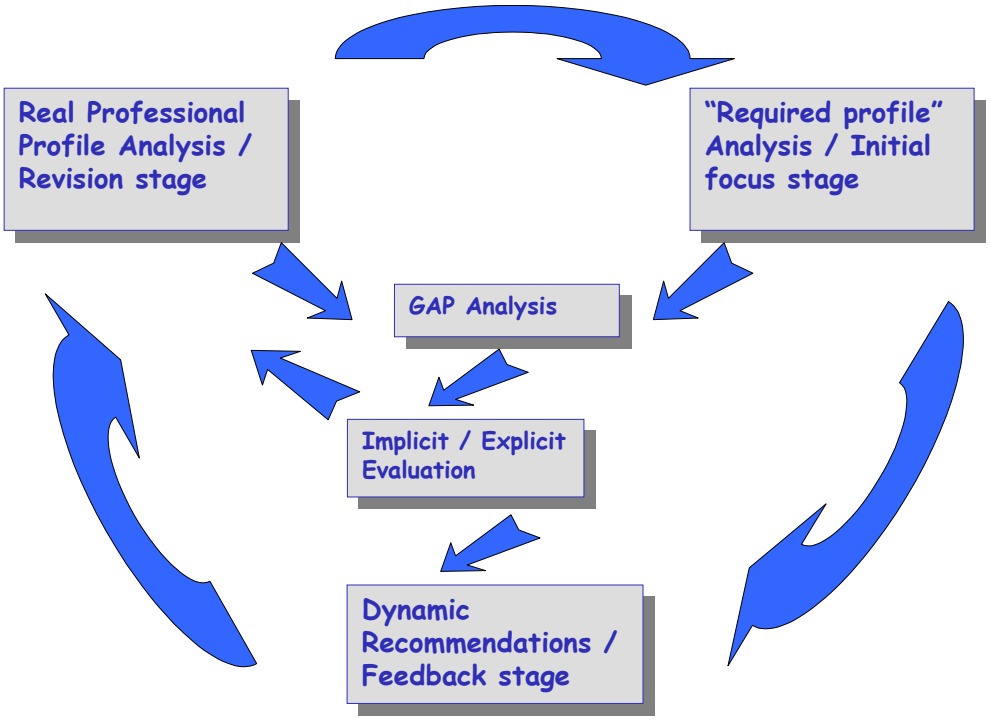

Figure 2: Employees Knowledge and Skills Evaluation Cycle

5. Conceptual architecture

The product perspective is assessed with a proposed conceptual architecture depicted in Figure 3. The conceptual architecture is an attempt to provide high-level view of an integrated solution that performs the required processes of the evaluation framework. It presents the main functional components that can achieve the competency based learning delivery to the end-users, the learners.

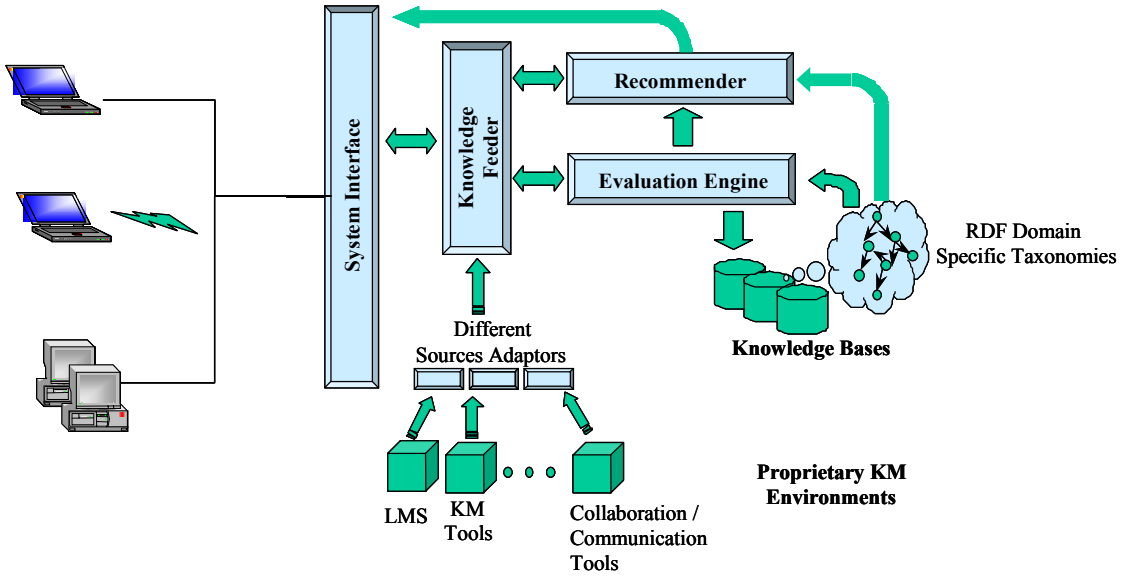

Figure 3: Conceptual architecture

Our approach considers a main precondition

- There are *Proprietary KM Environments* (PKME) in the target organisation, which usually play specific role in a training process. These can consist of Learning Management Systems, KM Supporting tools, Intranets, Organisations' file

servers, Communication and Collaboration tools, a combination of them and several other applications that the organisation may have in its possession. The data generated by these PKMEs may play significant role in the implicit evaluation of the learners' training process and usually are strictly connected with their tacit knowledge.

5.1.1 Sources adaptors

In order to trace the learners' behaviour during their training process, our approach considers all potential internal and external sources that the learner uses as the depicted *Proprietary KM Environments (PKME)*.

The PKMEs of an organisation used during a training process are generating data according to the learners' usage behaviour and their training patterns. Those data may well describe the tacit knowledge of learners generated through the training process and are considered as preliminary knowledge entities that need further processing in order to add value in the evaluation methodology.

The role of sources adaptors is to provide the appropriate interfaces for Knowledge Feeder in the process of collecting specific data related to learners training process strictly connected with their informal knowledge.

We differentiate between two types of sources with respect to the adaptors:

- proprietary applications/tools or content sources that comply with standards as for example a Learning Management System compliant with LIP standard that the organisation may possess [IMS-LIP (2001)].
- Applications or tools that may not be standards compliant, usually applications and tools developed in house or that serve individual and/or specific organisation's needs.

In the first case adaptors are set in order to collect data elements from PKMEs in a certain structure while in the second, adaptors have to be built in order to provide the relevant data in a specified standard compliant format.

5.1.2 Knowledge bases

These form an integral part of the proposed environment and are consisting of LMS repositories, Human Resources repositories, learning content repositories, competency/skills and other relevant RDCEO [IMS-RDCEO(a)] compliant repositories.

Moreover they are including registries that are used by discrete components in the form of native XML databases such as a registry for the publishing and description of Knowledge Feeder Web Services and the RDF registry for the Domain Specific Taxonomies.

5.1.3 Knowledge Feeder

The role of Knowledge Feeder is triple. It collects existing evaluation data, it collects learners' data from the knowledge bases and the most crucial it collects usage data from the PKMEs through the specific adaptors.
Knowledge feeder may consist of a set of Web Services for these three different categories and implements their choreography in order to provide the appropriate output to the Evaluation Engine.
It is the main component that interacts with the interface and interacts also bi-directionally with the Evaluation Engine and Recommender components.

5.1.4 Evaluation Engine

The Evaluation Engine forms the core engine of the environment. Its role is to provide implicit and explicit evaluation results according to the proposed evaluation methodology in a way that learning gaps and deviations from learning paths are identified in an adaptive and progressive manner. The evaluation engine implements the core algorithms for the evaluation process:

(i) It receives the test results, exercises and training performance evidence from the Knowledge Feeder and performs the explicit evaluation

(ii) It receives from the Knowledge Feeder data representing learner's behaviour and performs light reasoning with respect to the relevance/irrelevance of learner's behaviour patterns to the training subject. This is achieved by identification of Subject categories in these patterns and their mapping to predefined domain specific taxonomies. It proceeds with distance calculations and uses the outcomes for performing the learner's implicit evaluation.

(iii) It combines Implicit and Explicit Evaluation results with retrieved content from ad-hoc or existing competency/skills repositories and correlates with the required profile and/or the training subject goals.

(iv) It implements and performs the required Gap Analysis

The Evaluation Engine interfaces with Knowledge Feeder in order to get the appropriate input and also for calling specific Web Services needed during the Evaluation procedure

It provides as output to the Recommender component the Evaluation and Gap Analysis results.

5.1.5 Recommender

The Recommender component has the role to identify potential corrective activities that the learner should take in order to fulfil the training process goals.

It receives input from the Evaluation Engine and interfaces with the Knowledge Feeder for retrieving learning objects [ARIADNE 2003] and/or Internal or External Sources that have to be provided to the learner as a consequence of the Evaluation and Gap Analysis results. The identified internal and external sources are passed to the interface forming a close feedback loop for adaptive and progressive learning process assessment.

5.1.6 System Interface

The interface implements the learners' interface to the whole environment as well as it implements the service request client for the Knowledge Feeder Web Services

6. Conclusions and future work

In this paper we attempted to present a framework for supporting e-learning initiatives by viewing the issue from two different perspectives i.e. the "process": the project set up and execution and the "product": the learning delivery to the final-users. From the process viewpoint we suggested a way of working towards setting up an e-learning solution together with a set of conceptual tools in the direction of enhancement of learners profiling and feedback mechanisms in a recursive process. From the "product" viewpoint we proposed a conceptual architecture that takes advantage of informal knowledge tracing mechanisms, achieves enhanced evaluation and provides personal learning paths. While we attempt to provide a complete and integrated approach during our research several research issues have been raised which constitute the basis of further study, analysis and research. Such issues which are still open for research are: the approach for modeling professional profiles i.e. What makes a knowledge modeling approach appropriate for modeling such initiatives?; the mechanisms of tracing informal knowledge i.e. Is capturing of tacit knowledge feasible? How can we approach such a necessity?

We intend to apply the proposed approach in a series of ongoing related projects. These case studies will provide the evidence needed to evaluate the methodology per se and identify the potential for further improvement and advancements. Comparative results from different application domains may also provide insights for peculiarities and characteristics that exist in the individual learner's level and are totally hidden or difficult to extract when assessing a solution for a specific industry sector.

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