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# Pervasive Technology-Enhanced Learning System Integrating Working and Learning Situations

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**Abstract**— In the p-LearNet project, we are interested in TEL systems integrating context-aware corporate learning and working activities for e-retail (shops and hypermarkets). The main issues of the p-LearNet project are: work-integrated learning and customer learning support whatever the place, the time, the organisational and technological contexts of the individual or collective learning and working processes. We propose an adaptive and context-aware model of scenario based on an interdisciplinary approach (education, computer science, social sciences, and business) for a pervasive learning system supporting working and learning situations. This model enables us to choose how to achieve activities according to the current situation. The scenario model is based on a hierarchical task model having the task/method paradigm - methods define how to achieve a task.

*Pervasive Learning, Context-Aware, Adaptation, Task/Method Paradigm, Hierarchical Task Model*

## I. INTRODUCTION

Nowadays, technology-enhanced learning (TEL) systems must have the ability to reuse learning resources from large repositories, to take into account the context and to allow dynamic adaptation to different learners based on substantial advances in pedagogical theories and knowledge models [1]. In computer science, Lyytinen and Youngjin have defined the following terms: mobile, pervasive and ubiquitous [2]. Mobile computing is mainly about increasing our capability to physically move computer environment with us, by means of lightweight devices and/or access to computing capacity over the network. In mobile computing, the computing model does not really change while we move. It is an important limitation. In pervasive computing, computers have the capability to obtain information from their environment and use it to dynamically build models of computing. In other words, the computer is able to adapt its model of computing according to its environment. Thus, an important issue is the acquisition and management of a context model which describes the physical environment and the system goals. Ubiquitous computing integrates large-scale mobility with the pervasive computing functionality.

For TEL systems, several terms are used: pervasive, ubiquitous, mobile, ambient and nomadic learning systems. We

consider that these expressions are synonymous. They are used for highlighting a specific property in learning systems [3-5]. Generally, such type of learning systems used to have all properties of mobile, pervasive and ubiquitous computing. The main idea is to embed learning activities into everyday life or work by means of lightweight devices and network communications. Nevertheless, mobile, pervasive or ubiquitous learning is not just about learning using lightweight devices, but learning across context and are best viewed as mediating tools in the learning process [6]. Many definitions about these type of learning systems are given in literature [3, 5, 7, 8]. We can cite the following one: “*Pervasive learning environment is a context (or state) for mediating learning in a physical environment enriched with additional site-specific and situation dependent elements – be it plain data, graphics, information -, knowledge -, and learning objects, or, ultimately, audio-visually enhanced virtual layers*” [3]. In pervasive learning, some issues are as follows: combination of formal (at school) and informal (outdoor, at home, at workplace etc.) learning, integration of mobile devices in broader educational scenarios, combination of collaborative, mobile learning and inquiring learning, context-as-construct and seamless learning across different contexts [1, 6].

In the p-LearNet project, we are interested in TEL systems integrating context-aware corporate learning and working activities in a particular framework: e-retail (retail through shops and hypermarkets). The main issues of the p-LearNet project are: work-integrated learning and customer learning support, continuous professional training at workplace, professional learning whatever the place, the time, the organisational and technological contexts of the individual or collective learning and working processes context-as-construct and seamless learning. In this project, our corporate partnerships are international companies in the retails through shops and hypermarkets. The design and engineering of pervasive learning systems must be considered as an interdisciplinary problem requiring the integration of different scientific approaches from computer science, education, commerce, social sciences, etc. While learning focuses mainly on how to support individual’s and group’s learning process through the pedagogical guidance and how to enhance the learner’s knowledge. The workplace identifies the problems and requirements about quality and efficiency of information

and services to increase market share. Moreover, working activities are about solving tasks and particularly in knowledge-intensive organizations which implies continuous learning. Inexperienced persons learn from their experienced colleagues and they acquire the knowledge necessary to solve their work tasks. However, learning is a process that takes place mainly unconsciously. Solving the particular working tasks is prior - learning is just a means [9]. In such a framework, several innovative scenarios have been setting up according to two main learning and/or working situations for the seller and the potential customers as learners: i) Seller or customer, outside the shop counters: seller in the back office or storage areas, client at home or other place; ii) Seller in his department, alone or with a customer having resources from the Smart spaces surrounding them (large LCD screen, printers, RFID, etc.) [10]. Scenario analysis reveals that current learning and working situations could be modeled by an explicit task model partly because working and learning activities are well structured and stable. Activities, represented by tasks, cannot be achieved in the same way according to different situations. It is necessary to have a context-aware and adaptive mechanism to decide how to achieve an activity according to a given situation.

The main contribution of this paper is an adaptive and context-aware model of scenario based on an interdisciplinary approach (education, computer science, social sciences, and business) for a pervasive learning system supporting working and learning situations. This model enables us to choose how to achieve activities according to the current situation. The scenario model is based on a hierarchical task model having the task/method paradigm - methods define how to achieve a task. We defined a context model to deal with dynamic contexts - context-as-construct. The context-aware and adaptive process can be viewed as the selection of the relevant methods for a given task according to the current working and/or learning situation.

First of all, the context model and its organization are analyzed and explained. Secondly, we present our scenario model and its relationships with the context model. Thirdly, the context management, the detection and creation of new situations are explained. Fourthly, the adaptation process which links the context model, the scenario model and the context management is presented. Finally, the conclusion highlights the main results of this study and some perspectives.

## II. CONTEXT MODELING

There have been numerous attempts to define the notion of context in different fields. We only focus on definitions giving the relationships between the physical world and users' activity. We claim that activities embedded in a particular physical world (or environment) are key issues to give us intention and meaning according to different situations and finally to determine the relevant features describing the different situations. These definitions are as follows: « learning context is used to describe the current situation of a person related to a learning activity; in addition to attributes relying on the physical world model » [11]; « information and content in use to support a specific activity (being individual or collaborative) in a particular physical environment » [12].

In pervasive learning systems, a context model must consider a crucial context features: dynamic and/or "context-as-construct". According to Dourish, context can be viewed as an interactional problem: i) Contextuality is a relational property that holds between objects or activities; ii) The context is not defined in advance. On the contrary, the scope of contextual features is defined dynamically; iii) Context is an occasioned property, relevant to particular settings, particular instances of activities; iv) Context arises from the activity. Context cannot be separated from activities. It is actively produced, maintained and enacted in the course of activity [13]. In "Big issues in Mobile Learning", context is viewed as follows: "context-as-construct", i.e. "context should be reconceived as a construct that is continually created by the interaction of learners, teachers, physical settings, and social environments" and "learning not only occurs in the context, it also creates context through continual interaction" [1].

In retail framework, context is continuously produced during selling process: a seller can communicate with customers while revising his knowledge, checking the inventory or contacting the provider about products, etc. Our purpose is to enable learning scenarios in workplace on different mobile and ubiquitous devices to support learning and working activities. Our definition of context is not focus on static information. Instead, we pay attention to a mechanism that refines and generates dynamically context information following interactions for such learning situations in workplace.

### A. Context model

Our context model has to consider the context-as-construct property, the combination of formal (at school for professional) and informal (outdoor, at home, at workplace etc.) learning, the integration of mobile devices in broader educational scenarios, and the seamless learning across different contexts. Our context model is composed of: i) a set of dimensions  $D^c$ , defining a set of relevant features (represented as triplet) and their structure; ii) a set of Views  $V^c$ , a view consists of a subset of features which are relevant to a given content category (activity, resource, web service) for adaptation. Thus, an adaptation process does not manage the same features for different categories of content. For a given content category, its features and those of the corresponding view can be matched in the adaptation process; iii) a set of situations  $S^c$ , organized in historical dependencies. A situation is a partial instantiation of the context model consisting of the relevant features describing the current learning situation and its physical environment. A user activity can be influenced by his previous work and learning activities. As soon as a new situation is occurring, the next activity or the activity continuation can be chosen according to the historical dependencies, for instance to ensure seamless learning.

**Definition 1(Context model):** Let CM be a context model,  $CM = \langle D^c, V^c, S^c, P^c \rangle$ ,  $D^c$  be a set of dimensions  $D^c = \{d_1, d_2, \dots, d_n\}$ , where  $n$  is the number of dimensions and  $d_i$  is a context dimension;  $V^c$  be a set of different context views  $V^c = \{v_1, v_2, \dots, v_m\}$ , where  $m$  is the number of views,  $v_i$  is a context view. Each  $v_i$  represents a grouping of properties from different dimensions in term of their usage relating to a domain

type,  $S^c$  be a set of situations (or historical situations)  $S^c = \{s_1, s_2, \dots, s_p\}, \leq_s$ , where  $s_p$  is the current situation. A total order  $\leq_s$  on  $S^c$ , where  $s_i \leq_s s_j$  implies that the situation  $s_i$  precedes temporally the situation  $s_j$ ,  $P^c$  be a set of predicates that is used to manage situations including: the change, detection, creation, storage.

**Definition 2 (Context dimension):** Let  $d_i$  be a context dimension,  $d_i \in D^c$ ,  $d_i = \langle d_i^c, d_i^m, d_i^p \rangle$ ,  $d_i^c$  be a set of characteristics, each of them is defined by a name and a domain,  $d_i^m$  be a subset of context metadata associating to the dimension  $d_i$  that is used to manage the dimension  $d_i$ ,  $d_i^p$  be a subset of predicates, used for managing the dimension  $d_i$ . These predicates are using metadata in  $d_i^m$  and dimension characteristics in  $d_i^c$ .

The context dimensions are divided into two categories: abstract dimensions and atomic dimensions. An abstract dimension can be recursively decomposed into sub-dimensions which are abstract or atomic. An atomic dimension only consists of a characteristic set. Our context dimensions are the scenario (a hierarchal task model having a task/method paradigm), the user (a user can be a learner, a teacher, a salesman, a customer, etc.) with sub-dimensions: the role, previous knowledge, know-how, preferences, loyalty card, purchase intentions, intention of use), the retail shop, the device, the location, the time, the pedagogical tools, the network, the physical environment and the resource (learning object, services, media resource, system resource, etc.). The management of a context dimension (abstract or atomic dimension) is described by context metadata. It is a set of attributes used by predicates.

**Definition 3 (Context view):** A context view  $v_i = \langle D_i^{cv}, DT \rangle$ , where  $D_i^{cv}$  is a subset of properties formed by a regrouping of some dimensions or dimension characteristics in order to describe a viewpoint about the context usage relating to a particular domain type  $DT$ ,  $D_i^{cv} \subseteq D^c$ .

Context views are used to define different viewpoints about the context usage. Consequently, different adaptation categories and seamless learning strategies are specified accordingly. At present, we focus on two views: pedagogical context view and professional context view (cf. Table 1). The pedagogical view represents context for learning activities, the professional view represents context for working activities in workplace.

TABLE I. A SHORT DESCRIPTION OF CONTEXT VIEWS

Context views	Attributes
Pedagogical context view	{user(role, knowledge, how-know); learning collaborator; scenario (learning activity); pedagogical tool; learning objects; learning location; time} {device (PTA, RFID tag reader, large LCD screen); network (network type, bandwidth); system resource; physical environment (temperature, noise level); location; time}
Professional context view	{user(role, preference, loyalty, purchase intentions, intentions for use); organisation unit; professional collaborator; scenario (working activity); resources; working location; time} {device (PTA, RFID tag reader, large LCD screen); network (network type, bandwidth); system resource; physical environment

(temperature, noise level); location; time}
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### B. Pervasive learning situations in workplace

A learning situation in workplace is composed of the physical environment, learning and commercial setting of the user's current work situation. Several context dimensions are combined together to describe different pervasive learning situations. In a company, a learner used to work and sometimes learning and working are interweaved in a pervasive environment. A substantial part of learning does not happen during the training but during working activity performance. Learning and professional activity support must be integrated. The learning system must overcome three main obstacles: time pressure, inadequate learning support in the working context and cognitive and structural disconnection between work, knowledge, and learning [9].

In retail shops, a seller equipped with a PTA (Personal Training Assistant) close to shelves (without a customer) can revise his knowledge about products or can continue his previous learning activity to improve his/her knowledge or he/she can verify the product's labeling or access to product information. During the selling process or the selection / decision phase, the seller can use his/her mobile device for both revising his/her knowledge about products and selling characteristics or as a coach to help him/her, etc. According to the current and past user activities, the learning system has to select the relevant way to achieve the current activity, the resources and the web services according to context changes. Moreover, the current status of activities, suspended or unfinished in the past, need be restored to ensure the seamless learning and working. The relevant activities and resources can be provided to the user according to the current user's work situation. In a formal way, a definition of the situation is given as follows:

### Definition 4 (Situation)

Suppose  $s_i$  is a pervasive learning situation in workplace,  $s_i = \langle (e_{i1}, e_{i2}, \dots, e_{ik}), t_i^s, t_i^e \rangle \in S$  defines a complete context state associating to all interactions between the user and the learning system in workplace in a given time interval. It is specified temporally with a starting time  $t_i^s$  and an ending time  $t_i^e$ .  $e_{ij}$  is a dimension characteristic in  $s_i$ . It is acquired as follows: automatically detected by the learning system or gathered from interactions between the user and the system or dynamically inferred or generated by the learning system (based on inferences or adaptation rules defined in the adaptation model).

Our context model is represented by ontology. A situation and its historical dependencies are used to select and/or to continue an activity by means of a scenario model.

## III. SCENARIO MODEL

In our framework, the goal of scenarios is to describe the learning, working and tutoring activities to acquire some knowledge domain and know-how to solve a particular problem or to support working activities. A scenario may depend on several dimensions which describe different learning and working situations: the learning domain (course

topic), the learner (his know-how and knowledge levels), the tutor/teacher, the learning, working and tutoring activities (their typology, organization and coordination), the resources (documents, communication tools, technical tools, etc.), the activity distribution among learners, teachers and computers, the learning “procedures” according to a particular school or corporate.

The main role of a scenario model is to integrate mobile devices in broader learning and working scenarios, formal and informal learning and to enable us to manage seamless learning across contexts. Scenario analysis reveals that current learning and working situations could be modeled by an explicit task model partly because working and learning activities are well structured and stable. Several research studies in artificial intelligence focus on the hierarchical task model using the task/method paradigm [14-16]. In learning environment, hierarchical task models were also used for designing, for instance, authoring tools [17], learning systems [18-20]. The mechanism of hierarchical and recursive decomposition of a problem into sub-problems is one of the basic characteristics of the hierarchical task model [14-16].

In pervasive learning systems, activities cannot be achieved in the same way according to the different situations. It is necessary to have a context-aware and adaptive mechanism to decide how to achieve an activity according to a given situation. In the MODALES project, an adaptive and context-aware model of scenarios has been successfully proposed and implemented; it is based on an interdisciplinary approach (didactics, physics and its epistemology, computer science and education), a particular teacher community of practices and a hierarchical task model, having the task/method paradigm [21]. In such a framework, an activity is represented by a task having several associated methods. A method represents a way to achieve a task in a particular situation. This hierarchical task model has been reused and modified according to our new requirements.

### A. The task/method concept

Within the framework of the Task/Method paradigm, tasks represent activities and sub-activities managed by a knowledge-based system. A method describes how a particular task can be achieved. There exist two types of tasks: abstract task and atomic task. An atomic task is not composed of sub-tasks. It can be achieved by a simple procedure defined into a method. An abstract task represents a high level activity composed of sub-activities. A method defines how an abstract task is composed of sub-tasks which can be abstract or elementary tasks. Methods define the control structure which allows the recursive decomposition of tasks into sub-tasks and the control structure defines sub-task order at runtime. For a given task (abstract or atomic), several methods can be used for achieving it.

Methods are described by a context descriptor and an achievement descriptor. A context descriptor is dedicated to adaptation - selection of relevant methods. It is composed of a property set according to the corresponding context view (i.e. professional or learning activity). An achievement descriptor defines how to achieve the corresponding task. This descriptor

consists of one or several structures among the following four structures: i) the control structure defines how an abstract task can be composed of sub-tasks by means of operators. At present, three different operators are used: sequence, alternative and parallel; ii) the content requirement specification identifies how relevant resources are selected for the current task and situation; ii) the service requirement specification describes how to assemble relevant services (or web services) to achieve the current task <sup>1</sup>; iv) a procedure/function specification defines how to execute a simple procedure or function, which is either automatic (executed entirely by the system) or interactive (human computer interaction: interaction between the user and application or between two users via an application).

### B. Learning scenario for workplace

Pervasive learning scenarios in workplace are modeled by a hierarchical structure of tasks/methods representing learning and working activities. For a complete presentation and execution of the scenario, another category is needed: mixed activities. Thus, working and learning activities are represented by working, learning and mixed tasks. In Figure 1, the context descriptor and the control structure of some methods are represented for different categories of tasks.

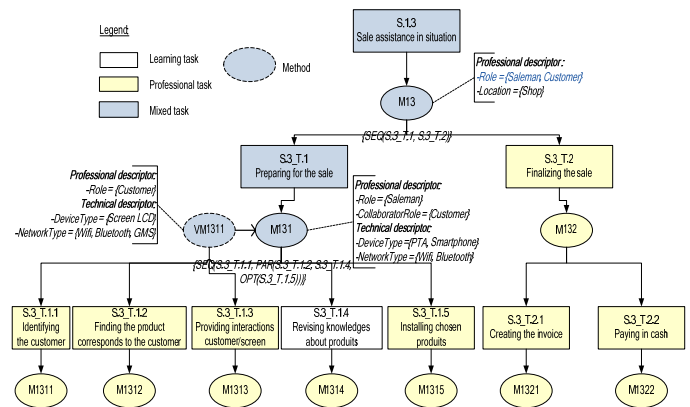


Figure 1. A small part of the e-retail scenario

A learning task represents a learning activity. It is a learning activity or a learning activity supporting a working situation. The latter aims at supporting the user to reach the working objective and to improve his/her knowledge and how-know about the domain. The selection of the relevant method to achieve the corresponding task takes into account the pedagogical context view. A working task represents a working activity that the user can perform in his professional environment. An abstract working task is maybe achieved by several working sub-tasks. It can be considered as a sub scenario that can be modeled independently. An atomic working task is the smallest unit of work. The selection of the relevant method to achieve the corresponding task takes into account the pedagogical context view. A mixed task is an abstract task which is composed of learning and working sub-tasks. The goal is to mix tasks of the two categories to support a high level activity in the learning scenario. To select a

<sup>1</sup> Context and service requirements are out of the scope of this paper.

method in a given task, the corresponding context view and the context descriptor are compared.

#### IV. CONTEXT MANAGEMENT

To solve complex and dynamic context changes and demands of situated learning, the learning system detects the situation changes. The context management process generates a new situation or updates the current situation for maintaining the activity relevance and continuity. This process is divided into four main steps: i) Stage 1: Context change detection and aggregation: this step determines context changes and check whether these changes leads to the creation of a new situation or an update of the current situation. The changes can come from collaborators (colleagues) or customers or tutors or learner - user interactions, location, network, device, time, scenario, etc.; ii) Stage 2: Gathering of the initial context information for creating the new situation, this is done by a partial or complete copy of the last situation and/or by querying the context ontology; iii) Stage 3 – Selection of the current task: the last task status can be restored in the new situation to ensure seamless learning and working based on the historical dependencies of situations. When the last task is finished, the next one is selected according to the current scenario and the historical dependencies of situations. When the last task is not finished, it is necessary to continue it; iv) Stage 4 – Searching for the relevant couples (Task, Method): According to the current situation and the task, the adaptation process has to select the relevant methods. The main role of the adaptation process is to maintain consistency between the learning system, the physical environment and the current learning or working situation and also to ensure seamless learning and working.

#### V. ADAPTATION

The fundamental issue in a pervasive learning environment is how to provide learners with the right learning content at the right time in the right way. Thus, adaptation is mandatory to all types of learning activities in pervasive learning environments [7]. At present, we focus on adaptation mechanism dedicated to scenarios: how to achieve an activity according to the current situation, or in other words how to select the relevant methods pour a given task. On other words, the learning system has to select dynamically the relevant way to achieve the different tasks included in a scenario. The main issues are seamless learning and working and the management of dynamic adaptation. Our current scenarios are not sufficiently detailed to enable us to define accurate strategies to deal with seamless learning and working. Thus, we mainly focus on the management of dynamic adaptation. As the context is dynamic, it is not possible to know in advance how the next situation will be structured. In other words, it is not possible to anticipate the set of features composing the different situations. For managing adaptation, it is necessary to trigger rules using the context descriptor of methods which are defined a priori and the set of situation features which can be unexpected – not known in advance. Consequently, it is not possible to define rules for each possible configuration of features in a situation. As in Mobilelearn European project [22], we associate specific metadata to situation properties and/or dimensions for managing adaptation.

Situation features are divided in to two categories: permanent and transitory. Features describing scenarios and users used to be available in all situations. They are permanent features in a situation. Thus, it is possible to manage them as usual because they are known a priori. Other features are transitory. For them, it is necessary to analyse how each property contributes to content adaptation – method selection - differently according to its role in the adaptation process. Some of them are used to filter the content while others are used to rank or annotate it – filtering, ranking and annotation are adaptation techniques. For instance, learning and working methods can be filtered according to learning places or used devices while it is annotated according to user’s knowledge, know-how or preference). As soon as features are used to filter learning and working methods, it is easy to manage them. In other words, a present transitory feature can filter or not a method; the method is eliminated or not. At present, all transitory features of learning and working methods are used to filter. Nevertheless, we shall have to investigate in depth this issue according to more detailed scenarios in future.

##### A. Adaptation Model

Our adaptation model is composed of several adaptation categories, a set of adaptation techniques, a set of equivalent classes and their membership rules. An adaptation category is defined by a content type (resource, web service or method) and a context view. For instance, we divide method adaptation into two categories: one is related to learning context view and another is related to professional context view. For a given adaptation category, methods – content – is classified in several equivalence classes – at least two classes, up to five classes {“Very Bad”, “Bad”, “To Consider”, “Good”, “Very Good”} – according to all permanent situation features. Equivalence classes are mutually exclusive and totally ordered. An equivalence class contains a set of membership rules which define necessary and sufficient conditions to check method membership. Rules are declarative predicates using the current situation and the method context descriptor. For each transitory feature, methods are classified into two classes {“Good”, “Bad”}. For example, the classes {“Good”, “Bad”} are associated to the location dimension while the classes {“Very Bad”, “Bad”, “To Consider”, “Good”, “Very Good”} are associated to the user’s knowledge sub-dimension.

The adaptation technique defines the technique used for adaptive navigation in our framework. It is sorting, hiding, annotation, direct guidance techniques found in Adaptive Hypermedia field [23]. An adaptation technique can be chosen for an adaptation category at runtime or a priori.

##### B. Adaptation Principles

Adaptation process in SCARCE is specified for a resource type and an adaptation category. It consists of three stages: i) Classification: content is classified according to the current situation in several equivalence classes: two classes {“Good”, “Bad”} for each transitory feature and up to five equivalence classes for all permanent situation features, together. The content belongs to an equivalent class if it satisfies its membership rules; ii) Filtering: all contents belonging to “Bad” classes according to a transitory feature are filtered. In other

words, these contents are discarded. For example, with the network dimension, the class “Good” is considered as relevant while the class “Bad” is not. So that the system will eliminate all content that belongs to the class “Bad”; iii) Adaptive navigation: an adaptive technique can be chosen by the system or by the user according to an author decision. All methods belonging to the same equivalence class are treated in the same way. Annotation and sorting are process according to the total order of equivalence classes. For hiding, only methods belonging to the class “Good” are kept.

## VI. CONCLUSION

We have proposed an adaptive and context-aware model of scenario based on a hierarchical task model having the task/method paradigm - methods define how to achieve a task - for a pervasive learning system supporting working and learning situations. This model enables us to choose how to achieve activities according to the current situation. In other words, the relevant methods are selected dynamically according to the current situation. Integration of mobile devices in broader learning and working scenarios, formal and informal learning and management of seamless learning across contexts has been achieved by means of the scenario model and the adaptation process in using the context model. Our context model and adaptation process is able to manage to deal with dynamic contexts - context-as-construct – and seamless learning and working across contexts. These issues are managed in a limited way. Thus, our current scenarios are not sufficiently detailed to enable us to define accurate strategies to deal with seamless learning and working. Our context and scenario models have necessary properties to managed seamless learning (situation and its historical dependencies). We need investigate in depth our scenarios to establish rules able to manage seamless learning. As our scenarios are limited, we also have to study in depth our adaptation policies to manage dynamic context.

## REFERENCES

- [1] N. Balacheff, "10 issues to think about the future of research on TEL," *Les Cahiers Leibniz, Kaleidoscope Research Report*, 2006.
- [2] K. Lyytinen and Y. Yoo, "Issues and challenges in ubiquitous computing," *SPECIAL ISSUE: Issues and challenges in ubiquitous computing*, vol. 45, 2002.
- [3] J. Hundebol and N. H. Helms, "Pervasive e-Learning - In Situ Learning in Changing Contexts," 2006.
- [4] M. Sharples, "Learning As Conversation: Transforming Education in the Mobile Age," in *Proceedings of Conference on Seeing, Understanding, Learning in the Mobile Age* Budapest, Hungary, 2005, pp. 147-152.
- [5] T. Siobhan, "Pervasive Scale: A model of pervasive, ubiquitous, and ambient learning," in *An International Workshop on Pervasive Learning, in conjunction with Pervasive 2007*, Toronto, Ontario, Canada, 2007, pp. 10-18.
- [6] M. Sharples, "Big Issues in Mobile Learning: Report of a workshop by the Kaleidoscope Network of Excellence Mobile Learning Initiative.," LSR1, University of Nottingham 2006.
- [7] B. Bomsdorf, "Adaptation of Learning Spaces: Supporting Ubiquitous Learning in Higher Distance Education," in *Mobile Computing and Ambient Intelligence: The Challenge of Multimedia*, Dagstuhl Seminar Proceedings, 2005.
- [8] V. Jones and J. H. Jo, "Ubiquitous Learning Environment: an Adaptive Teaching System using Ubiquitous Technology," in *ASCILITE*, Perth, Australia, 2004, pp. 468-474.
- [9] J. Farmer, S. N. Lindstaedt, G. Droschl, and P. Luttenberger, "AD-HOC - Work-integrated Technology-supported Teaching and Learning," in *5th conference on Organisational Knowledge, Learning and Capabilities*, Innsbruck, Austria, 2004.
- [10] A. Derycke, V. Chevrin, and T. Vantroys, "P-Learning and e-retail: a case and a flexible Software Architecture," in *Pervasive Learning 2007, an International Workshop on Pervasive Learning*, Toronto, Ontario, Canada, 2007, pp. 43-50.
- [11] M. Derntl and K. A. Hummel, "Modeling Context-Aware E-learning Scenarios," in *Pervasive Computing and Communications Workshops, 2005. PerCom 2005 Workshops. Third IEEE International Conference on*, 2005, pp. 337-342.
- [12] A. Kurti, M. Milrad, F. Alserin, and J. Gustafsson, "Designing and implementing ubiquitous learning activities supported by mobile and positioning technologies," in *the Ninth IASTED International Conference computers and Advanced Technology in Education*, Lima, Peru, 2006, pp. 193-199.
- [13] P. Dourish, "What we talk about when we talk about context," *Personal Ubiquitous Comput.*, vol. 8, pp. 19-30, 2004/2// 2004.
- [14] F. Trichet and P. Tchounikine, "DSTM: a Framework to Operationalize and Refine a Problem-Solving Method modeled in terms of Tasks and Methods," *International Journal of Expert Systems With Applications, Elsevier Science*, vol. 16, pp. 105-120, 1999.
- [15] B. Wielinga, W. V. d. Velde, G. Schreiber, and H. Akkermans, "The KADS Knowledge Modelling Approach," in *Proceedings of the 2nd Japanese Knowledge Acquisition for Knowledge-Based Systems Workshop*, R. Mizoguchi and H. Motoda, Eds. Hitachi, Advanced Research Laboratory, Hatoyama, Saitama, Japan, 1992, pp. 23-42.
- [16] J. Willamowski, F. Chevenet, and J. M. François, "A development shell for cooperative problem-solving environments," *Mathematics and computers in simulation*, vol. 36, pp. 361-379, 1994.
- [17] M. Ikeda, K. Seta, and R. Mizoguchi, "Task Ontology Makes It Easier To Use Authoring Tools," in *IJCAI*, 1997, pp. 342-351.
- [18] M.-L. Betbeder and P. Tchounikine, "Structuring collective activities with tasks and plans," in *IEEE International Conference on Advanced Learning Technologies (ICALT'2003)*, 2003.
- [19] C. Choquet, F. Danna, P. Tchounikine, and F. Trichet, "Modelling Knowledge-Based Components of a Learning Environment within the Task/Method Paradigm," in *Intelligent tutoring Systems, ITS'98*, San Antonio (USA), 1998.
- [20] C. Ullrich, "Course generation based on HTN planning," in *Proceedings of 13th annual Workshop of the SIG Adaptivity and User Modeling in Interactive Systems*, J. A. and B. B., Eds., 2005, pp. 75-79.
- [21] J. L. Tetchueng, S. Garlatti, and S. Laubé, "A Context-Aware Learning System based on generic scenarios and the theory in didactic anthropology of knowledge," *International Journal of Computer Science and Applications*, p. Volume V, Issue I, pp 71-87, 2008.
- [22] P. Lonsdale and R. Beale, *Towards a dynamic process model of context*. To appear in Proceedings of Ubicomp 2004 workshop on Advanced Context Modeling, Reasoning and Manage, 2004.
- [23] P. Brusilovsky, "Adaptive Hypermedia," *User Modeling and User-Adapted Interaction*, vol. 11, pp. 87-110, 2001.