An Instructional Design Process for Creating a U-Learning Ecology

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***Abstract*—The ubiquitous computing (UbiComp) is considered as an extension of the computational capabilities of the physical environment, allowing the computational structure to be present everywhere in the form of small, robust, networked processing devices distributed at all scales through everyday life and generally turned to distinctly common place ends. There are various research challenges regarding the design and use of instructional design tools in complex learning contexts such as Ubiquitous Computing, Mobile learning (m-learning) and Internet of Things (IoT), the technologies defined as UMI technologies. This paper presents the rationale, important issues and methodology constructed in the context of UbiComp so as to initially define an instructional design process for building a U – Learning Ecology for multidisciplinary education. We provide a consistent framework and structural view of integrating instructional design principles in UbiComp learning: we discuss our ideas on the design of a U-learning ecology by the gradual building of a robust design process and we provide an overview of our ongoing work on design/analysis tools supporting early stage prototyping for using UMI technologies.**

Keywords—U-learning, Internet of Things, instructional design, innovation, learning ecology

I. Introduction

The Internet of Things (IoT) is defined by International Telecommunication Union (ITC) and European Research Cluster in the Internet of Things (IERC) as a dynamic global network infrastructure with self-configuring capabilities based on standard and interoperable communication protocols where physical and virtual "things" have identities, physical attributes and virtual personalities, use intelligent interfaces and are seamlessly integrated in the information network. Significant business decisions have been taken by major ICT players like Google, Apple and Cisco to position themselves in the IoT landscape. Not only the assimilation of ICT concepts and its constituencies are pivotal but also integrating them in smart environments and ecosystems across specific application domains, in the sense of paving to new ways of interacting, working and living. With the advent of smart devices, learning with IoT in an array of subject domains, seems unavoidable for future generations: under this scope the need to design and develop instructional tools and processes that adapt to the complexity of UMI technologies, emerges as an extremely important challenge. Instructional design is a system of developing well-structured instructional materials using objectives, related teaching strategies, systematic feedback and evaluation [1]. Building on these concepts of IoT and instructional design principles, our aim is to introduce the term *learning ecology* as a conceptual basis for describing processes, relationships, context and interaction in learning opportunities with IoT, to construct a U-learning ecology. For that purpose, we present characteristics of U-learning, arguing for the innovative components of a learning ecology structure and how these could be encapsulated in the proposed instructional design process for delivering learning experiences. Section II presents important issues in UMI technologies, disputing on constructing a U-learning structure through the use of the metaphor of *learning ecology*. Section III presents the methodology proposed for designing the instructional design process for U-learning. Section IV presents empirical evidence of instructional design process implementation as well as the evaluation framework for the present research scheme. The research questions of this paper are: a) which are the basic components of an instructional design process for developing a U-learning ecology, and b) which are the basic steps for constructing an instructional design process methodology for U-learning ecology.

II. U-Learning: Challenges and Drawbacks

A. *U–Learning: Features and Added Value in a New Learning Era*

UbiComp has been proposed by Mark Weiser [2] as a direction for the development of computing technology for the

21st century and comprises guiding principles, proposals for a computing infrastructure and scenarios. This immersion of computers in the background *"into the fabric of everyday life until they are indistinguishable from it*" [p.94] would make information technology achieve its real potential: its potential for revolutionary transformation of everyday life. Learning with the technology immersed in the background should be understood in two different but related senses: first, it means the physical integration of computing technology into the world by embedding into tools, things, tasks and environments. But second, this embedding has to be accomplished in a way that the computerized tool or thing does not "interfere" with the activities in which it is used. In their dealings with their world, humans are primarily engaged in "works" or activities. The IoT – which connects, people, processes, devices and data- enhances the volume and value of the information collected during the learning process, allowing educators and administrators to turn data into actionable insight. Capturing, managing and analysing big data collected by the use of multiple devices and processes in an IoT learning context results in the dynamic creation of *asset intelligence* [3]: a real time view of students, staff and assets. By leveraging asset intelligence, institutions can improve educational outcomes by providing richer learning experiences and by gaining real time, actionable insight into students' performance. The use of wireless devices enables on line lesson plans and scenarios that have the potential to feature highly engaging interactive content. With e-learning applications in a UMI context, learners can work at their own pace while assessment can become more seamless, less manual and time intensive. Educators spend time focusing on learning activities that have the greatest impact of students. With mobile computing solutions operational roadblocks can be dealt with in real time. Educators can monitor the condition of their resources in real time, so if there is need, items can be replaced with minimal disruption of the learning process. Tracking devices can ensure that students are accounted for in real time, minimizing time consuming activities like recording attendance. In addition to these immediate benefits, educational institutions can harness long term value from these technologies by analysing the resulting data to better plan resource allocation, curricula and safety procedures in the years to come. Facilitation of tasks' performance supported by this technology, contributes to its widespread propagation so that computer access will penetrate all groups in society: learning becomes seamless while the use of technology brings to fore new *"properties, contributing to invisible enhancing the world that already exists"* [p.97].

B. Design Issues: Constructing the U-Learning Ecology

The complexity of building a learning environment based on IoT technology imposes the alignment with pedagogical and learning schemata that are structured, however flexible enough to allow for differentiation in time and space during the learning process: *anytime anyplace* learning as defined by IoT paradigm implies a new dynamic in the learning process. For that reason we have selected the term *"learning ecology"* [4] to start shaping a U-learning environment through the proposed instructional design process described in the later sections of the paper. The ecological metaphor has been applied to many contexts and is well suited to human interactions between people and environment, their process for learning, doing and achieving and for *developing new knowledge in ill-structured contexts.* An individual's learning ecology comprises processes, set of contexts, relationships and interactions that provide opportunities and resources of learning, development and achievement. Each context summarizes a unique configuration of purposes, activities, material resources, more relationships and interactions as well as the mediated learning that emerges from them. Learning ecologies have *temporal dimensions* as well as *spatial dimensions*: they provide the framework to connect different spaces and contexts existing simultaneously across a person's life course as well as different spaces and contexts existing through time throughout their life course. According to Siemens [5] *learning ecologies* are: a) adaptive, dynamic and responsive, b) chaotic, c) self-organizing and individually directed, d) alive, e) diverse, f) shaped by structured informality, g) emerging. However, learning ecology also emphasizes what happens also in that space: "the set of contexts found in physical or virtual spaces that provide opportunities for learning … each context is comprised of a unique configuration of activities, material resources, relationships and the interactions between them" [5, p.9]. A *learning ecology as a social technical network* is described by saying what's going on, what's and who is participating and how one on –going process, actor or artefact is interdependent with another. Important aspects also in the learning ecology context, along with time and space are *affordance networks* which are functionally bound in terms of facts, concepts, tools, methods, practices, commitments and people that can be enlisted towards a particular goal. Personal learning ecologies are created within social learning environments and contexts. In these ecologies, the social-cultural arrangements of processes and artefacts and the ecosystem of environmental processes are treated as a single unified system. Also the semiotic practices are regarded. Actions and activities have to be planned and choices have to be made about what to do, effects have to be observed and actions have to be modified in response to what happens. Action in a learning ecology context is the process of engaging with emergent problems in real time, the structuring of the environment to create resources of learning, the adaptation and transfer of ideas to new contexts, the use of repertoire of communication and inter-intrapersonal skills to achieve a goal, the juggling and prioritizing of numerous tasks and the nurturing of relationships. In using UbiComp for learning an existing pattern emerges: each possibility carries with it a displacement, transformation, substitution, or loss of fundamental properties of aspects of the "world" in such a way that its otherness is increasingly eliminated. Seeing also the big picture, making sense of what has happened draws deeper meanings of the learning experience, intriguing reflection. Acting and performing are related with the structuring of the environment to create resources of learning, intra personal skills to achieve a goal and, complying with concepts such as capacity and standards. In order to fit into all the diversity of everyday life environments so as to subsequently fade into the background the components of this technology must take on a variety of *sizes, shapes and* *functionalities.* Fig.1 presents an initial schema of the proposed U-learning ecology:

Fig. 1. The proposed U-learning ecology

The design and placement of devices in an UMI ecology have to be conceived according to users' tasks and the context of interaction, as happens for context aware applications where devices can both sense and react based on the environment [1]. Under this scope, computation cannot be localized in a single point but it is extended to different spots of the real world settings. Technologically enhanced spaces are a manifestation of this concept of ubiquitous environments. They are physical spaces where the affordances of physical objects are augmented with digital capabilities, thus creating an ecology of heterogeneous network devices: *device ecology* is the word used in the literature to define such collection of different devices with relationships among each other [4]. Following the same rationale, toolkits for ubiquitous interaction might help designers in the development of novel systems, especially in the context of where not only the software interface matters, but also the hardware component is important: "there will be a great variety of shapes, sizes and input-output designs in new devices … much of the user interface will be built into the hardware itself, such as the physical buttons and switches ... therefore the designers have to take into account not only the software but also the physical properties of the devices and their capabilities" [4, p.7]. As a learning ecology is a living system it contains a diversity of factors that interact with each other organically: these factors interrelate and function in a nested manner, in a variety of levels: *the micro, meso and macro level.* The micro level entails the learner's immediate environment, defined by individual situations and the ways learners respond to this. The meso level encompasses the interrelations between two settings, for example between life experiences and the educational content, based on organized activities at which tools and guidance are provided, The macro level, entails the wider society with socio-economic and cultural contexts, policies and strategies that support lifelong development.

C. Instructional Design Processes and Models

Instructional design models can provide a systematic approach of implementing the instructional design process for specific educational initiatives [6]. There is a wide variety of instructional design models describing the ID process created for different situations and settings. These models can function as visual and communication tools to help conceptualize complex schematics or instructional design processes along with how the various stages of elements relate to each other. The application and value of a model is dependent on the instructional situation, problem or task. Most ID models bear the conventional core elements of analysis, design, development, implementation and evaluation also known as the ADDIE model [7]. Sub-phases of this instructional design model have been followed in the sense of building a methodology for an instructional design process on U-Learning ecology. These sub-phases are presented as follows:

- Creation of instructional goals according to U-learning situations.
- Identification of learners' prior skills, knowledge and attitudes.
- Identification of learning objectives.
- Identification of pre instructional activities, content presentation, learner participation.
- Selection/development of instructional material.
- Design formal evaluation.

U-learning ecology implies the schema of a complex both technologically and socially learning structure, further elaborated by the components of learning ecology as presented in Fig. 1. For that reason, we have chosen to target at the design micro level not applying strictly the whole spectrum of phases of an ID model so as to allow for flexibility and gradual composition of the final product: since a variety of design parameters, processes, relationships are core elements in the U-learning ecology design process, we chose not to confine the design, mapping it on a specific ID model at this phase, but use sub-phases of ID model.

III. Methodology for Instructional Design Process

Designers are currently trying to provide new ways for the users to interact with the surroundings in order to promote a natural approach. Present interactive systems include tangible artifacts, which provide physical form in digital information and conceptual entities embedded in the everyday world [6]. Based on handheld computing permanency, accessibility and immediacy have been characteristics of U-learning, expanded however by new characteristics such as interactivity, situating of instructional activities and adaptability. These characteristics comprise important components of the instructional design process proposed. In dynamical theories of complex systems the fundamental unit of analysis is a *process*: it is in relation to this process that participants are defined, as filling roles in that process. Every process, action, social practice or activity occurs in a time scale. Constructing a U-learning ecology based on IoT structure involves complexity in conceptualization and representation: a whole system is constructed in terms of actors, processes, relationships, and description in various levels regarding these. We chose to work backwards to design instruction from its expected outcomes: in order to define basic steps of the instructional design methodology proposed we had to describe

a) concepts of subject domains involved, b) external conditions for learning (i.e. use of media, types of orchestrating student interaction), c) internal conditions for learning (i.e. definition of attitudes, skills and knowledge involved).

Iterative design methodologies are based on the underlying assumption that requirements, the problem and the solution contexts can be only understood over time: prototyping is essential, products emerge throughout the process and quality steadily improves. Though iterative methods are often presented as a radical departure of sequential methodologies, every iterative methodology has some sequential characteristics when viewed from a "coarse grained" perspective. The expected output of the instructional design process methodology proposed is the following:

- Explore the educational context of UMI learning experiences tracing in parallel technological barriers.
- Explore user acceptance testing, focusing on UMI applications which are not currently operational and require research.
- Promote innovation by providing a framework comprising sensors/actuators and a relevant platform that will enable users to develop innovative applications.
- Demonstrate multidisciplinary best practices, to validate the concepts of subject domain and generic technologies that can serve a multiplicity of environments.

By the use of the term instructional design process [7] we mean a set of basic components and steps that define sequencing of creating a U-learning ecology. This actually provides a generic framework which has the following advantages:

- Its structure makes it easy to understand and implement.
- It can be widely used in an array of subject domains involving UMI technologies.
- Reinforces good design habits: define- before-design, design-before-code.
- Supports building documentation of UMI products.
- Supports the signs of progress of design process early.

A. A Work Product and Reused Centred Methodology

Rapid prototyping is not only seen as a method to develop products but as a tool to facilitate real user participation and socialization, as a general tool for organizational development processes [6]. The rapid prototyping process involves quickly developing a prototype product in the very early stages of the instructional design process and then go through a series of rapid try-outs and revision cycles: this design technique has been advocated as a means of producing quality instructional materials in less time than it is required when more conventional instructional design techniques are employed [8]. Developing a prototype is practically the first step while front end analysis is generally reduced or converted in an ongoing, interactive process between subject matter, objectives and materials: an interactive process which involves subject matter, objectives and materials. We adopted rapid prototyping for gathering requirements and developed a working prototype based on these requirements. After finalization of the software requirement specification, the developer attempts to use existing program segments from the prototype and an actual system is then developed and finally good quality is produced. A work product centred methodology orientation has been selected in this case. A work product oriented development process provides a framework for structuring and managing object oriented development. Development, thus, can be defined in terms of interrelated work products. Each work product is defined by its purpose and contents, the inputs needed and the techniques used to produce it. The definition of the development process and the production of a single work product are therefore more straightforward. Thus, all work products follow detailed content description and build on the creation and management of the knowledge base to facilitate their reuse. This has been the basic rationale of further describing the instructional design process methodology. After the selection of U-learning ecology components, through content analysis we have designed an Educational Scenario (ES) template so as to capture the important components of the design process: a *proof of concept semantic organization tool.* In that sense by the use of work product centred methodology through the design process we have started to:

- Construct the conceptual model of the subject domains involved.
- Construct prototypes through rapid prototyping using open source software and educational scenarios.
- Design the CTI platform architecture and develop the pilot version.
- Provide design guidelines for the learning environment initially shaped.
- Select and develop virtual resources/material.
- Set design specifications.

B. Instructional Design Process for U-Learning Ecology

Individual learning ecology comprises the learning context and set of processes, relationships and interactions that provide opportunities and resources for learning, development and achievement [9]. Both individual and social dimensions had to be taken into account as components of the U-learning ecology instructional design process: the ES template, described in section C, provides an initial presentation of individual aspects of the learning environment whereas the CTI platform is expected to shape the social dimensions and relationships between actors and artefacts during the learning process. In order to start shaping an instructional design process for U-learning ecology we have:

- Set the design problem needed to be resolved by our instructional strategy.

- Selected the design components of the instructional design process distinguishing between a) individual learning dimension, b) social learning dimension.
- Selected the rapid prototyping and mediating artefacts as semi structured products so as to a) define the concepts of the domain involved, b) construct software applications by using open source software.
- Used UDOO NEO as software since it a) comprises state of the art technology, b) supports the users' engagement in programming skills, c) has been selected as a versatile tool for structuring U-learning experiences.

What has been important, was to describe domain concepts of subjects involved and use these as a springboard to start shaping domain requirements. The use of mediating artefacts such as the CTI ES template has been selected to act as a springboard to highlight important aspects of the educational and technological requirements involved. The instructional design process is presented in the Fig. 2.

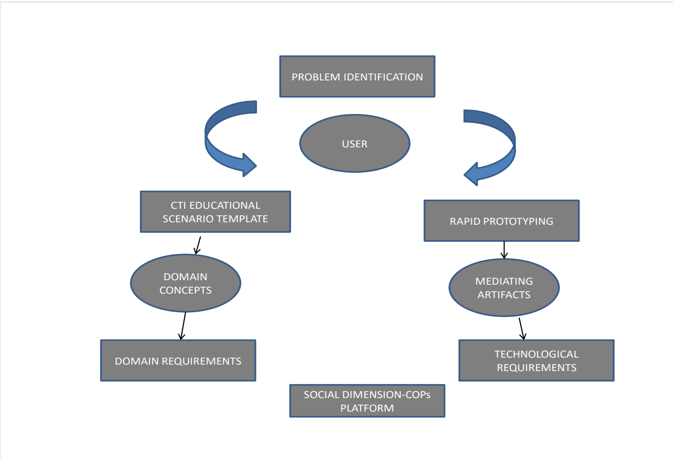

Fig. 2. The UMI Learning Ecology Instructional Design Process

The instructional elements were structured in a top down manner and relationships between components have not been defined in all circumstances as further relationships and roles are expected to emerge as the work is still in progress. The instructional designer through content analysis defined the important components and designed the CTI Educational Scenario Template. As a next step Subject Matter Experts in UbiComp proceeded in further filling its blocks which are described and presented in the following paragraph through ES content analysis so as to produce qualitative data. As an output of this process the following actions have taken place:

- Provide overview of the designed learning experience.
- Define student learning objectives.
- Develop instructional information.
- Design learning activities.
- Develop practice and support activities as well as feedback.
- Develop assessment of student learning objectives.

Basic aim has been to analyse and understand the goals that are set for learners and how they evaluate students' learning before developing instructional material so as to save time and energy.

C. *Educational Scenario Template: A Process Methodology Artefact*

The CTI Educational Scenario (ES) Template has been designed so as to capture important aspects of a U-learning ecology. Its role has been to form *a reflection-of-methodology* product, a semantic artefact that is the output of the proposed methodology. Through the identification of its blocks and the top down design approach adopted by the designer, the focus has been to identify the conceptual framework of designed U-learning experiences and start building learning experiences for youngsters based on components of learning ecology: the CTI ES template has been used as a means to develop new knowledge in unstructured contexts. In defining new design situations it is important to have knowledge that is relevant to the design task in hand. In a new situation we often lack the knowledge we need to solve a problem or meet a challenge, so knowing how to acquire the information or seek knowledge from people who have relevant knowledge, are important aspects of dealing with the situation. Under this scope, to establish design components of the U-learning ecology we designed the CTI ES template as main semantic artefact which supported through content analysis feedback from subject matter experts resulted in further design of (2) CTI Educational Scenarios. The CTI Educational Scenario template is presented in Fig. 3.

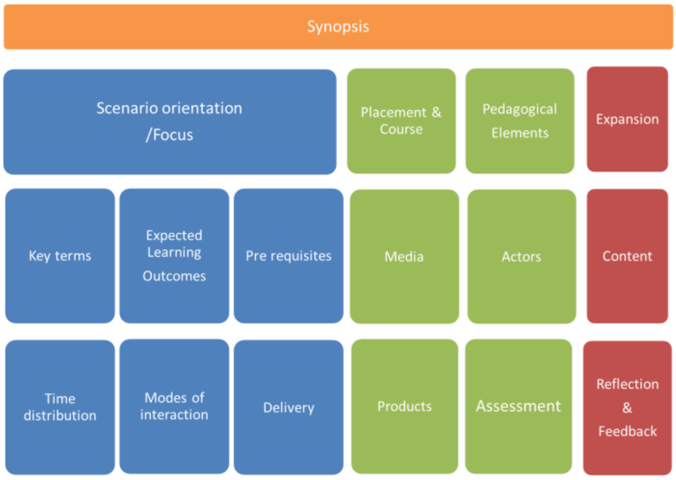

Fig. 3. The CTI Educational Scenario Template for UMI-Sci-Ed

Synopsis presents a brief educational scenario description. The Scenario orientation/ Focus includes information describing the scenario on the basis of knowledge, skills and attitudes expected during the scenario implementation process. A brief content analysis on the basis of key terms presents basic information for scenario categorization. Shaping the temporal space of the educational scenario the block Time Distribution refers to the actual implementation time of the described educational scenario. Using the revised Anderson and Krawthal's Bloom taxonomy, the Expected Learning

Outcomes block provides information on the basis of precise sentences describing what learners are expected to accomplish. Though u-learning scenarios are multidisciplinary, we thought it was important to place the scenarios' design on specific curriculum areas, presented by the block Placement and Course. The Actors that actually influence the learning process are primarily the teacher and students. Modes of Interaction, Delivery, Media and Products have been included as blocks. Modes of Interaction refer to the types of orchestration and organization, the desired modes of interaction between Actors. Media refer to the technological tools involved in the educational scenario implementation whereas Delivery includes on ways the students have access in the educational scenario. The block Products of the educational scenarios includes artefacts, source code and digital material produced during the learning process.

IV. Implementation of Methodology: CTI Case Studies

The instructional design process methodology has been implemented in designing the CTI ES template: as cases of practical implementation of the design process methodology, (2) CTI Educational Scenarios have been formed. The package of hardware components used is UDOO Neo which is an- all in -one open hardware low cost computer equipped with a NXP™ i.MX 6SoloX applications processor for Android and Linux. The embedded 9-axis-motion sensors and a Wi-Fi + Bluetooth 4.0 module the board is ideas to create robots, drones and rovers as well as Mobile IoT projects.

A. CTI Educational Scenario, "My Smart and Efficient Comfortable Classroom"

The instructional goal of this educational scenario is students to set up and run a project through which they make the necessary steps to improve the comfort and energy efficiency of their classroom. Digital and printed artefacts, on line resources and lesson plans have been the media selected for the implementation of this educational scenario in classroom settings. The Learning Objectives [7] defined through Anderson and Krawthal revised Bloom Taxonomy have been to: a) summarize physical quantities of interest, b) outline electricity characteristics and c) explain the basic functionality of a telecommunication network.

B. CTI Educational Scenario "Cryptography"

The instructional goal of this educational scenario is students to understand and learn to use basic primitives of cryptography. Digital and printed artefacts, on line resources and lesson plans have been the media selected for the implementation of this educational scenario in classroom settings. The Learning Objectives [7] defined through revised Bloom Taxonomy have been to: a) understand the fundamental primitives of cryptography, b) experience data encryption and decryption, c) select algorithm parameters for improving performance, d) summarize security issues in UbiComp.

C. The Social Dimension: UMI-Sci-Ed CoPs Platform

The social dimension in constructing a U-learning ecology has been pinpointed as an important factor of the instructional design process methodology. As networks of practitioners and learners are key actors in the learning process, the design of the UMI-Sci-Ed platform is supporting Communities of Practice (CoPs) [9] as groups of people who share a passion for something they do and who interact regularly to learn to do this better. Important dimensions of the UMI-Sci-Ed platform design are: a) peer to peer collaborative networks, b) focus on learning and building capacity, c) engagement in sharing knowledge, developing expertise, problem solving, d) emphasis on good practice and professional development, e) spawn new ideas of products and services and connect learning with action. The design of a platform supporting CoPs is much more than a technology project and requires a thoughtful strategy that considers the communities' goals, incentives, roles, contents and many other non-technological criteria. An iterative, prototyping model, is adapted for the development of the UMI-Sci-Ed CoPs Platform. In brief, after the initial and the most critical user and system requirements, the iteration process includes version analysis and design, fundamental services implementation, testing, prototype delivery and user evaluation. Each evaluation triggers a new iteration with further user requirements and development of new or less critical services. That is every new version is an increment of the previous one. After the conclusion of the user requirements, the rest of the services are added in order to develop and deliver the final system.

In brief, the most important features of the UMI-Sci-Ed platform are the following:

- Enables CoPs members to publish content to a wide audience and to work together in private spaces where they can share documents and send messages to one another.
- Enables students to work collaboratively on the source code of their projects and share with other CoP members.
- Provides an "application store" for UMI-Sci-Ed ecosystem connected to hardware resources for program execution, enhanced with a library of training materials and other information to support application use.
- Combines a content management system for creating GUIs and a special-purpose middleware for integrating applications with the hardware educational platform (UDOO educational kit) and retrieving data.
- Supports the creation of "topic" pages, which are wiki pages with a specific list of authors.
- Supports the creation of reports with extensive metrics (e.g., total number of users in a given period, the number of web hits, etc.).

V. Evaluation Framework

We have started shaping an evaluation plan that is collaboratively developed in a UMI-Sci-Ed stakeholder group, is responsive to program changes and priorities so as to create a shared understanding of the purpose, use and users of evaluation results. The evaluation standards are grouped around these important attributes: a) utility, serve information needs for intended users, b) feasibility, be realistic, prudent, diplomatic and frugal, c) propriety, behave legally, ethically and with due regard for the welfare of those involved and those affected, d) accuracy, evaluation comprehensive and grounded on data [10]. The evaluation framework as initially shaped is structured on critical elements which have been important milestones for the success of the research scheme. Table 1 presents the critical elements for evaluating the instructional design process as well as the rationale for selecting these regarding the educational scenarios:

TABLE I. CRITICAL ELEMENTS OF EVALUATION FRAMEWORK

Critical elements	Rationale
Define smart learning objectives	Reflect intended outcome based on student level - low for task training - high for critical thinking
Identify the level of application effectiveness: high, moderate, low	Scenario based on knowledge, skills, attitudes
Define level of complexity (problem solving)	List theoretical foundations for learning objectives
Use evidence based reference	Peer review scenarios
Incorporate instructor feedback	Assistance in the form of clues and prompts after scenario is completed
Time for debriefing and guided reflection	Study of time and locatio

VI. CONCLUSION

Awareness of ecosystems of learning involves the understanding of processes learners create and perform in the context and situations that comprise their lives. Exploring the design of learning ecologies in a domain such as UbiComp/ Mobile Learning and IoT (UMI technologies) emerges as a challenging and complex instructional design task. The term of learning ecology has been suggested as a pedagogically oriented, umbrella term for supporting the spaces and actions developed in learning context involving IoT settings. Through application of work based methodology, the components of a U-learning ecology have been defined as a subsidiary structure further supporting the Internet of Things (IoT) global network infrastructure: time, space, actors, participation, reflection, processes, relationships and knowledge have been important components in the structuring of the U-learning ecology. The U-learning instructional design process for a U-learning ecology has been based on the creation of the conceptual model of subject domains involved, through the use of rapid prototyping and mediating artefacts. The U-learning ecology has been the macro level out of which the meso level has been identified regarding the design problem: the design of the CTI Educational Scenario Template emerged out of the need to pinpoint important actors and processes in the instructional design process. The instructional design steps which structure all the components involved have been presented. This paper also presented an initial evaluation framework along with the critical elements shaping its orientation. The design of educational scenarios is still in progress as well as the process of planning their implementation in real classroom settings.

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REFERENCES

[1] G. Marinagi, C., Skourlas, C., &Belsis, P. Employing Ubiquitous Computing Devices and Technologies in the Higher Education Classroom of the Future. Procedia-Social and Behavioral Sciences, 73, pp.487-494, 2013.

[2] Weiser, M. The computer for the 21st century. Scientific American, 265(3), pp. 94-104, 1991.

[3] Yahya, S., Ahmad, E. A., Jalil, K. A., & Mara, U. T. (2010). The definition and characteristics of ubiquitous learning: A discussion. International Journal of Education and Development using Information and Communication Technology (IJEDICT), 2010.

[4] Jackson, N. J. Personal Learning Ecology Narratives. In N. J. Jackson and G. B. Cooper (eds) Lifewide Learning, Education and Personal Development e-book (2013). Available on line at: http://www.lifewideebook.co.uk/research.htm.

[5] Siemens, G. Learning ecology, communities, and networks: Extending the classroom. (http://www.elearnspace.org/Articles/learning_communities.htm), 2003. Accessed 1 August 2012.

[6] Chyung, S. Y. Y. and A. S. Trenas. Content Design for Perfor-mance-oriented Reusable Blended Learning. The eLearning Guild's Learning Solutions eMagazine (1-9). Retrieved from http://m.cedmaeurope.org/newsletter%20articles/eLearning%20Guild/Content%20Design%20for%20PerformanceOriented%20Reusable%20Blended%20Learning%20%28Aug%2009%29.pdf, 2009

[7] Dick, W., Carey, L., & Carey, J. O. The systematic design of instruction (6 ed.). Boston: Pearson/Allyn and Bacon, 2005.

[8] Fragou, O., & Kameas, A. Developing a User Oriented Design Methodology for Learning Activities Using Boundary Objects. International Conference e-Learning 2013 (IADIS 2013). Prague, Czech Republic, 2013

[9] Wenger, E. Communities of practice: Learning, meaning, and identity.Cambridge: Cambridge University Press, 1998.

[10] Yin RK. Qualitative Research from Start to Finish. New York, NY: The Guilford Press, 2010.