# Internet-based Performance-centered Learning Environment for Curriculum Support (IPLECS) and its application in mLearning

C. Martinez-Mediano[1], M. Castro[2], N. Rioperez[1],G., N. Mileva[3], S. Stoyanov[4], S. Tzanova,[5] W. Kicken[4], Diaz[2], E. Sancristobal[2], S. Varela[1] and S. Martin[2] ,
cmarme@edu.uned.es

[1]MIDE-I and [2]IEECD – UNED Madrid, Spain
[3]ED – University of Plovdiv – Bulgaria; [4]CELSTEC – Open University of the Netherlands [5]TUS –Sofia – Bulgaria

***Abstract*— IPLECS is a virtual campus platform for the development of performance-centered reusable learning materials, and its application in mLearning for educational and training purposes. The combination of performance support systems and mobile devices present both opportunities and challenges for work-based learning design.**

***Keywords- Internet-based learning; Performance-centered learning, curriculum development.; Engeenering Education.***

## I. INTRODUCTION

We present two Projects financed by Socrates Agency. The first in about the curriculum development of one ' Information and Communication Systems' Master; the second one is about its application and development in mobile leaning.

Internet-based Perfo rmance-centered Lea rning En viron-ment for C urriculum Supp ort (IPLEC S) i s a vi rtual cam pus platform for p erformance-centered reusa ble l earning m aterials development, t heir com position a nd or ganization i n performance-centered settin gs an d th eir u sage to sup port university curri culum in phy sic-engineering e ducation. IPSS_EE is a n integrated e lectronic environm ent, which is available via Internet and is stru ctured to provide individualized online access t o th e full ra nge of inform ation, guidance, advice, data, images, tools and software to permit the user t o per form a task wi th a minimum of su pport an d intervention by ot hers. The sy stem has el ements of performance sy stem, el ements of t raditional W eb-based educational pr ograms and au tomatic t est syst em. The sy stem uses a new technology for improving students' competency and performance by providing support for processing, analysis and reflection on information and learning experience.

The i dea of e ducational per formance supp ort sy stem had been im plemented in different Eu ropean u niversities an d training in stitutions with in a number o f p ilot p rojects su ch as IPSS_EE ( Internet-based Per formance Support System with Educational Ele ments) an d DIPSEIL (Distrib uted In ternet-based Perf ormance Supp ort Envi ronment f or In dividualized Learning), with stro ng positive resu lts in stu dents' learn ing. [1].

The com bination of performance suppor t sy stems and mobile d evices p resent bo th opportunities an d ch allenges for work-based l earning design. We describe four possible m obile performance sup port sce narios, namely: mobile perf ormance support c ourseware; ind ustry-based m obile perform ance support sy stems; mobile soci al suppo rt s ystem; and co ntext-based performance support.

The mobile perform ance support course ware repackages the exi sting courses i n which t he pri nciples of perf ormance support are implemented. In the second scenario, industry-used mobile perfor mance suppo rt sy stems becom e part of hi gher education l earning a nd i nstruction. St udents l earn h ow t o use them wh en they p erform p articular work-related tasks. The social support scenario explor es the opport unities created by Web 2. 0 t echnologies (m icro-blogging t ools such as Twi tter, social bookmarking and wikis) to connect people and facilitate their co llaboration. In the fourth scenario, mobile performance support is part of a bl ended solution of knowledge distribution rather than a primary channel for c ontent d elivery. Mob ile performance sup port i s i ncluded i n a b roader co nstructivist instructional co ntext and u sed on ly in p articular ti mes. With in the scenarios a set of pedagogical guidelines are form ulated based on a nu mber of theories: Four C omponents Instructional Design Mo del (4 C/ID) [2 ]; Co gnitive Ap prenticeship [3 ]; Cognitive Flexibility Th eory [4]; Cognitive Load The ory [5]; Multimedia Learning [6] ; Minimalism [7]; Design The ory of Problem Solving [8]; and Anchored Learning [9].

Learning materials in IPLECS take the format of "l earning objects" (LOs), specific for th e performance-centered approach and presentation. We presen t the conc eptual model and description of so called IPSS_EE LOs and extend the IE EE LOM. Model and description of IPSS_EE LOs are useful for understanding their feat ures, for e nabling t heir publ ishing in a Web c ontext and for e nabling t heir reuse across di fferent learning sessions. A new curriculum in the field of science and technology - " Information ph ysics and co mmunications", will be developed. Learni ng m aterials t o su pport a com plete integrated p rogram, devel oped an d us ed i n a virtual

performance-based learning environment will be developed. In the whole process, various competences, innovative and consolidated information and communication technologies will be used.

The main reason for the application of Performance-centered Approach in Mobile Learning for educational and training purposes is to contribute to the continued development of mobile learning and to address the imbalance between mobile devices availability and the lack of education and training provision on the sophisticated communications devices which every student and workers carries and uses constantly – except in education. The advantages for trainees are derived from providing learners with a job aid in their own work context. Given the trend to lifelong learning, many "students" are workers adults with full- or part-time jobs. Mobility offers them an opportunity to maximize their learning time.

Mobile devices are always available and can be used for a variety of learning functionality - providing access to content (both informational and instructional) and for communication and collaboration purposes. They can be used with formal or informal learning purposes as well as performance support, i.e. for delivering information and support just-in-time and in context.

## II. Objectives and target population

The IPLECS and mPSS Projects aim: Design, composition and reuse of IPSS_EE LOs and experiment the usage of the learning platform and of IPSS_EE LOs for the physic-engineering integrated curriculum support.

The main purposes of the IPLECS project are:

- Design a master on Information and Communication System (ICS), online, performance centered,
- Apply the ICS master, by means of an educational platform, in Bulgarian Universities involved in the project, Plovdiv University and Technical University of Sofia.
- Evaluate the 'ICS master' in its design, during the process and in their results.

Together with the main objective, others purposes of the project's are:

- Support the development of innovative ICT-based content, services, pedagogies and practice for lifelong learning to support university curriculum in physics-engineering education.
- Provision of open educational resources on-line and testing innovative performance-based e-learning.

The target groups to which the project is addressed are:

- Higher education teachers in physics-engineering and other fields, by transference.
- Students in the same field and, by transference of lessons learned, in other specialities.
- Universities and enterprises management, by transference of outputs and results.

The main purposes of the mPSS project are to contribute to the continued development of mobile learning and to address the imbalance between the availability of mobile devices and the lack of education and training provision on the sophisticated communications devices which every student and workers carries constantly.

The projects objectives are linked directly to support the realization of an European Higher Education Area as much as the development of innovative ICT-based content, and open educational resources on-line provisions, testing innovative performance-based e-learning and contributing to mobile learning development in education.

## III. The Project Approach

The project approach responds to the '*Principles of Performance Centred Curriculum'*, which are derived from the first concept of Electronic Performance Support System, but evolved, to adapt it to the Higher Education System.

The Principles of Performance Centred Curriculum: The EPSS concept (Electronic Performance Support System) includes the idea of just-in-time, just-enough, and just-at-the-point-of. This needs computer support for an effective and efficient job performance. An EPSS is an integrated learning environment structured in a particular way to provide immediate access to the full range of information, advice, guidance and tools allowing effective and efficient job performance.

EPSS to PSS in Higher Education is characterized by its focus on active learning, acquisition and application of skills, technology power in addressing instructional issues, appropriate representation and filtering of learning resources and one integrative approach for operational performance support.

The integrative approach to PSS is based in the following learning theories: Cognitive Apprenticeship (Brown, Collins & Duguid, 1996[3]); Cognitive Flexibility theory (Spiro & Jehng, 1990) [4]; Four-Components Instructional Design Model (Van Merriënboer & Kirschner, 2007[2]); Design Theory of Problem Solving (Jonassen, 2004) [8]; Cognitive Load Theory (Sweller, 1994 [5]).

The Performance learning center concept operates by defining a set of authentic problems and constituting tasks related to a specific working environment; shifting the focus from the lower levels of the learning taxonomy such as knowledge and understanding, towards its higher levels such as solving real-world problems; applying adequate summative performance-oriented assessment methods.

The learning support is delivered by the following learning strategies:

- Designing a sequence of easy-to-complex tasks;
- Creating opportunities for deliberate practicing these tasks: giving formative performance feedback;
- Gradually diminishing the amount of support (scaffolding);
- Adapting instructions to students' knowledge level and learning style;
- Providing a variety of instructional stimuli (resources) and
- Allowing constant access to learning resources.

The system is characterized by using recent developments of information and communication technologies (ICT), presenting embedded performance support into the interface and functionality of the application. The system depends on how comprehensively performance and support are defined and how well they are operationalized in the architecture and in the interface of the system.

*The Structure of the learning content*, for all the courses in the ICS curriculum, lies in:

- Background information (facts, definitions, principles and theoretical frameworks)
- Examples (worked-out examples, modeling examples, demonstrations and simulations)
- Procedures, techniques and tools
- Presenting learning content
- Split-attention principle (People learn better when words, pictures and graphics are physically and temporarily integrated)
- Self-explanation principle (People learn better when they are encouraged to generate self-explanations during their learning)
- Guided discovery principle (People learn better when guidance is incorporated into a discovery-based multimedia environment)
- The main purposes of the IPLECS project are:

*'The instructional design for Performance-centered E-learning* of DIPSEIL, as a typical performance support system [11], [12], is an integrated electronic environment, which is available via Internet and it is structured to provide individualized online access to the full range of information, guidance, advice, data, images, tools and software to permit the user performing a task with a minimum of support and intervention by others.

## IV. THE DESING OF THE IPLECS AND MPSS PROJECTS

In the IPLECS Project, the ICS Curriculum Design has been developed having into account ' The Principles of Performance Centred Curriculum' and 'The Instructional Design for Performance-centered E-learning' of DIPSEIL, we have developed 'The Workflow Model for an Information and Communication Systems curriculum'. With these three elements teachers in charge from different courses have enough information for developing the ICS courses.

The Workflow Model also offers to the course developer complete guidelines, with explanations, and examples that give all the partners unified criteria for developing the courses and their activities supporting the ICT performance centered task design.

The IPLECS Workflow Model for curriculum development is based in:

*1)* State a reference situation in which the students will use what they are going to learn.

*2)* Formulate a few Learning goals and clear and specific objectives oriented to competences.

*3)* Create learning tasks with performance support, to provide the students:

- Background information,
- Examples,
- Procedures and
- Feedback,

in order to help the students to perform the task easier and also to facilitate their learning.

4) Summative evaluation.

The 'Workflow Model', at the same time that serves as a guideline to courses developer, also works as a complete check-list for evaluation purposes of the ICS courses design, being used as a 'PSS Validity Scale'.

*The ICS Master Program and its* ***Implementation Plan in DIPSEIL Platform***

The ICS Master Program is integrated by 6 mandatory courses and 4 electives courses. The student should enroll 8 courses in total, divided into two semesters.

- Semester 1
  - Introduction to Information and Telecommunication systems (PU)
  - Realtime and Industrial Communications (UNED-DIEEC)
  - Internet Technology (DEIS)
  - Advanced electronics for information and communication technologies (TUS)
- Semester 2
  - Satellite and Mobile Communications (PU)

- Optical Fiber Communication Systems (CIME)

And two of electives from these four courses:

- Power Supply for TICs Equipment (UNED-DIEEC)
- Multi Media (DEIS)
- Digital Functions Design (CIME)
- Microelectronics and Nanolectronics (TUS)

The different subjects programs that integrate the ICS Master have been developed according to the 'Instructional Design for IPLECS project and the guidelines included in the Workflow Model for IPLECS.

The designers were facilitated to send their reviewed courses to the responsible of PSS Model, in order to check them according to the 'PSS validity scale'. In July - September 2009 the courses designers had sent to the experts in curricula design their courses.

The course started the 15th of October 2009 in two Bulgarian Universities (Plovdiv University and Technical University of Sofia).

The mPSS application is presented as a form of performance support system for educational and training purposes. This is the case of learners who are studding something in relation with their job, studding to improve and promote themselves at work what is really frequent, specially in Distance Universities. The majority of students in Distance Universities choose careers related with their actual job to gain in knowledge and improve their professional practices and to obtain benefices of the relations hip with professional-teachers and other students-colleges, in collaborative relations.

The advantages for trainees are derived from providing learners with a job aid in the context of their work:

- Puts training and performance support where their actual work is taking place.
- Allows new skills or knowledge to be immediately applied
- Enables training when it is needed
- Allows use of rich media when appropriate

The advantages for students:

- They have more flexibility and choice in where and when they learn, outside of the wired (or un-wired) classroom.
- Students use the technology in their study that would enhance their readiness for tomorrow's workplace where employers want graduates who know how to use technology for learning and working, as one opportunity/chance for lifelong learning.

Given the trend to lifelong learning, many "students" are working adults with full- or part-time jobs. Mobility offers them an opportunity to maximize learning time [13].

## V. Application of IPLECS to MPSS Project

Research by Stoyanov, Kommers, Bastiaens and Martinez-Mediano (2008) [1], shows that the concept of performance support system (PSS) should be implemented adapted to the specific goals and characteristics of higher education. Thus, it is important to keep in mind the specific goals of education when developing the support to improve learning. This means that students should not only be supported to perform the task at hand well, but also to understand underlying processes and concepts. They should learn from performing the task. Furthermore, it is important to keep in mind that when designing mobile PSS, this should be done from the perspective of the learning process and the learner and not from the perspective of mobile technology. [14].

Founding in results obtained in previous research in IPSS in higher education, we propose concrete instructional design steps for four scenarios for the implementation of PSS in mLearning. The scenarios are based on existing learning theories and take into account different learning processes and educational goals. The following scenarios are distinguished:

*a)* Mobile performance support courseware,

*b)* Industry-based mobile performance support systems,

*c)* Mobile social support systems and

*d)* Integrated mobile performance support learning.

Each scenario requires a different structure and presentation of the content and addresses different educational goals.

## VI. The Evaluation Strategies of the IPLECS and the MPSS Projects

Our conception of evaluation is the following: 'Evaluation is the systematic application of scientific methods to assess the design of one program or project, responding to some needs, having into account its goals, action plan, implementation, results and impact, with the purpose of knowing how well works the program to meet goals and achieve valuable results, in order to contribute to its understanding and to guide its improvement, with the criteria of its worth and merit'.

The evaluation strategy of the IPLECS and mPSS projects aims to study the total purposes of the project. Our main objective is to validate the ICS curriculum by means of different strategies and instruments.

To content validity we will use the IPLECS Validity Scale, based in the PSS instructional design.

To check the mPSS-IPLECS characteristic of educational design and the functionality of the platform we will use specific one check-list and usability questionnaires addressed to collect users' evaluation: teachers and students that follow the courses. The evaluation of the 'usability and functionality of the platform' deals with how well the platform satisfies the

user needs and requir ements. This variable works as estrange variable that should be controlled, because in one online course the way that the platform or the 'system 'works could affect the entire learning process and also the final results.

The in strument to ev aluate th e p latform i s a 'u sability questionnaire', whi ch i s sh owed i n t he A nnex 1 .Instruments. 'Computer Syst em Usabi lity Quest ionnaire' based o n Lewi s, (1995). Beside the questionnaire the platform is evaluate by the peer review technique before starting the courses. The projects partners a nd teachers, wh ich will collaborate in the Implementation of t he IC S curri culum, are the sa mple to evaluate the platform.

Attitude is a fa ctor that could be an important influence in learning. Only when there is a favourable attitude towards the TICs an e-learner can effec tively face web-based learning tasks. Learn ing requ ires a po sitive at titude fro m th e u sers to show their full potential. [15].

In according with Anastasi [16], attitude is defined in terms of the tende ncy to react favourab ly or unfavourably towards a certain class of stimuli, was det ermined by visible, both verbal and non-verbal, behaviour.

We will u se a q uestionnaire o n 'Attitu de to learn by computer', based in a Likert scale, valuing every item from 1 to 5, minimal to maximal agreement with the statement contended in every item.

To value the entire learning pr ocess we will use specific 'reflective qu estionnaire' a s sat isfaction i ndicators o n t he learning p rocess. W e will collect information b y p ersonal interviews to students and t eachers, in order to c heck satisfaction indicators with the functioning of the program, the IPLEC and mPSS models and the dipseil-iplecs platform during the process, taking measurements from teachers a nd students.

We want to measure th e satisfact ion with th e ICS curriculum, in relation with the ICS curriculum goals, and with the im plementation process and their results. These are indicators of i mpact, i n relat ion wi th t he IC S M aster and IPLECS Model.

The research design is the proper of the evaluative research, focused on multiple sources and variables. T he methodology is exploratory. We will u se descrip tive stat istical an alysis, an d value an alysis, u sing quantitative an d qu alitative d ata an alysis as correspond to the evaluative studies.

The m ajority of c urriculum eval uation models sugg est evaluating the planned, enacted and experienced curriculum;

- The pl anned c urriculum i s the theoretical curriculu m that one intends to implement, that is, the program
- The enacted curriculum is the cu rriculum that is actually implemented, the program in action
- The experienc ed curriculum represents the curriculum as it was experienced by its users, such as teachers and students.

Programs, processes and products should be evaluated. This means that we should evaluate not only the match between the objectives of t he cur riculum and performance out comes, that means the effe ctiveness of the cu rriculum, but al so how i t i s functioning during the execution of the curriculum and ho w is being used t he reso urces, t he IPLEC S M odel and t he m edia trough the dipseil-iplecs platform.

To summarize, we need to ce ntre the curriculum evaluation in the following:

- Planned, enacted, experienced curriculum
- Process & product
- Objective & subjective variables
- Quantitative and qualitative data
- Teachers' and students' experiences

The data analysis that we will do are:

- Quantitative, d escriptive an d co rrelation an alysis, b y mean of the Statistical SPSS program.
- Qualitative, Gro unded th eory, Co ntent An alysis, with the 'Q uantified C ontent Anal ysis, Lexim ancer' program.

The sam ple from which we are collecting inform ation are the own cours es author s, teachers responsible of applying the ICS cur riculum, t heir st udents, an d t he p artner as e xperts t o validate the ICS curriculum.

## VII. CONCLUSSIONS

Our projects have time duration of two years and nowadays we are in t he first years. Th e theoretical fra me-mark and the strategies and resources for its application and evaluation have already fulfilled. In the current year we are applying the course in b oth project, an d fo llowing th e process to collec t information to ev aluate th eir ap plication an d resu lts. Th e evaluation strategy, using quasi-experimental research methods besides q ualitative o ne, g ive a g ood exp ectative to b e ab le to contribute t o the sci entific com munity abo ut som e advanc e in both pr ojects, center i n PSS in com puter and m obile l earning device.

## ACKNOWLEDGMENT

The au thors would lik e to ack nowledge th e su pport o f th e European Union Socrates in the project IPLECS. 141944-LLP-1-2008-1-ES-ERASMUS-ECDSP an d i n t he pr oject m PSS Leonardo P roject 14 2788-LLP-1-2008-1-BG-LEONARDO-LMP.

## REFERENCES


[1] S. Stoyanov, P. Kommers, T. Bastiaens & C. Martínez Mediano. Performance support system in higher engineering education – introduction and empirical validation. In International Journal of Continuing Engineering Education and Lifelong Learning, Vol. 18, No. 4, 2008, 491-506.

[2] J. Van Merriënboer, & P. Kirschner. Ten steps to complex learning. A systematic approach to four-component instructional design. Mahwah, New Jersey: Lawrence Erlbaum Associates. 2007.

[3] J. S. Brown, A. Collins & P. Duguid, Situated cognition and the culture of learning. 1989. Retrieve Febr uary, 2 2002 from: http://www.ilt.columbia.edu/ilt/papers/ JohnBrown.html

[4] R. Spiro, & J.-C., Jehng. Cognitive flexibility and hypertext: theory and technology for the nonlinear and multidimensional traversal of complex subject matter. In D. Nix & R. Spiro (Eds), Cognition, education and multimedia. Exploring ideas in high technology (pp.163-205). Hillsdale, New Jersey: Lawrence Erlbaum Associates. 1990

[5] J. Sweller. Cognitive load theory, learning difficulties and instructional design. In Learning and Instruction, Vol. 4, , 1994, 259-312.

[6] [R. Mayer. Introduction to multimedia learning. In R. Mayer (Ed.), The Cambridge handbook of multimedia learning (pp 1-16) . New York: Cambridge University Press. 2005.

[7] J. M . Carroll. Minimalism beyond the Nurnberg Funnel. Cambridge, MA: MIT Press.1998.

[8] D.H. Jonassen. Learning to solve problems. An instructional design guide. San Francisco, CA: Pffeifer. 2004

[9] J. Bransford, S., Derry, D., Berliner, & K. Hammerness. Theories of learning and their roles in teaching. In L. Darling-Hammond & J. Bransford (Eds.), Preparing teachers for a changing world: What teachers should learn and be able to do (pp. 40–87). San Francisco: Jossey-Bass. 2005.

[10] J. Bransford, M. Slowinski, N. Vye, S. Mosborg,. The learning sciences, technology and design for educational systems: Some thoughts about change. In J. Visser and M.Visser-Valfrey (eds.), Learners in a Changing Learning Landscape (pp. 37-66). Dordrecht, NL: Springer. 2008.

[11] S. Desrosiers, & S. W. Harmon. Performance support systems for education and training: could this be the next generation? 1996. Retrieved Januar y 22nd 2009 from http://www2.gsu.edu/~wwwitr/docs/nextgen/index.html

[12] G., Gery . Performance support – driving change. In A. Rossett (Ed.), The AST D e- learning handbook. Best practices, strategies, and case studies for an emerging field ( pp. 24- 37). New York: McGraw-Hill. 2002

[13] N. Mileva, and S. Stoyanova-Petrova. Performance Support System (PSS) Methdology for Mobile Learning ( m-learning). Researchs,Reflexions and Innovations in Integrating ICT in Education. Lisboa. 2009, 1399-1403.

[14] W. Kicken, S. Stoyanov & D. Nadeem , (2009). Four implementation scenarios for performance centred mobile learning. CELDA. Rome, November, 2009.

[15] J. González and R. Wagenaar, (eds.). Tuning Educational Structures in Europe. Final Report. Phase 2. Universities' contribution to the Bologna process, Bilbao, 423 pp., 2006.

[16] ANECA. Informe Ejecutivo: El profesional Flexible en la Sociedad del Conocimiento. (REFLEX). UE. Nº CCIT2-CT-2004-503-352). ANECA (Agencia Nacional de de la Evaluación de la Calidad y Acreditación). Madrid. MEC. 2007.

[17] J. R. Lewis. IBM Computer Usability Satisfaction Questionnaires: Psychometric Evaluation and Instructions for Use. International Journal of Human-Computer Interaction, 7:1, 1995, 57-78.

[18] R. Olfos & H. Zulantay. Reliability and Validity of Authentic Assessment in a Web Based Course. Educational Technology & Society, 10 (4), 2007, 156-173.

[19] A. Anastasi. Tests psicológicos. Madrid. Aguilar. 1982.