1. Introduction

The rapid evolution of science, engineering, economy and society in the age of globalization also requires a rapid evolution of skills and thus necessitates massive life-long education, massive know-how training and re-training. At the same time, education must become more personalized, as the skills needed to master an increasingly sophisticated technological world continually change and become more diversified. POEM aims at designing the first open LMS (Learning Management System) for Massive Personalized Education. In other words the POEM Platform has to reconcile Massive Education — as with the strong development of MOOCs (Massive Open Online Courses [1]) — with Personalized Education.

**Personalized Education** must have the following specific requirements as with the personal tutor of ancient times: firstly, a strong personal involvement of the students to actively participate to their own education; secondly, predictive strategies for guessing the next step toward the best skill level in the preferred domain of knowledge for each student; finally, preventive strategies for avoiding future difficulties, especially withdrawals. We call such conjunction of participative, predictive, preventive and personalized education 4P Education or more simply Personalized Education, if the emphasis is not on the preconditions but on the result.

It can seem that massive education and personalized education are antagonistic objectives but on the contrary, they are in synergy. Without a massive number of previous observed educational trajectories, the educational ecosystem will be not able to guess the best future for a new trajectory. Best guessing supposes the data assimilation of a massive number of such trajectories. Thus, the participation of everyone to such an educational ecosystem is extremely desirable, for any human of any age to come back to education, for actively and quickly learning more and something different from what he already knows. Such synergy between massive and personalized education is only possible within a social

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1 POEM is an Educational Management ecoSystem (EMS) that is more general than a standard Learning Management System (LMS) because it is a social intelligent ICT system (like Wikipedia) including the active participation of learners and teachers and the capacity to be predictive for personalized education.
An intelligent ICT platform, i.e. the main aim of the POEM proposal. And this social intelligent ICT platform for massive personalized education has to respond to the four following objectives:

- A massively participative educational ecosystem
- A predictive educational ecosystem
- A preventive educational ecosystem
- A personalized 4P Educational Ecosystem with its multi-level Quality Measurements

2. Creating a massively participative educational ecosystem

One of the important concept that allows Personalised education is the deconstruction of courses and curricula into hundreds and thousands of short independent units that will interact together as a complex system. Typically courses in an European University year are made of 60 ECTS with 10 hours per ECTS, decomposed into small (3 ECTS) and large (6 ECTS) courses. Suppose now that courses are decomposed into short independent videos of 15 to 20mn focussed on a particular pedagogic topic. A typical 5 year Master’s degree curriculum therefore consists of 3x10x60x5 = 9 000 independent short videos. At University scale, this must be multiplied by as many Master’s curricula as there are different domains.

The objective is then to get these thousands of small independent courses to self-organise into optimal pedagogical paths that allow individual students to validate curricula as fast as possible depending on their personal skills, aims and previous knowledge.

A basis for this project is a former work conducted by Pierre Collet, that lead to designing and implementing a modified Ant Colony Optimisation system where artificial ants were replaced by real human students that was named a man-hill [2, 3, 4, 5]. This man-hill paradigm has been exploited by the Paraschool company with as many as 500 000 students, therefore validating its scalability. In addition, the Paraschool man-hill also implemented automatic ranking based on the ELO system [6, 7, 8] used in chess ranking that could automatically evaluate both the level of students and of pedagogical items.

POEM (developed within the UNISTRA Complex Systems Digital Campus http://cnsc.unistra.fr) is expected to be the first open 4P-EMS (Educational Management System). It developed under Creative Commons and will be as interoperable as possible with the other open Learning Management Systems (LMS) like CANVAS, Star2Go or EdX.

The educational ecosystem will involve students in many individual and collective educational activities for their mutual benefit: assessment, inter-tutorship and construction of dynamical Knowledge Maps. All these activities are in relation with the main functions of the educational system, i.e.:
1. A first function is to construct and visualize dynamic Knowledge Maps of domains as well as, inside the POEM, individual, MOOC and Curricula trajectories. This function is useful to students when they have personalized choices to make and to professors for examining the consistency of their MOOC inside a Curriculum or the consistency between Curricula. Conversely, crowdsourcing by students is useful for extracting a corpus from a new domain and for constructing a new Knowledge map.

2. A second function is inter-tutorship, which is a necessary feature of successful MOOCs that are typically joined by tens of thousands of students, which is expected to be the case with UNISTRA POEMs, as renowned professors such as Jean-Marie Lehn, 1987 Nobel Prize in Chemistry have agreed to contribute with small video courses). Direct Professor-Student interaction is impossible in a MOOC with 50 000 students, so in POEMs, each student has a tutor, who is also a student who is more advanced in the same curriculum; the student can ask questions to his tutor. If no answer is found, then the tutor can forward the question to his own tutor and again and again, until there is no tutor anymore and the question reaches a professor.

3. A third function is an automatic assessment depending on success/failure along the personalized trajectories of students. Different automatic assessment methods will be proposed: sophisticated MCQ, open responses to open questions (thanks to the participation of Prof Tijus, head of LUTIN laboratory, who will participates with the platform that won the 2012 world championship for measuring the semantic distance between textual responses to open/closed questions, and the different possible textual prototypical responses), automatic correction of exercises with remediation proposals. But peer-to-peer exchange will be also used either when it is known to bring an advantage or in order to compete with automatic assessment until there is no doubt about the best between peer-to-peer assessment and automatic assessment. Peer-to-peer assessment is recognised to be of mutual benefit. Whatever the assessment method, skill-level evaluation will be provided like Elo-points in chess or Tennis ranking. The skill-level of students and the difficulty-level of the tests are co-evolving until the student skill-levels and tests difficulty-levels are consistent. Because tests do not evolve, they form a stable basis that can be used to evaluate relative students skill-levels.

4. A fourth function is to let students bring new questions and new contents. As a part of their evaluations, students are asked to imagine new questions for a particular content. The quality of the proposed questions can be evaluated by their discriminating power and their ability to correctly discern between good and bad students. Then, above a certain Elo skill-level, the system can offer a student to come up with new contents that will be inserted in the education ecosystem.
Good contents will find their way into participatively evolved trajectories, while bad contents will eventually get discarded.

The individual and crowdsourcing activities will be observed by the Educational Ecosystem and controlled by professors, who will serve as moderators as they make sure that the contents remain sound and of good quality. Online data assimilation of individual educational trajectories will allow to create *integrated individual profiles (including a skill-level)* as the best summary of the past activities of the student. Similarly, data assimilation of crowdsourcing activities will allow creating an *integrated social profile (including a reputation-level)* by best summarizing the past. The reputation-level is increasing for a tutor whose student has a rapidly increasing skill-level.

Finally, Mozilla-like Open Badges will be used to validate lessons made of several independent short courses on a particular topic. A curriculum can consist of a collection of different badges, determined by a Department. Companies who need engineers or workers with specific skills can also elaborate badges containing specific evaluation contents. Students who want to join a particular company can work towards validating the company badge and the ant-hill paradigm will soon create an optimal pedagogical path that allows to validate such badges, therefore creating a tailored education system for a particular company. Fees can be asked from companies to elaborate such badges, as a reward for the elaboration of a tailored education system specific to the company. Each student who validates a badge will receive a mail from the company inviting him for an interview, therefore creating strong links between companies and students through an optimal tailored education system helping towards full employment.

**A predictive educational ecosystem**

An essential quality criterion for personalized education is to maximize skill-level increase on the best preferred curriculum. This is obtained through a best individual educational trajectory. The main problem is the same as for the ancient personal tutor: *choosing for the student a very limited number of next steps for his best trajectory while leaving to the student the final guess of the next step.*

The POEM proposal is conjecturing that, given an individual profile, the best next incremental step is determined in probability by the distribution of the choices of previous learners with similar profile. This conjecture is the *Personalized Educational Man-Hill Problem*, because of the similarity with ants' collective behaviour, which is known to quickly find optimal paths towards food sources.

The meaning of this conjecture is that the educational ecosystem plays exactly the same role as the ancient personal tutor, thanks to the large number of students: it collects all the educational trajectories, categorizes them dynamically using personal profiles and uses the empiric distribution of successful next
steps observed for the same profile of previous trajectories. The most difficult operation is automatic categorization that can however be obtained thanks to data-mining techniques.

This conjecture holds when the number of educational trajectories tends to infinity. But it is never the case because the dynamic Knowledge Map is never stationary, because of the arrival of new hot topics that can be provided by students through crowdsourcing. And the students can observe the scientific trajectories of these hot topics and even better: observe how the old domains are splitting or splicing into new domains.

3. Established partners

Collaborations are already established on the POEM project with Philippe Portelli (Département des Usages du Numérique of UNISTRA, 44000 students), Charles Tijus (CHArt Laboratory “Cognitions Humaine et Artificielle”, which is a Joint Research Unit between the “Ecole Pratique des Hautes Etudes” (EPHE) and Paris 8 University (27 000 students including 4500 PhD Students), Maria Escalona of the IWT2 (Web Engineering and Early Testing) research group in computing of the University of Seville (largest public University of Andalousia with 70000 students), Jeffrey Johnson of Open University, the world leader distance education and e-learning institution with 240000 students, Jorge Louça of the Observatorium Research Team of ISCTE-IUL Lisbon University Institute (9500 students), Wolfgang Lehnhard of the Institute of Psychology of the Julius-Maximilians University of Würzburg (24000 students), Paul Bourgine of CNRS-GIF, who will launch the POEM platform throughout the world, Michael Kohlhase of the KWARC group of Jacobs University Bremen (1320 students from 109 nations) and Jean-Philippe Cointet of INRA-Sens, for his extensive work on knowledge networks.

Foundation Getulio Vargas in Brasil (largest distance education institution in South America with 100 000 students) has also agreed to participate to 4P Education, so all in all, nearly 500000 students will have access to 4P-Education and POEMs through the different partners.

POEMs will be presented at Taipei University in Taiwan on May 17th and at Université Cheikh Anta Diop in Senegal on July 10th and at AIMS Next Einstein on July12th.

4. Requested budget: €178,272 over 2 years

In order for this ambitious projects to be as successful as possible, we would need the maximal two years span during which we require a stipend to reduce Pierre Collet’s teaching time so that he can devote as much time as possible to develop the Strasbourg POEM within the Strasbourg CNSC
(http://cnsc.unistra.fr), one Post-Doctoral researcher to implement the existing man-hill concept and extend it to inter-tutorship and crowdsourcing functionalities and two internship students.

Requested budget is:

- 50% ATER (€1.757/month over 2 years = €42.168) for courses.
- A 24 months post-doc (€3,996/month over 2 years = €95,904) to implement the man-hill education system and integrate the different elements provided by other participants.
- €2,000 for a computer for the post-doctoral fellow.
- €10,000 to organise a 3 days international workshop to promote the results of the Strasbourg POEM obtained by November 2015.
- €16,200 for two internship students for 2 full years, one to assist the Post-Doc fellow and the other to maintain a web page, keep links between the partners and recruit new partners.
- €12,000 travel expenses.

Bibliography