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Specification, Design and Development of a Pyramidal Learning Platform †

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Abstract: The aim of this article is to design an online learning platform that allows tutoring between learners from different levels and the possibility of adding content to the fields of knowledge, using measures that assess quality. It is a versatile technological tool appropriate for the collaboration between different agents, both for acquiring new professional skills and for lifelong learning and formal regulated learning of education systems. Learning takes place through a two-way scheme: On the one hand, the learner is assisted through online tutoring by another highly qualified learner (that acts as a teacher). On the other hand, the same learner assists others from lower categories. In that way, their-skills will be consolidated by forcing reflection on the subject in order to explain it. The knowledge base is a wiki platform stratified in the same levels as the professional and training categories. This platform features evaluation and accounting modules for tutorials and contributions to the content of the wiki. The assignment of several disciples of a given level to each tutor of the superior level makes possible an exponential expansion that is of great interest for using the pyramidal school in projects of solidarity cooperation.

Keywords: online learning platform; lifelong learning; pyramidal structure; dual-track learning; cascade training; stratified wiki; solidary education

1. Introduction

The insertion of Information and Communication Technologies (ICT) in education and its quick development has increased the number of people who have access to education via e-learning platforms, be it informal or formal and recognized [1]. Although these platforms offer great advantages, they all have the same disadvantages [2]. This paper proposes an innovative approach to e-learning systems. The idea is to use a pyramidal structure in which each user acts as a student for the upper levels and as a teacher for the lower levels. In this way, the apprentice reflects on the acquired knowledge, since, in addition to understanding, he or she must be able to explain it. In addition, the system can scale up to a huge number of students in a highly distributed way.

1.1. Motivation

This project raises the need of developing a cognitive justice within the paradigm Teaching-Learning (T-L) taking advantage of the rise of online learning systems. The reason for proposing a pyramidal learning platform is that it is an online learning platform that incorporates

a two-way learning system (studying and teaching), establishing a pyramidal tutoring that allows massive training and at the same time abstracts the figure of the traditional teacher and focuses learning on the learner. The operation of the platform will generate a multifield knowledge base stratified by levels of specialization. It provides an ideal platform for solidarity use by offering quality content and learning without the needing teachers or specific infrastructures.

1.2. State of the Art

E-learning systems are one of the most widespread methods to support formal training, retraining and lifelong learning [3]. These systems allow the student or the professional to acquire new skills and knowledge without having to move to a specific place and it is the user who decides when and where to study. There are multiple types of e-learning platforms, with similar or very different teaching methods [4], but they all have some points in common; for example, all of them need a monitoring and evaluation system, as learning is not just reading information, it requires guidance [5]. They all depend on a teacher who introduces content into the course. This has a direct impact on the quantity and quality of the content, as well as a subjective decision of what is included and what is not, in addition to the obvious cost of time and effort that the teacher must make to add information to the course. In addition, the fact that most entities carry out their own courses privately means that there may be multiple courses of the same subject with different degrees of quality, information will be repeated many times or even be absent. Some of the most extended methods for online learning are Learning Management System (LMS) platforms, Massive Open Online Course (MOOC) courses and the use of wikis.

LMS platforms offer the possibility of sharing materials, doing tutorials and exams and following the work of students and teachers. These characteristics make them both a frequently used distance learning method as well as tools for conventional education [6].

MOOCs are a training methodology using mass access courses to which, at first, anyone could sign up (there are courses of similar methodology but private) [7]. The advantage of these free online courses, which allow mass training by reaching a large number of students, is also a drawback, because there are no minimum requirements for matriculation, so many students of insufficient level leave the course without completing it [8].

The use of wiki platforms in education has been studied on several occasions, determining their usefulness for reinforcing learning by enabling learners to transfer and apply their knowledge and promoting their active role in learning. The operational character of a wiki allows it to be used to support pedagogical activities such as collaborative writing, reflective learning through active participation, and peer collaboration and interaction [9]. Wiki-based learning requires an active approach to knowledge building on the part of learners, who are constantly forced to seek and filter information and generate a discourse about knowledge that leads them to be transmitters, and not just receivers, of knowledge [10].

This attitude in the construction of knowledge and in the transmission of knowledge is also observable in the paradigm T-L, as it is a conception of pedagogy that gives rise to a pedagogical model in which the recipient of the teaching, in addition to benefiting from the condition of the mentioned learner, also exercises the role of teacher to teach others less qualified (obtaining in this way also the benefits of having to exercise the attitudes of teaching responsibility, of having to develop the skills to communicate, and of the knowledge required to build cognitive objects with teaching utility). In fact, the process of teaching makes the knowledge learned objective and produces a higher state of consciousness about that knowledge [11].

From the constructivist point of view, learning is constructed in daily interaction between the elements of the environment and the personal ones, but, above all, of the relationship between subjects. The student only learns when learning is significant according to its structure and previous value scheme [12]. Therefore, one learns what one understands, hence the importance of the process that leads one to seek solutions [13].

The application of a two-way learning scheme, studying on the one hand and teaching on the other hand, in addition to ensuring the assimilation of contents through teaching, guarantees the distribution and personalization of the effort to avoid one single teacher overseeing all the students [14].

These practices are encompassed within the theoretical framework of expert–novice formative pedagogy, of formative programs of "mentors" [15]. Mentoring is an in-person or online practice that was extended to the mid-1970s, in the Anglo-Saxon world, to facilitate the processes of adaptation, transition or personal and professional development, where a mentor and another less experienced or mentored individual are related in a learning process to develop the competencies and capabilities of the novice in a given field [16]. Examples include that of Jones, Fremow and Carples in pyramid training of elementary school teachers to use a classroom management "skill package" [17], in the beginning, or of the more recent Pence, Peter and Giles, in teacher acquisition of functional analysis methods using pyramidal training [18].

With the proposed pyramidal tutoring structure and level stratification, cooperative work is favored, not only with peers, but also between teacher and learner, in an asymmetric relationship, and group work, which is necessary to achieve proper learning. This system generates a cascade training independent of the figure who initiated the process, achieving independent self-learning of the figure of the teacher that was sought [19].

1.3. Objective

Taking advantage of the improvements that have been made in education through technology and the increase in people used to learning through e-learning systems, the aim of this article is to design and develop an innovative platform capable of providing quality learning to a huge user community thanks to its explosive expansion.

This platform will make possible the usual teacher–student role exchange in a new training space, e-learning type, in which learning uses ICT as an educational paradigm change where the participation of the teacher and the student is materialized in a pyramidal school that uses the two-way learning scheme and all are considered learners with new educational practices, where the strong point is the active and democratic collaboration of all participants.

2. Functional Specification

2.1. Modeling

The starting point to develop the solution to the specified problem is to obtain a model. This model is created by abstracting the common points of the elements of the problem as a whole. In this case LMS, MOOC platforms and other different but equally learning-oriented platforms are compared. The objective is to discover whether the "pyramidal learning platform" fits any of the models to which these platforms belong or, on the contrary, it is necessary to create a new model. Each platform proposed below serves as an example to obtain the properties that we want or not in our model.

The result of the analysis of these platforms is the Table 1, which indicates if each platform complies or not with the extracted characteristics. If a platform presents a "NO", it means that its model is not the appropriate one. According to the table, pyramidal learning platform could belong to the LMS model. However, due to the learning methodology presented and the innovative nature of the proposed platform, a new model is considered: tutored e-learning platform.

$$\begin{aligned} M_{T_{ELP}} = & < AccesToCourses : byLevel > \wedge < Evaluation > \wedge < Forums/Chats : Yes/No > \\ & \wedge < Tutorials : betweenLearners > \wedge < GradeQuery : yes > \wedge < CreateCourses : byRole > \\ & \wedge < Content : stratifiedWiki > \wedge < PublishAndDownloadContent : byLevel > \\ & \wedge < IntegrationWithOtherToolst : yes > \end{aligned}$$

Therefore, the pyramidal learning platform belongs to the **tutored e-learning platform** model.

Table 1. Model decision for the pyramidal learning platform.

	Access to Courses	Evaluation	Forums or Chats	Tutorials	Content Structuring by Hierarchies	Publish and Download Content	Grade Query	Create Courses	Integration with Other Tools
Moodle	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Chamilo	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No
Claroline	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SWAD	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes
ILIAS	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Udacity	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No
Coursera	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No
edX	Yes	Yes	Yes	No	Yes	No	Yes	Yes	No
Udemy	Yes	Yes	No	No	No	Yes	No	Yes	No
UACloud	No	No	Yes	Yes	No	Yes	Yes	No	Yes

2.2. Formulation

The established model indicates the basic functions that the platform must fulfill, but it is necessary to extract the particularizations capable of providing a solution to the specific problem dealt with in this article.

Extracted from the objective:

EA—Easily accessible.

EGL—Explosive growth of learners.

OIALL—Offer information according to the learner's level.

AIGC— Auto-incremental growth of contents.

EQLL—Ensuring quality levels of learning.

SU—To be used in solidarity.

Extracted from the state of the art:

MLE—Make learning easier.

ILL—Independence of learning from localization.

EAK—Evaluate the acquired knowledge.

Arbitrary inspired objectives:

EIOT—Easily integrated with other tools.

"Pyramidal learning platform" is a particularized tutored e-learning platform model to be easily accessible and independent of learning from localization, allow an explosive growth of learners, have an auto-incremental growth of contents, offer the appropriate information to the level of the learner, usable in a solidary way, facilitate and evaluate the learning and to ensure quality levels of learning, and be easily integrated with other tools.

Alternatively:

$PLP = T_{ELP} \wedge EA \wedge ILL \wedge EGL \wedge AIGC \wedge OIALL \wedge SU \wedge MLE \wedge EAK \wedge EQLL \wedge EIOT$

3. Proposed Solution

Once the specific functionalities of the platform have been defined, the modules that conform the solution proposal are considered. Table 2 shows the established modules and the functionalities covered by each one. It has been decided to group the functionalities so that the proposed solution consists of two sub-platforms that can be reused in other projects and allow their implementation separately.

Table 2. Grouped features.

Wiki Platform	**EA**	**ILL**	**MLE**	**EGL**	**OIALL**	**EQLL**	**SU**	**AIGC**	**EAK**	**EIOT**
Access API	x	x					x			x
Knowledge Database (stratified wiki)			x				x			
Content management (consultation-edition)					x			x		
Management of contributions and queries									x	
Contribution quality management						x		x		
Learning system	EA	ILL	MLE	EGL	OIALL	EQLL	SU	AIGC	EAK	EIOT
Access API	x	x					x			x
Pyramid tutoring system			x	x		x				
Access to information management					x					
Teacher quality management						x				
Evaluation system							x		x	
WebApp	x	x					x			

WebApp: The access to the platform will be done through a web application in charge of generating the user interface and carrying out the requests to the Application Program Interfaces (APIs) of the other sub-platforms. This module allows access from any location, making the learning independent of the geographical location and the solidary use of the platform.

Wiki Platform: This grouping will form the knowledge base of the platform and will manage the content, contributions and queries and the quality of the information stored. It will be made up of the following modules:

- Access API. API that is able to receive requests from any web application and send the response.
- Knowledge Database. It will be the database stratified by levels.
- Content management (consult-edition). The objective of this module is to organize the information obtained from the knowledge base.
- Management of contributions and queries. This module will count the contributions and queries.
- Contribution quality management. Each contribution must pass a quality assessment.

Learning platform: This grouping will manage the learning and assessment system. It consists of the following modules:

- Access API. It will have the same objective as the wiki's API.
- Pyramid tutoring system. It will be responsible for establishing tutor–student relationships.
- Access to information management. The objective of this module is to select the options that will be shown to each learner according to their level.
- Teacher quality management. It will evaluate the performance of each tutor.
- Evaluation system. This module will evaluate the knowledge acquired.

The possibility of adding and modifying content to the knowledge base, as well as the evaluation that other learners make of these contributions, together with the tutoring between learners of different levels, and the transmission of knowledge that this entails, causes the construction of knowledge by the learners exercised in their two roles, learning and teaching. Through this two-way methodology, the traditional learning figure is transformed into an active participative reality in the management and acquisition of knowledge. The application of the learning cascade generated by this methodology to a pyramidal tutoring structure enables a great growth of the platform and therefore the possibility of offering learning to a large percentage of the population. The structure of the proposed solution is Figure 1. Starting from this modular structure, the organizational proposal can be seen in Figure 2.

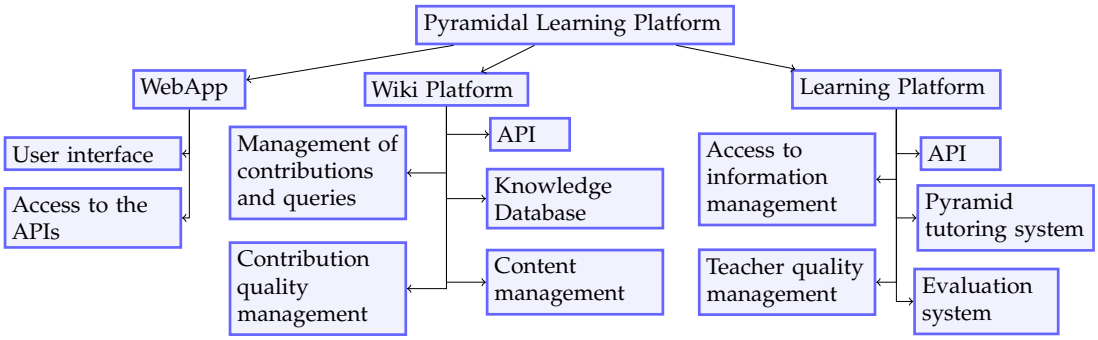

Figure 1. Structure diagram.

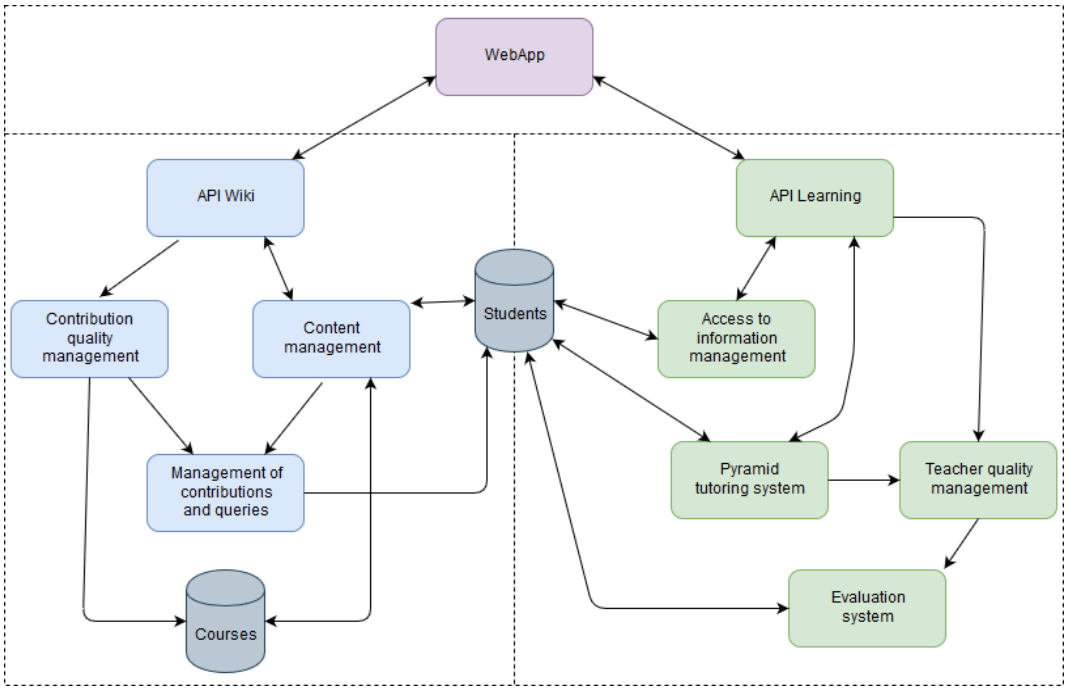

Figure 2. Organizational diagram.

Prototype Technology

The implementation of the prototype was carried out using different technologies for each grouping of modules of the platform; all of them are open source. The front-end was programmed with Angular, which allows separating the modules and the code of the web application by using components. The wiki and the learning platform were programmed with Lumen, a reduced version of the Laravel framework specialized in the creation of APIs for microservices. The database selected for this project is MySQL due to its simplicity, the stability it has, and the large amount of information available on the Internet.

4. Validation

To check the correct functioning of the platform, a series of phenomenological tests was performed. The deployed prototype did not have all the functionalities, but it allowed testing the main features of the platform, such as the interaction between users through tutorials and the contribution of knowledge to the courses that the platform had available at that time. First, two groups of 50 learners each were generated with arbitrary data to complete their profiles. Once created, the following formula was used to distribute the tutors in an adequate and equitable way.

$$\begin{cases} e \geq N/(\nu^2+\nu+1) \\ m = e\nu \\ b \leq e\nu^2 \end{cases} \qquad \begin{cases} e & \text{number of learners at the expert level} \\ m & \text{number of learners at the medium level} \\ b & \text{number of learners at the basic level} \\ N & \text{total number of learners} \\ \nu & \text{tutoring module} \end{cases}$$

The level of knowledge was distributed initially in three levels, which can be appreciated in the previous formula. Both groups were provided with different knowledge parameters more or less suitable for the pyramidal distribution; this was done to check the proper functioning of the formula for distribution of tutors. Once the groups were ready, we proceeded to create a large volume of tutorials, thus generating the first interactions between users. All this was with the aim of verifying that consumption and contributions were correctly recorded. Having already verified the tutoring part, the functioning of the contributions to the wiki was tested. It was checked if, when the users of the higher level accepted the new content that it x published and became the current information, and, conversely, when the users of the higher level decided that the new information introduced did not meet the quality requirements, it was discarded. Having in mind the above data, the prototype passed a rigorous testing, thus we can estimate that the Technology Readiness Level (TRL) of this project is 4 out of 9: component and/or breadboard validation in laboratory environment. (TRL is a tool used to measure the maturity level of a technology, providing us with a common methodology to measure its state. It is assigned a level according to the requirements met by the current state of technology, being 1 the lowest and 9 the highest. https://www.nasa.gov/directorates/heo/scan/engineering/technology/txt_accordion1.html)

5. Conclusions

The learner is an active actor in the acquisition and construction of knowledge, in feedback and continuous evaluation, through the study of the content of the courses, the performance of the proposed tests and the incorporation of new knowledge in the wiki. In that way, the platform acts as an integrative element together with the subject in the active construction of knowledge. The way of working of the platform provokes the growth, updating and continuous improvement of the contents of the wiki, generating a multidisciplinary knowledge base of great value in itself. Due to the learning system and tutorials, along with the information stored in the knowledge base, this platform is suitable for disseminating and promoting training in resource-poor environments where quality training is normally not easily accessible. Therefore, in addition to being an online learning tool and supporting formal training, it is appropriate for solidarity learning projects. After analyzing the results of the tests performed, the developed platform is ready for real-world testing. These tests must show the effectiveness of the methodology and the increase of the skills developed by the students. In future versions, it is planned to work on the quality management system in order to automate the process as much as possible. In anticipation of an increase in the number of learners and courses on the platform, it will be advisable to deploy it in a cloud environment capable of distributing the load of requests in order to ensure optimum performance at any moment.

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References

1. Sudam Kaware, S.; Kumar Sain, S. ICT Application Education Overview. *Int. J. Multidiscip. Approach Stud.* **2015**. *2*, 25–32.
2. Sáez López, J.M.; Domínguez Garrido, C.; Mendoza Castillo, V. Valoración de los obstáculos, ventajas y prácticas del e-learning: Un estudio de caso en Universidades Iberoamericanas. *Educ. Siglo XXI* **2014**, *32*, 195–220, doi:10.6018/j/202221.
3. Al-Gahtani, S.S. Empirical investigation of e-learning acceptance and assimilation: A structural equation model. *Appl. Comput. Inf.* **2016**, *12*, 27–50, doi:10.1016/j.aci.2014.09.001.
4. Ouadoud, M.; Chkouri, M.Y.; Nejjari, A.; El Kadiri, K.E. Studying and comparing the free e-learning platforms. In Proceedings of the 2016 4th IEEE International Colloquium on Information Science and Technology (CiSt), Tangier, Morocco, 24–26 October 2016; pp. 581–586, doi:10.1109/CIST.2016.7804953.
5. Welsh, E.T.; Wanberg, C.R.; Brown, K.G.; Simmering, M.J. E-learning: Emerging uses, empirical results and future directions. *Int. J. Train. Dev.* **2003**, *7*, 245–258, doi:10.1046/j.1360-3736.2003.00184.x.
6. Sezer, B.; Yilmaz, R. Learning management system acceptance scale (LMSAS): A validity and reliability study. *Australas. J. Educ. Technol.* **2018**, *35*, 15–30, doi:10.14742/ajet.3959.
7. Vinader Segura, R.; Abuín Vences, N. New educational models: The MOOCs as online teaching paradigm [Nuevos modelos educativos: Los MOOCs como paradigma de la formación online]. *Ilu* **2013**, *18*, 801–814, doi:10.5209/rev_HICS.2013.v18.44278.
8. Pursel, B.K.; Zhang, L.; Jablokow, K.W.; Choi, G.W.; Velegol, D. Understanding MOOC students: Motivations and behaviours indicative of MOOC completion. *J. Comput. Assist. Learn.* **2016**, *32*, 202–217, doi:10.1111/jcal.12131.
9. Page, K.L.; Reynolds, N. Learning from a wiki way of learning. *Stud. High. Educ.* **2015**, *40*, 988–1013, doi:10.1080/03075079.2013.865158.
10. Barajas, M.; Frossard, F. Mapping creative pedagogies in open wiki learning environments. *Educ. Inf. Technol.* **2018**, *23*, 1403–1419, doi:10.1007/s10639-017-9674-2.
11. López, N.C.; Rada, T.S. La participación del alumnado en los procesos de formación y mejora docente. una mirada a través de los discursos de orientadores y asesores de formación. *Profesorado* **2014**, *18*, 228–244.
12. Levy, B.L.M. Youth Developing Political Efficacy Through Social Learning Experiences: Becoming Active Participants in a Supportive Model United Nations Club. *Theory Res. Soc. Educ.* **2018**, *46*, 410–448, doi:10.1080/00933104.2017.1377654.
13. Carretero, M. Constructivismo y Educación. Reseñado por Maximiliano E. Korstanje. 2009. Available online: https://edrev.asu.edu/index.php/ER/article/viewFile/1560/227 (accessed on 15 November 2019)
14. Perkins, R.; Aufegger, L.; Williamon, A. Learning through teaching: Exploring what conservatoire students learn from teaching beginner older adults. *Int. J. Music Educ.* **2015**, *33*, 80–90, doi:10.1177/0255761414531544.
15. Irby, B.J. Editor's Overview: Mentoring, Tutoring, and Coaching. *Mentor. Tutor. Partnersh. Learn.* **2012**, *20*, 297–301, doi:10.1080/13611267.2012.708186.
16. Single, P.B.; Muller, C.B. Electronic Mentoring: Issues To Advance Research and Practice. In Proceedings of the 12th International Mentoring Association Annual Meeting, Atlanta, GA, USA, 15–17 April 1999.
17. Jones, F.H.; Fremouw, W.; Carples, S. Pyramid Ttraining of elementary school teachers to use a classroom management "SKILL PACKAGE". *J. Appl. Behav. Anal.* **1977**, *10*, 239–253, doi:10.1901/jaba.1977.10-239.
18. Pence, S.T.; St. Peter, C.C.; Giles, A.F. Teacher Acquisition of Functional Analysis Methods Using Pyramidal Training. *J. Behav. Educ.* **2014**, *23*, 132–149, doi:10.1007/s10864-013-9182-4.
19. Calero García, M.J.; Cruz Lendinez, A.; Campos Calero, Á. La mejora de la salud de la población saharaui a través de la innovación docente en educación: Un proyecto de formación en cascada. *Index Enferm* **2016**, *25*, 198–202.