NeuroK: A Collaborative e-Learning Platform based on Pedagogical Principles from Neuroscience

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Abstract: The use of online education platforms has grown extensively and most education centers and companies use them for their learning programs. Although technology has changed the learning environment, the pedagogical model has mostly remained the same as it was many years ago. Therefore, another education paradigm should arrive to online platforms in a generalized way. In this paper, NeuroK is presented as a new e-Learning platform leveraging the latest technologies and, moreover, implementing new tools that support pedagogical principles from neuroscience. While most of traditional platforms focus on content, content management and applying teacher-centred methodologies (everything goes through the teacher), NeuroK focuses on students, and uses collaborative learning, motivational processes and a "learning by doing" perspective to achieve a long-term relevant learning. The proposed NeuroK framework describes the already implemented tools and the new ones to be included in next versions. An active R&D process allows new methodologies from the fields of Learning Analytics, Data Mining and Social Learning to be proposed and implemented. The main contribution of this platform is to deploy a significant improvement in the e-Learning process based on a neurodidactics approach and data analysis research results.

1 INTRODUCTION

During the last decade, there has been significant changes in the educational field, especially strengthened by new technological developments. Tools as e-learning platforms or Learning Management Systems (LMS) are now common for educational institutions and companies. Indeed, NMC Horizon Report (Johnson et al., 2014) pointed out that online, blended and collaborative learning will be widely adopted in the short term, and that learning analytics environments, using predictive modelling, will be adopted in the mid-term.

The main advances happened around online training frameworks, enabling people to learn almost everything remotely and costless. This new concept of learning is called e-learning. It is defined as a remote way of learning which facilitates and makes more flexible the teaching/learning process, adapting it to the skills, needs and availability of each different student. E-learning saves time, money, materials, and resources by keeping everything online. As technology continues to push e-learning forward, education and training will become more popular and reach wider audiences. But it is not only the technology alone what makes e-learning so important (Haythornthwaite et al., 2016), but also the inclusion of innovations from different fields such as the use of educational gaming and gamification (De Marcos et al., 2016), big data techniques (Anshari et al., 2016), collaborative learning (Masud, 2016), among others.

There are many e-learning platforms allowing the communication and interaction between teachers, students and the study contents. They include different learning systems such as instructor-led learning, e-books, tests, video tutorials and so on. And they can be served from web browsers, mobile apps or desktop applications mainly (Fallon and Brown, 2016). Also, e-learning platforms can be

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extended with administrative resources, and these systems are called Learning Management Systems. In this paper the interest will be focused on web-based applications.

Some of the most recognized platforms in this field are commercial as Blackboard, WebCT, OSMedia, Saba, eCollege, Fronter, SidWeb, E-ducativa or Catedr@, among others. Nevertheless, the market of open source solutions has grown a lot in the last years and platforms as ATutor, Dokeos, Claroline, dotLRN, Moodle, Ganesha, ILIAS or Sakai are as known and useful as the commercial ones. In some cases, offering even more functionalities than commercial solutions.

Massive Open Online Courses (MOOCS) have also experienced a great improvement with platforms as Udacity, Coursera, Udemy, edX, Ecaths, Wiziq or Edmodo. But this kind of platforms are more limited than the general ones mentioned before. They are focused only on video-based lessons and tests/exercises, with the purpose to obtain badges demonstrating some kind of knowledge.

Analyzing the market for all these applications, it can be highlighted that more than 90% of the US higher education institutions are using LMS's (De Smet et al., 2016). But OECD reports that universities use LMS for administrative and communicative purposes, instead of offering new pedagogical ways of teaching (Dalsgaard, 2006). So, there is still a lot to research to improve learning processes, experiences and students' satisfaction.

One of the main problems for online education is the attrition and dropout rate of students. Many researchers are focusing on this subject (Monteiro et al., 2016). The issue is that students motivation fall down after the first two weeks and they leave the course. Also, the completion rates are too small, especially for MOOCs where the completion rate almost always falls between 2% and 5%, and in few occasions exceeds 10% (Jordan, 2015). Moreover, the information learnt by the students is forgotten in a short period of time (Bacon & Stewart, 2006).

The issue underneath all the advances in education is that technology has changed a lot, but the way of teaching remains the same. Platforms such as Moodle, Blackboard or even MOOCs have just displaced traditional education from classrooms to websites, but without changing the way of teaching knowledge.

Neurodidactics (Anastasia 2016; Sabitzer, 2011), also called brain-based teaching, tries to overcome classical education with some new tools, and starting to teach from a different point of view. "*Knowledge cannot be transferred, it must be newly created in the brain of each student*" (Roth, 2004). According to this, neurodidactics proposes a learner centred education. It avoids just giving materials to study, instead of that, it offers examples, associations and linking information to build knowledge. The reason is that just giving new information, the long term memory is not activated. The more often associations and links are used and practiced, the better the knowledge will be acquired (Westerhoff, 2010). The magic recipe to learn with the long term memory is motivation (Di Gesù & Seminara, 2012; Rivas, 2009), which gives the students the incentive to learn and the ability to concentrate (Hermann, 2009 and Harandi, 2015). There are several ways to achieve this goal, for example, using gamification, learning by doing, flipped classroom, cooperative learning, small group learning, peer tutoring, and the use of real life challenges, among others (Hattie, 2009).

Most of the current e-learning platforms don't implement any of these tools to manage motivation as a keystone of the education, nor follow the neurodidactics perspective. Therefore, there is a research opportunity in the e-learning field. The overall objective of this paper is to address on-line education from the perspective of the new trends in e-learning and the principles of the neurodidactics provided by the proposed new platform NeuroK (https://neurok.es/en). This could provide an important step in changing traditional online learning paradigm, allowing to learn in a collaborative and cooperative way by means of an attractive and motivating social network environment. In addition to the already implemented tools, there are many others that will be incorporated in the next versions. These tools are based on new research lines in the field of Learning Analytics and Social Learning that match the neurodidactics approach.

2 NeuroK FRAMEWORK

After many successful experiences in software development, ASPgems started collaborating with some Universities trying to develop an innovative e-learning solution. NeuroK platform was built based on the latest methodological advances of neurodidactics (Sousa, 2014; Edelenbosch et al. 2015). As other social networks, it pays special attention to debate, new opinions and engaging features as notifications, hashtags or mentions. All

of them encouraging to learn by motivation (Waelti et al. 2001).

NeuroK focuses on the student, not on the content or the teacher like traditional learning paradigms do. The students interact and collaborate to build the information they will learn. They choose, analyze, compare materials, and argue about the proposed learning units. They also peer review the activities of their classmates, and give opinions about them. The teachers are not expendables, as other online platforms intend. They are not eligible for expense reduction. In NeuroK, the teacher has a fundamental role as a "learning guru", providing the course criterion, the main guidelines to follow, managing the information provided by the students, and personally supporting them. He tries to achieve the goals of the course, following the path the students set up, and redirecting according to his experience.

The NeuroK environment is a social network. It gives the teachers the tools to teach by doing. The knowledge is built by all the participants of the course in a continuous way, thanks to their comments, favorites, reviews, documents sharing, cooperative problem solving and much more. This kind of social learning boosts their motivation and makes easier reaching a long term learning.

The main features of NeuroK are oriented to serve the three C's: Communication (to share the knowledge), Community (to connect students and build groups) and Cooperation (to propose ideas and solve problems with cooperative learning).

NeuroK is a cloud platform always accessible from any device. It is very easy to use, and the learning curve is very soft, according to the students' opinions who have already tested it. It supports from small groups to a large number of students. Many different kinds of documents can be published from Youtube, Vimeo, Drive, Dropbox, or local materials from students and teachers.

Every course starts on the home page (see Fig. 1). The central space is devoted to the social activity, the same as Facebook or Twitter do, denoting the importance given to collaboration and interaction among students. The students follow the teacher and other students who they think are especially relevant. The social interactions appearing in the central timeline can be filtered including everything, just the people they are following, or just the teacher. This collaborative way of creating contents by publishing documents, debating, solving problems and peer based rating, strictly follows the neurodidactics principles, and it is very attractive and motivating to the students (Elsenbaumer, 2013). They see NeuroK as another social network, easy to use, engaging, offering new materials and comments all the time, and challenging their skills to solve problems. Students are intended to learn with motivation, like if they were playing.

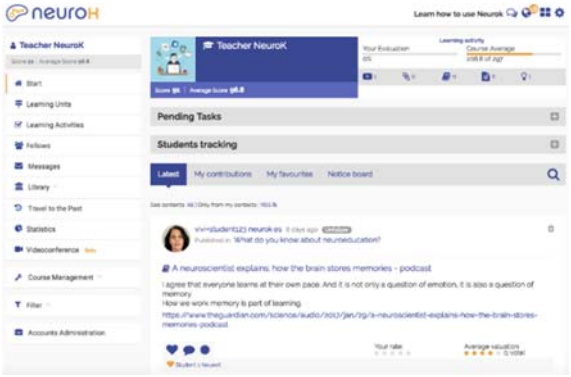

Figure 1: NeuroK home page.

The main actions to take in NeuroK are accessed from the home page. At the top, the one-on-one contact and the notification buttons can be found. Just below, there is a small summary about the user participation on the course. In the central panel the timeline shows the latest publications, but the user can also filter by only his contributions, favourites (marked before), or the noticeboard (communications from the platform or the teacher). The student can directly read, comment, recommend or mark as favorite any publication. It is very easy and intuitive to interact giving opinions, rating others comments, or even peer reviewing activities from other classmates.

In the left panel the access to *Learning Units* can be found. It includes the proposed contents to generate a debate, *Learning Activities* and practical questions and problems about the contents of each learning unit. Everything to "learn by doing" both in an individual or collaborative way.

Figure 2: Global statistics.

Some other important options in the left panel are *Library* (with contents shared by the teacher), *Travel*

to the past (if the student leaves the course for some time, then he can restart from that point and follow the evolution of the posts, comments, etc), *Statistics* (more detailed global and individual statistics) and *Video call* (allowing a group of students to contact by video conference).

The global statistics table shows the participation level of the students in a color scale (Fig. 2). It gives the teacher quick information about the development of the course in general and lets him know which students are at risk of abandonment. With the individual statistics (Fig. 3), the teacher can observe the students at risk, and make some engaging actions to try to motivate them to continue participating in the course. Some actions to re-engage students can be performed based on these data. Some actions can be automated (with rules e.g., sending an automatic e-mail) and others can be done directly by the teacher.

The objective of these descriptive measures is to offer all the information available to the teacher, so he/she follows the students, motivates them, customizes the contents, and redirects the courses. As we mentioned before, dropping out is one of the main concerns for e-learning. To reduce the dropout rate, some new measures are being developed, as the use of percentiles, the estimation of probabilities of abandonment or the evaluation of a social index to detect influencers. Other new tools have also been researched and/or developed at Cátedra ASPgems (University of Extremadura), i.e.: word clouds, multi-text summarization and social graphs (see Section 3). They will be used to evaluate students, identify possible dropouts, and to direct the course in case that data show the learning units are deviating from their objectives.

Besides, other features such as gamification have already been implemented. The students earn points with the actions they do in the platform. Then, a ranking by points is shown at the global statistics. This motivates them to earn more points participating in the course. It could be possible to expand this feature to include badges.

In conclusion, NeuroK not only has implemented tools supporting neurodidactics theories, but also it obtains very interesting information by using learning analytics to follow and evaluate students in real-time. With the integration of new educational tools, a robust e-learning platform is built, leaving behind the traditional ones just focused on contents.

Figure 3: Individual statistics.

3 NEW EDUCATIONAL TOOLS

There are some educational tools that will be considered for inclusion in the NeuroK platform in next versions. Specifically, one module for natural language processing and another one for social network analysis are under implementation or under a research phase.

The first module comprises two different, but related functionalities. On the one hand, a word or tag cloud tool has been implemented (see, e.g., Resendes et al. 2015). The objective is to provide a fast and visual representation of the contents provided by the students within the different learning units. After considering all the messages provided by the students in a certain learning unit, the instructor will be able to analyze if they are using the right concepts in their comments. Several metrics to measure the deviation from the theoretical situation defined by the instructor have been also implemented. On the other hand, an automatic multi-document summarization approach is under research. Multi-document summarization consists in the extraction from multiple texts about the same topic. The problem consists in a multi-objective optimization to obtain the maximum coverage with the minimum redundancy (see, e.g., Saleh and Kadhim, 2016). In this case, the multiple texts would be the messages of the students in a learning unit about a concrete topic. This allows the instructor to analyze both, the comments in a learning unit and the contribution of each particular student to the summary. Multi-document summarization is a current research line with a great potential for this kind of online platforms. Both the word cloud and the multi-document summarization tools share some aspects of the natural language pre-processing step.

The second module is based on social network analysis applied to NeuroK software. Nowadays, social network analytics is playing an important role in online platforms (see, e.g. Buckingham and Ferguson, 2012). A lot of important information can be extracted from the relationships among the members of the social network. Firstly, a good graphical implementation should be displayed, followed by a number of metrics. These graph and metrics should represent the relative importance of each student in the social network based on his/her comments, observations or ratings, providing a great information about the structure of the network and how the students relate. This would help in the identification of influencers or key players, who may be good knowledge brokers. Identification of a set of key players in a given social network is of great interest in this context. Up to now, most of the used algorithms for this task are based on single objective, however, in this case, it is necessary to find a set of key players which can perform well with respect to multiple objectives of interest (see, e.g., Gunasekara et al., 2015). There is much room for improvement in this area.

4 CONCLUSIONS AND FUTURE WORK

NeuroK e-learning framework has been presented. It is an innovative neurodidactics-based platform. NeuroK offers teachers the essential tools to follow, guide and evaluate students and, most important, to motivate them achieving an effective long-term learning.

It is not a MOOC or a traditional e-learning framework focused on contents. NeuroK is, instead, a social network focused on the students which lets them learn by doing activities in a collaborative way and not in a memorizing-based approach. It has innovative features such as gamification, learning analytics, peer reviewing, content analysis, social network interface, travel to the past, and a collaborative learning perspective, among others.

NeuroK has already been tested in relevant institutions with users such as Universidad Rey Juan Carlos (Spain), Universidad Libre de Música de Guadalajara (Mexico), Niuco, Banco Santander or Catenon Multinational. More tests, including learning analytics data analysis, will be driven at the University of Extremadura. Some experimental results to try to demonstrate the efficacy of this approach will be obtained during the next months.

Now, Cátedra ASPgems (University of Extremadura) leads the R&D actions in the fields of Learning Analytics, Data Mining and Social Learning. The future work includes researching and implementing new methodologies, including Big Data techniques to analyze massive amounts of data coming from the platform. The results will allow to understand what happens during the educational process and to predict what will occur in the future. This will give to the teachers a deeper knowledge of the students behaviour (what they know, what they need and what they are going to do next), allowing to act in advance by improving the learning process and completion rate.

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