



ALAS-KA: A learning analytics extension for better understanding the learning process in the Khan Academy platform



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ABSTRACT

The Khan Academy platform enables powerful on-line courses in which students can watch videos, solve exercises, or earn badges. This platform provides an advanced learning analytics module with useful visualizations. Nevertheless, it can be improved. In this paper, we describe ALAS-KA, which provides an extension of the learning analytics support for the Khan Academy platform. We herein present an overview of the architecture of ALAS-KA. In addition, we report the different types of visualizations and information provided by ALAS-KA, which have not been available previously in the Khan Academy platform. ALAS-KA includes new visualizations for the entire class and also for individual students. Individual visualizations can be used to check on the learning styles of students based on all the indicators available. ALAS-KA visualizations help teachers and students to make decisions in the learning process. The paper presents some guidelines and examples to help teachers make these decisions based on data from undergraduate courses, where ALAS-KA was installed. These courses (physics, chemistry, and mathematics) for freshmen were developed at Universidad Carlos III de Madrid (UC3M) and were taken by more than 300 students.

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1. Introduction

Education is being boosted by new tendencies to improve the learning process, and learning analytics is one of the most promising tools. Although there is a debate about the definition of learning analytics, we consider the learning analytics term in a broad sense as introduced in the call for papers of the 1st LAK conference¹: “Learning analytics is the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs.”

There are two main approaches for making decisions based on learning analytics techniques. On the one hand, work on visual analytics (Duval, 2010; Leony, Pardo, de la Fuente, Sanchez, & Delgado, 2012; Mazza & Dimitrova, 2004; Schmitz et al., 2009) aims at providing students with visualizations for self-reflection and at providing teachers with visual information so that they can interpret and make decisions taking into account the educational context. Therefore, teachers and students make final

decisions with the help of the visual information. On the other hand, other works (Chen & Persen, 2009; D’Mello, Lehman, & Graesser, 2011; Ya Tang & McCalla, 2005; Özyurt, Özyurt, Baki, & Güven, 2013) aim to implement automatic actuators, such as recommenders or adaptive systems, which take into account different variables related to the learning process to carry out their actions. These automatic actuators do not require teacher or student intervention but are usually restricted to specific indicators (while visual analytics usually cover a wider range of possibilities); however, they might make more errors in their decisions than live people.

The use of MOOCs (Massive Online Open Courses) is emerging as a new paradigm. In this context, the use of learning analytics becomes more necessary because it requires instructors to analyze and to interpret students’ learning processes on a large scale (thousands of students in a course). Tools that provide insights about this learning process are required because a teacher cannot take care of so many students in detail in an efficient way without technological help.

The Khan Academy² platform is one of the pioneer systems for running MOOCs. The Khan Academy system provides an advanced

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¹ <https://tekri.athabasca.ca/analytics/>.

² <http://www.khanacademy.org>.

learning analytics support (considering the previously introduced broad definition of learning analytics). Some of the included features are related to the skill progress, the exercise report, or the student activity report. Even though the Khan Academy system offers this analytical support through several visualizations, some interesting information is not included in its module. Therefore, an extension is required to achieve the goal of including this additional information.

In this paper, we present our implemented ALAS-KA module (Add-on of the Learning Analytics support of the Khan Academy) as a contribution to the visual analytics area, and specifically make the following contributions:

- We provide an overview of the implemented architecture of ALAS-KA for extending the Khan Academy learning analytics support (Section 4). This architecture enables teachers to process the huge amount of educational low level data (in the form of events) and to obtain higher level learning information that can be presented in the form of visualizations and recommendations.
- We describe new types of visualizations that were not previously present in the Khan Academy platform with new types of information (Section 5). On the one hand, these types of visualizations are novel because other visual analytics works have usually focused on direct indicators (such as number of accesses, number of posts, and correct number of exercises) but these visualizations show information about complex processes (e.g. taking into account pedagogical aspects such as for unthoughtful users, hint abusers, and affective information). On the other hand, the new visualizations imply an advancement with respect to the previously supported Khan Academy functionality.
- We give an analysis about how ALAS-KA visualizations can be used for making decisions about the learning process (Section 6), illustrating with different examples with real student data from pre-graduate courses at UC3M with more than 300 students. The ALAS-KA visualizations can give teachers a general view of different useful indicators of their classes so that they can make proper corrections, enable students' self-reflection, or use a user model's automatic definition based on learning styles and emotions.

2. Related work

2.1. Learning analytics

Learning analytics can be seen as a particular case of the Big Data phenomenon in the e-learning scenario (Duval & Verbert, 2012), it aims to combine historical and current user data to provide useful information in each moment (Elias, 2011). Following the visual analytics paradigm, several systems incorporate visualization tools, including: CAMERA (Schmitz et al., 2009), which enables social network visualizations; GLASS (Leony et al., 2012), which shows the most used events by students; CourseVis (Mazza & Dimitrova, 2004), which is integrated in the on-line WebCT platform; or other works applied in Moodle, such as Moodog (Zhang & Almeroth, 2010), which tries to make an analysis of some interactions in a course through visualizations, or the application of visual analytics techniques to logs using tag clouds (García-Peñalvo, Conde, Bravo, Gómez, & Therón, 2011). The work in (Duval, 2010) shows several learning dashboards and recommender examples. Furthermore, they do a comparison between educational and non-educational user tracking environments (Duval, 2010).

There are also many recommender educational systems. These tools are focused on providing feedback related to some elements

of the learning process (i.e. what video should be seen next or what forum post could be useful). In this direction, there are tools that assist the learning process with forum posts that might be helpful for students, or messages which might benefit current students based on former learners' knowledge (Chen & Persen, 2009). There are also several other recommendation tools that help people by offering resources and papers that could be of interest to them (e.g. Recker, Walker, & Lawless, 2003; Ya Tang & McCalla, 2005).

Although the Khan Academy platform already provides powerful learning analytics visualizations (e.g. for knowing the students' progress in different skills or the students' last activity in the different resources), there is room for improvement. One example of the new analysis of learning processes provided by ALAS-KA is the analysis and visualizations of affective states. This issue has been approached from several perspectives, ranging from the use of physical sensors (Arroyo et al., 2009) to the probabilistic analysis based on the student actions (Baker, D'Mello, Rodrigo, & Graesser, 2010; Conati & MacLaren, 2009). Intelligent tutors are among the tools with the most use of emotional information. For instance, AutoTutor uses natural language processing to detect the affective state of the learner and respond accordingly (D'Mello, Lehman, & Graesser, 2011). Other categories of tools that have taken advantage of affective information are educational games such as Prime Climb (Conati & MacLaren, 2009) and immersive environments, with Crystal Island as an example (Robison, McQuiggan, & Lester, 2009). In our case, a MOOC framework (within Khan Academy) is used for the calculation and visualization of affective states.

The work presented in this article is also related to the concept of learning styles. The ALAS-KA module gives (among other things) individual visualizations with personal learner values for different user features, which can define a learner model as a combination of different indicator values. Felder and Silverman (1988) initially elaborated in detail upon the concept of learning styles. Learning styles are one of the individual traits considered to be part of the user model in adaptive educational systems (Brusilovsky & Millán, 2007; Graf, Liu, Chen, & Yang, 2009); this can be also observed in more recent developments of adaptive educational environments (Özyurt et al., 2013). Researchers have recently studied the analysis of the relation of learning styles to cognitive load during an activity to learn programming (Abdul-Rahman & du Boulay, 2014).

2.2. Learning analytics support in the Khan Academy platform

The Khan Academy platform has a powerful learning analytics module. Khan Academy was one of the pioneer platforms to implement a great learning analytics support. The system allows people to access a great amount of educational data, including most of the low level events and users' interactions during their learning paths. In this way, all the required data is available for processing.

The learning analytics module has individual visualizations so that students can access their own information. There are also some global class visualizations that can only be accessed by teachers. One example of individual visualizations allows users to access their activities organized by time. With this feature, they are able to see what resources they have been using each day or for different intervals of time. Another type of individual visualization allows students to know their time distribution for the different skills or videos (shown as a percentage). Moreover, users can access the option "Skill Progress" to check their progress status in the different skills.

Fig. 1 shows one example of global visualization with two screenshots. One screenshot contains visualizations of each student, and another, visualizations of the entire class. The screenshot on the left side of Fig. 1, which is called "Progress Report," has as rows the different students and as columns the different exercises

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