Design of a Learning Analytics framework proposal in academic context

Proposta di un framework per i Learning Analytics nel contesto accademico

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In the last decades, learning analytics (LA) have been considered as one of the key emerging trend in higher education (Vassakis et al., 2018) and they have attracted a lot of attention among researchers and designers for their potential to address some of the major challenges in the academic sector (Bach, 2010). Despite the broad interest and implementation of LA processes, there remain numerous issues regarding the availability of developed and adaptable-to-the-context reference framework across Universities (Gaševi et al., 2015). Furthermore, scholars and practitioners have approached LA from a range of perspectives: it is necessary to define not only the aims of what could be achieved using LA but also what should be done to attain it. Generally, LA are considered as measurement, collection, analysis and reporting of learners' data and their contexts, to optimize learning and the environments in which it occurs (Khalil and Ebner, 2016). Starting from this definition, and using an action research method, we propose an "extended" LA framework that puts learner and instructor at the centre of it.

Keywords: Learning Analytics; framework; personalized learning

Negli ultimi decenni, i learning analytics (LA) sono stati interpretati come uno dei trend di maggiore importanza nell'ambito dell'istruzione universitaria (Vassakis et al., 2018) e hanno attratto l'attenzione di ricercatori e instructional designer per il loro potenziale nell'affrontare alcune delle principali sfide all'interno delle istituzioni accademiche (Bach, 2010). Nonostante l'interesse generale e l'implementazione di processi di LA, nelle università permangono numerosi problemi relativi alla disponibilità e allo sviluppo di modelli di riferimento adattabili ai diversi contesti (Gaševi et al., 2015).
Inoltre, ricercatori e instructional designer hanno indagato i LA da una serie di prospettive: è necessario definire non solo gli obiettivi che si possono raggiungere usando i LA, ma anche ciò che dovrebbe essere fatto per raggiungere tali obiettivi. Generalmente, i LA sono considerati come misura, raccolta, analisi e reporting dei dati degli studenti e dei loro contesti, per ottimizzare l'apprendimento e gli ambienti in cui esso si verifica (Khalil and Ebner, 2016). Partendo da questa definizione e adottando il metodo della ricerca-azione, il paper propone un framework di LA "esteso" che metta al centro lo studente e il docente.

Parole Chiave: Learning Analytics; framework; Apprendimento personalizzato

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1. Introduction

A learning analytics (LA) intervention is considered as the surrounding group of actions through which analytic tools, data, and reports are taken up and used. It refers to a soft technology that involves human processes (Arthur, 2009; Hlupic et al., 2002). To date, most research and development in LA has focused on the principal issues of data collection, management, processing and display. However, as we enter a stage in which LA are rapidly being rolled out for more general use, the design of a framework for LA becomes a critical element in supporting the effective implementation of these tools in the academic domain (Wise, 2014).

Nevertheless, short attention has been paid to adopt analytic models from operations to improve students and instructors' "direct" involvement even though their contribution seems to have had a large impact on their success (Bach, 2010).

To come into line with this research's flow, we conducted a systemic literature review of LA. Then, we propose an extended framework for a successful LA design and management that put the learner and instructor at the centre of the process.

In the following sections, we depict first a rationalization of LA, then we describe different components concerning LA. Secondly, we present our research method in which the process to define our framework design proposal is illustrated. Results, discussions and conclusions are drawn in the last part of the paper. Implications for practitioners are also considered.

2. Learning Analytics: definitions, data, models and obstacles

A LA intervention is described as the surrounding frame of activities through which analytic tools and data are taken up and adopted; it is a soft technology that involves the orchestration of different procedures. For this reason, existing research on LA focuses on different elements.

Firstly, some scholars explored LA definitions and their possible stakeholders (Campbell and Oblinger, 2007). For example, LA are intended as the measurement and reporting of data about learners, and have been advocated as a support tool for instructor regulation of collaborative learning or they have been considered ad statistical techniques and predictive modelling to help faculty and advisors in

determining which students may face academic difficulty, allowing interventions to help them in succeeding (Campbell and Oblinger, 2007) In these definitions, learners are usually considered "passive actors" or, mainly, "sources of data" even if there is a growing learners' demand for active participation to enhance their learning (Gaševi et al., 2015).

Secondly, research has pondered elements that must be taken into consideration when conducting LA studies. In such regard, Greller and Drachsler (2012, p. 43) define six elements that must be considered "to ensure appropriate exploitation of LA in an educationally beneficial way": stakeholders, objectives, data, instruments, external limitations (i.e. ethical, legal, managerial/organizational) and internal limitations (i.e. the lack of experts in analytics projects).

Thirdly, more recent analytics models about LA have been implemented by numerous scholars (Clow, 2013; Greller and Drachsler, 2012; de Freitas et al., 2015; Buckingham et al., 2012). The Learning Analytics Model (LAM) (de Freitas et al., 2015) is one of the most frequently used and defines how information should be tracked, aggregated and reported in a Learning Analytics System (LAS). Furthermore, Greller and Drachsler (2012) proposed a generic model intended as a guide in setting up services within an educational institution. In particular, they put in evidence the challenges of the soft dimensions of LA like ethics and the need for instructors to develop competences in interacting with data. Others are mainly oriented on tracking behaviours, persistence, achievement (Macfadyen and Dawson, 2010), participatory and peer learning (Clow and Makriyannis, 2011) and social LA (Buckingham et al., 2012).

Nevertheless, these studies continue to derive from traditional models that basically consider learners as "passive actors" and instructor the one who collects data on learners' activities (Siemens, 2013). Moreover, to date, the conceptualisations of these frameworks aspire to be completely realised, and LA implementations across higher education organizations are typically immature with limited ability to demonstrate manifest impact (Colvin et al, 2015).

Finally, obstacles in LA are often related to data sources and management: big sets of data and data collected from diverse sources, with distinctive standards and from users with different levels of access, reveal an important challenge presented by incorporating data analyses into strategic planning. Data are abundant and usually easy to extract, but they need to be turned into useful information (Van Barneveld et al., 2012), that is the crucial issue when designing an LA institutional strategy.

2.1 *Learning Analytics in the academic context*

There are different opinions about the main meanings of academic analytics. Some scholars (U. bin Mat et al., 2013; Aljohani and Davis, 2012; Goldestain and Katz, 2005) consider academic analytics as a new way of applying business intelligence in academic domains to provide data with the emphasis being on institutional, regional, and international levels; others (Huda et al., 2017; Maseleno et al., 2018) thought academic analytics as mainly focused on the improvement of organizational processes, workflows, resource allocation through the "use" of learner, academic, and institutional data. Likewise, academic analytics clarify the role of LA at the institutional, administrative and policy making levels (Aljohani, 2012).

Thanks to a well-defined process of LA, Universities could use specific set of data to develop decision making and resource allocation, recognize at-risk learners and areas of concern, they can get a better insight into their strengths and weaknesses, they can drill down on causes of complex challenges, and they can generate and try different academic strategies (Marks et al., 2016).

To reach these "potential aims", the actors involved (i.e. instructors, learners, designers) need to become further familiar with issues related to the use of LA, so most part of institutions continue to encourage training and innovations in this field (Avella et al., 2016).

3. Learning analytics: insights on the literature gap

As it is evident, no complete agreement exists on definitions, elements to be considered, obstacles to face and models to be adopted. The lack of a reference architecture causes troubles, both for institutional collaboration, setting an agenda and for the teaching and learning improvement.

The charge to Universities is to determine what data can support the improvement of learning and teaching, what actors have to be involved and at what level (Mattingly, et al, 2012). Furthermore, there are few considerations about learners and instructor as "active" participants in the whole LA processes (Gaševi et al., 2015).

Additionally, research shows that typically instructor is not viewed as a user and as an analyst at the same time, specifically as an analyst who goes deep into collected data to approach educational problems (Siemens, 2013). On the contrary, if instructors come through the mapping of data (i.e. methods and number of students, type of stu-

dents or level etc.), they would dynamically enter the framework being able to reflect on data that concern them directly or indirectly.

For these reasons, we strongly support the hypothesis of the creation of a structure of LA in which instructor and student's role are "integrated" in it. Learners will be viewed not only as the "source" of data, but they will be part of an interactive approach to explore their views and ideas about LA (Piotrkowicz, 2017). Thanks to LA outputs, learners can be encouraged to take personal responsibility for their personal situations - making use of the feedback available about what they are doing, and making proper decisions about support. Additionally, the instructor need to be more engaged and supported in the process and his/her role need to be more specified to give him/her authentic opportunities for reflection and reaction (Van Leeuwen, 2014).

4. Methodology

The research method adopted for the scope of this paper is the action research, which aims at "producing practical knowledge that is useful to people in the everyday conduct of their lives" (Eden, and Huxham, p. 238), through a continuous cycle of developing and elaborating theory from practice. Subjects and researchers are jointly responsible for developing and evaluating theory to guarantee that the results of the research help to solve a real challenge of the subjects and reflect the knowledge created through the participative process (Caporarello et al, 2020). Action research has been chosen because it aims to contribute both to the practical challenges of people in an immediate problematic situation and to further the goal simultaneously (Gilmore et al., 1996).

In our specific case, the challenge was related to the need of providing a tool based on data and information in LA processes enabling learner and instructor to have an active role.

Broadly speaking, our research entails phases of groundwork, intervention and theory testing and development. At this stage of the research, we are in the intervention phase.

In the groundwork phase, we identified the research gap analysing previous studies on LA: we search for best practices, conducting obviously first of all a literature review. Specifically, a structured documents retrieval process has been realized by launching on Scopus database the search terms "Learning Analytics", which have been cross-referenced (AND search) with "University", "learners", "definitions", "obstacles" and "models". The first search showed more 26.400 results after 2018. As our domain of analysis of LA is the higher education, then we ap-

plied the criteria more pertinent for academic domain (i.e., academic analytics, analytics and universities' course and programmes) and a short list of about 100 relevant papers emerged.

In the intervention phase, we organized focus groups with small groups of students held at Bocconi University. The aim of these meetings was to design a LA framework viewed as the best fitting tool able to reach the challenge. A choice of heterogeneity has been made for the creation of the groups. During the focus groups, an instructional designer acted as moderator and an academic developer transcribed the answers. Then, a team of academic developers put together the focus group outcomes, gathered the data and developed the framework.

In the theory testing and development phases, we will include the implementation of our framework within a real University context. Being the research method cyclic, theory testing and development phases will imply revision and modification of previous phases' results.

5. Framework proposal

As described in the previous paragraph, the action research method has been adopted to design the framework here presented (Fig. 1).

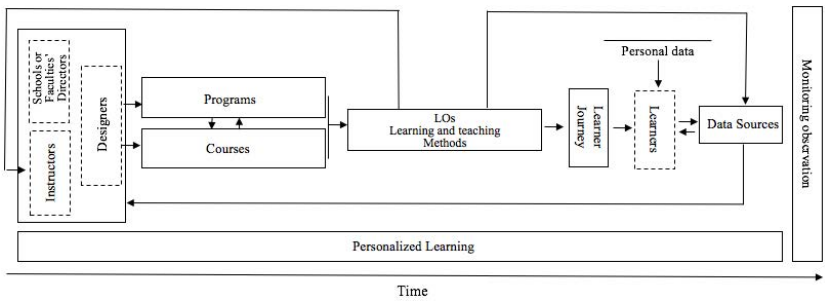

Fig. 1: LA Framework proposal

The list of elements in the framework is not intended to be exhaustive and can be extended on a case-by-case basis. More in detail, this framework identifies and maps each potential element of the LA in the academic context. The framework gives a picture of these elements considering a timeline that highlights the iterative nature of the entire process.

5.1 *Actors in the framework: the role of the instructor*

This framework is organized as follows. In the left part of figure 1, the actors potentially involved in the LA processes are illustrated: instructors, Schools or Faculties' directors and designers.

More in detail, the label "designers" refers to all different actors that can have responsibilities in all phases of courses' design. The educational actors in the framework are indicated in the dashed boundary boxes.

Instructors and Schools or Faculties' directors are in relation with the other components of the framework as described later on. Specifically, Schools or Faculties' directors and instructors interact to guarantee the coherence between programs and courses (i.e. in terms of outcomes, teaching and assessment methods) and to ensure the best possible learning experience.

Thanks to analytics, instructors can reflect on data that concern them directly (i.e. teaching methods) or not directly (i.e. students' performance). Regarding the data concerning the instructors directly, they can act as "designer" and then re-evaluate the goodness of their course design in a longitudinal perspective. Regarding the data concerning the instructors not directly, they can look at the students who perform worse and, therefore, intervene in good time.

5.2 *The learning experience: the role of the learner*

Then, moving from the left to the right, there is the part related to the teaching and learning experience that is articulated in programs and courses.

Of course, both programs and courses are designed starting from learning outcomes (LOs) identification and teaching and learning methods definition, according to the constructive alignment principle that emphasize the importance of the direct alignment among teaching activities, assessment and learning outcomes (Biggs, 2003). In fact, the next element of the framework is represented by the set – when available - of LOs of the programs as well as those of the courses. Between these two groups of LOs a relation exists: LOs of the programs refers – and should be coherent - with the LOs of the courses. In fact, ideally single courses' LOs should be integrated with the LOs attaining the whole program. Moreover, the LOs are - or should be - the basis of design and teaching methods choices. So, LA can be an also an excellent opportunity to verify the achievements of the outcomes themselves at

different layers: the single course learning outcomes as well as the program's learning outcomes. Of course, this can be possible only thanks to a precise articulation of the LOs. Nevertheless, over time LA can potentially support the analysis of the outcomes and their reformulation according to information on a larger scale optimizing the learning journey that will be defined later on. So, LA permit to highlight some discrepancies between expected and collected data. At this stage, the competence of designers is needed in order to identify at which level the redesign should be realized in terms of outcomes, methods or assessment.

In such perspective, analytics provide a great opportunity for design reflection: outcomes and methods can be more easily evaluated and discussed by whoever acts as a designer of the single course as well as of the degree courses.

After the space devoted to LOs and learning and teaching methods, it is possible to note the learner journey box.

Learner journey provides data (such as class or work groups participation or other data according to the used LMS tracking capabilities) and could be connected with other personal data of the learners and, eventually, with individual data. Learners, being at the same time providers and users of the data, could - and should - be part of the framework at different layers. Depending on whether the learner has access to data relating to her/his peer group of the same course or attend the same programs, she/he has the opportunity to check how she/he is placed with respect to the target group. This is in line with what affirmed by Kruse and Pongsajapan (2012) who proposed a "student-centric" approach, as opposed to an "intervention-centric" approach to LA. This suggests that student should be considered "as co-interpreter of their own data and perhaps even as participants in the identification and gathering of those data" (pp. 4-5). In addition, if the student is given the opportunity to identify the types of peers with whom to deal, the opportunity to consciously plan learning path increases.

Sources are the last element of our framework. Examples of available sources can be the attendance data, exams grade, data from LMS that are often managed by different professionals belonging to diverse units. Connecting these available datasets can facilitate the development of mash-up applications that can lead to more learner-oriented services and therefore improved personalisation (Greller and Drachsler, 2012).

Concluding, this framework allows us to put in evidence that the same information available to the learner is also the one available to the designer (i.e. instructor and/or Schools or Faculties' directors), who

obviously has at her/his disposal the aggregated data, as well as the data of the single learner and can intervene directly on him/her to prevent any drop out or difficulty (Greller and Drachsler, 2012).

Obviously, the learner lives a learning experience that derives from the choices made by the designer.

5.3 *Monitoring observation*

Shifting from the single course edition to diverse editions means to add a timeline dimension in the framework. LAs process results regarding different editions of the same program/course can be compared. Schools or Faculties' directors evaluate LA data to understand if and how it is possible to improve the programs' organization. These kinds of analyses can be conducted on two layers: the first one concerns the whole program's performances; the second one regards single courses.

Even the instructor analysis is done on two layers. The first one regarding the general performance of the course; the second one conducted at single lecture's layer to understand the single lecture method effectiveness as well as what are the more difficult topics to be comprehended by learners.

These two layers are part of an iterative process that develop itself along a specific timeline as showed in Fig.1. If the process is well organized and the data well structured, different goals could be reached:

- from the point of view of the learners, a real commitment and a personalized learning experience;
- from the point of view of all the designers involved the great opportunity to evaluate and eventually re-align the course or program's design.

What represents an added value of a well-structured LA frame is the fact that instructor can be pushed to think deeply about different learners' need or preferences, so that he/she can better approach "new" learners on the bases of all meaningful data available.

6. Discussions and conclusions

LA involve relatively long time processes, using data from various institutional layers (for example, courses, programs, etc.) to inform decisions about future (Wise, 2014).

In this paper we propose an extended and efficacious LA design and management framework in which the learner and instructor are at the centre of the process. Our methodology can be considered appropriate because the action research involved different LA profiles. These profiles included not only technical professionals but also educational experts as well as students.

Based on our review of the theory background, what emerged is the necessity to design an architecture where:

- all actors are involved at different and well-defined layers;
- data are integrated from multiple sources to improve the accuracy of a learner profile and the subsequent personalization;
- instructor is both viewer and analyser of data resulting from LA;
- learner is both provider and viewer of data;
- sources of data are clearly indicated.

The proposed framework represents a first contribution - to be further developed in successive research - to rethink the concept of LA itself and the interactions between different LA layers with the intention of better defining actors involved, and then, learner's profile and her/his "personalized" learning path. Moreover, thanks to the proposed framework, instructors can periodically improve their teaching from the point of view of both quality and efficiency. In this sense, our work offers a significant contribution in the LA research's area.

This reflection sets the ground for novel investigations on how LA sustain personalized learning experiences through customized recommendations (Siemens, 2010).

Additionally, in the near future, context - and so the framework itself - could be enlarged with the inclusion of data from other sources like mobile devices, physical data from supervision meetings and game environments in addition to the usage of university resources such as libraries as well as learners' preferences, might result in a more complete learner and instructor profiles (Baalsrud-Hauge et al., 2014).

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