Evaluating And Monitoring The Learning Progress: Learning Analytics

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ABSTRACT
Within educational society, metrics and grades (e.g., standardized-tests) are commonly being employed to assess the knowledge, skills and educational achievement that can be measured according to specific criteria or standards. This traditional practice of assessment is currently being replaced with an emerging and promising measurement technique for learning processes, that is, Learning Analytics. With the help of innovative ICT-enhanced applications, learning analytics has already been utilized to apply a process of gathering and analyzing large amounts of data about learning progress for purposes of understanding and optimizing learning experiences and environments. In this paper, we discuss the notion of learning analytics that presents a paradigmatic change in the measurement, collection, analysis and reporting of data about making decisions to improve the learning process.

INTRODUCTION
We have been witnessing the emergent of innovative techniques and applications within the learning and teaching processes in parallel to the rapid developments in information and communication technologies. The new methods or techniques in the measurement of learner success are one of those, which have been affected in the sense of practice and idea by new technologies. The traditional practice of assessment is currently being replaced with an emerging and promising measurement technique particularly for ICT-supported learning processes. Actually, a need for assessing the knowledge, skills, behaviors and educational achievement of "the net generation" learners has been conspicuously recognized by the educators and researchers. It is due to the fact that the net generation learners live in a world of high technological sophistication, which is their medium and métier (Hughes, 2009) that is "integral to the world they know and that world is the only one they have known." (Hughes, 2009, p 39).

"The new technologies emerging with this generation have particular characteristics that afford certain types of social engagement" (Jones, 2011, p.42) and consequently, a new learning experience. This includes a "strong sense of group identity; and a disposition to share and to participate[;]...a preference for instant answers; a downgrading of text in favour of image; and a casual approach to evaluating information and attributing it" (Hughes, 2009, p 39). The new usage of and accessibility to technology anytime anywhere even during mobility has changed school practices, learner expectations and experiences. Learners have increasingly developed as being equipped with the ability of self-controlled learning and the attitude of life-long independent learning. This has also lead to new trends in education such as mobile learning, open educational resources, virtual learning, cloud computing, and learning analytics. "Learning analytics has emerged as one of the most common terms for the community seeking to understand the implications of these developments for how we analyse learning data, and improve learning systems through evidence-based adaptation" (Buckingham Shum, 2012, p.2).

LEARNING ANALYTICS DEFINITIONS & CONCEPTS
Learning analytics (LA) is a fast growing field of ICT-supported learning and teaching. Learning analytics is defined on the website of the first international Conference on Learning Analytics and Knowledge (LAK 2011) (https://tekri.athabascau.ca/analytics/) and adopted by the Society for Learning Analytics Research (SoLAR) as "The measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environment in which it occurs." Siemens (2010) defines learning analytics as "the use of intelligent data, learner-produced data, and analysis models to discover information and social connections, and to predict and advise on learning."

According to Johnson et al. (2011), Learning Analytics "refers to the interpretation of a wide range of data produced by and gathered on behalf of students in order to assess academic progress, predict future performance, and spot potential issues" (p.28). Based on this definition, learning analytics has a potential in helping us "evaluate past actions and to estimate the potential of future actions, so to make better decisions and adopt more effective strategies as organisations or individuals. Analytics allows us to increase the degree to which our choices are based on evidence rather than myth, prejudice or anecdote." (Cooper, 2012, p. 3). According to Phil

Long and George Siemens (2011), "[t]he idea is simple yet potentially transformative: analytics provides a new model for college and university leaders to improve teaching, learning, organizational efficiency, and decision making and, as a consequence, serve as a foundation for systemic change" (p. 32).

Based upon the definitions above, it could be summed up that learning analytics could be positioned and conducted in terms of 3 different time scales: past, present, and future which provides information as well as insights and understanding for each time frame (Davenport et al., 2010) (see Table 1). LA could produce reports and descriptions about what happened in the learning stage and try to understand the reasons how and why actions in the past of learning process took place by building models and explanations. Moreover, LA provides near-real time information about what is happening in the current learning process and correspondingly, various recommendations are provided to take the best next action. Furthermore, LA analyzes the past data and produce new information about patterns of learning process leading to a point. LA makes predictions about the effect of actions and identifies the optimal interventions in the learning process.

Table 1. Analytics Position (adapted from Davenport et al., 2010)

	ANALYTICS POSITION		
	PAST	**PRESENT**	**FUTURE**
INFORMATION & FACT	Analytics produces ***Reports & Description*** of data: What happened?	Analytics ***Alerts***: What is happening now?	Analytics ***Extrapolates past data***: Where are trends leading?
INSIGHTS & UNDERSTANDING	Analytics builds ***Models & Explanation***: How and why did something happen?	Analytics provides ***Recommendations***: What is the best next action?	Analytics provides ***prediction***, simulates the effect of alternative courses of action, or identifies an optimal course of action: What is likely to happen?

Data-driven approach or data-driven decision-making processes for the purpose of understanding and improving learning currently stimulate interest in making more use of learning analytics. However, since the term "learning analytics" is kind of a newborn term for actors in education, it is interchangeably used with other terms such as "educational data mining" or "academic analytics" which have roots from data mining, business intelligence and statistics fields.

Educational Data Mining has emerged from the field of data mining as a database research field specifically in education for the last 10-15 years (Buckingham Shum & Ferguson, 2011). Ferguson (2012) views educational data mining as it focuses on mainly the technical challenge of education, that is, the possible ways of extracting a value from big sets of learning-related data. On the other hand, Learning Analytics focuses on the educational challenge where educators try to optimize opportunities for learning (Ferguson, 2012). Educational Data Mining, in other words, focuses more on research – data retrieval and analysis through the processes of, for instance, clustering, classification, sequence mining, social network analysis. One of the key application areas of *Educational Data Mining* is to look for "empirical evidence to refine and extend educational theories and well-known educational phenomena, towards gaining deeper understanding of the key factors impacting learning, often with a view to design better learning systems." (Baker & Yacef, 2009, p.7).

In terms of *Academic Analytics*, Ferguson (2012) emphasizes its focus on the political or economic challenge, which seeks for considerable improvements in learning opportunities and educational results at national or international levels. *Academic Analytics* provides solutions based generally on data analysis at an institutional level whereas *Learning Analytics* look for relationships within learning process (e.g. teacher, learner, content, and learning context). The most common users of analytics in higher education today are administrative units in education employing it as an engine to make decisions or guide actions (Campbell & Oblinger, 2007).

LEARNING ANALYTICS PROCESS

Chatti, et al. (2012) proposes a LA process as an iterative cycle in three major steps: i) data collection and pre-processing, ii) analytics and action, and iii) post-processing (see figure 1). The first step in this model is

collecting data and according to the type and size of the data, pre-processing data techniques such as data cleaning, data integration, data transformation, data reduction, data modeling take in place. The second stage – analytics and action - is to discover the data and explore the hidden patterns to imrove the learning experience by means of actions including "monitoring, analysis, prediction, intervention, assessment, adaptation, personalization, recommendation, and reflection" (Chatti, et al. 2012, p.6). The third stage – post-processing – is critical for continuous improvement. This stage involves "compiling new data from additional data sources, refining the data set, determining new attributes required for the new iteration, identifying new indicators/metrics, modifying the variables of analysis, or choosing a new analytics method." (Chatti, et al. 2012, p.6).

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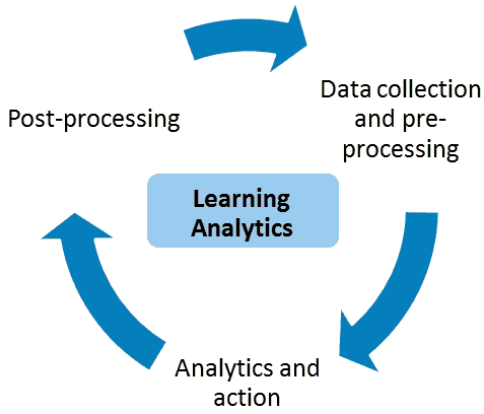

Figure 1. Learning Analytics Process (Chatti, et al. 2012)

George Siemens (2010) suggests another LA process, which is not an iterative process but more like a structured equation modeling (see figure 2). In a technology-enhanced learning environment, learners constantly create and input data via different tools such as learning management systems, blogs, or other social media. The data supported with learner's profile and becomes increasingly an interlinked or intelligent. Then, analysis takes in action to make predictions for personalization, adaptation of the learning process, and to do interventions for effective learning outcomes. Within this mind, "adaptation and personalization needs to be holistic and multi-faceted, incorporating technology, socialization, and pedagogy" (Siemens, 2010).

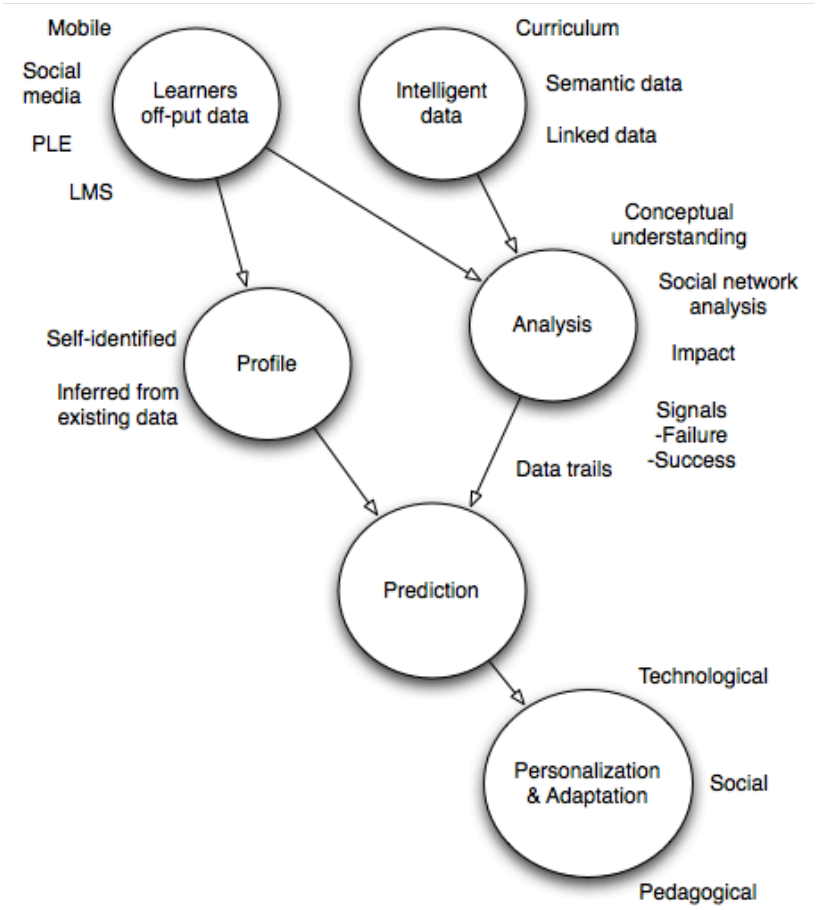

Figure 2. The Process of Learning Analytics (Siemens, 2010)

THE IMPLICATIONS OF LEARNING ANALYTICS

Learning Analytics is relatively a new technique for analyzing huge data sets to both redirect learners to more successful learning experiences and provide help and guide to redesign curricula for more successful learning opportunities. Huge data set is recurrently named as "big data" that is collected by different ICT tools, for instance, Learning Management Systems. So what is big data called? "Big data is a buzzword, or catch-phrase, used to describe a massive volume of both structured and unstructured data that is so large it is difficult to process using traditional database and software techniques" (www.webopedia.com/TERM/B/big_data.html).

Structured data is generally stored in databases in a standardized storage format and ontology (e.g., load, enrollments, usage data). Unstructured data including text, audio, lecture videos, chat rooms, emails often requires pre- processing before facilitating structured data analysis. These sorts of data provide valuable real time information by analyzing usage-tracking data for different stakeholders in the field of education in terms of student behaviors, student interactions and course content design. Educators and learners are two critical stakeholders among others (e.g., computer agents, institutions, instructional designers, LA researchers) that they can have many educational benefits of LA. According to Sharples et al. (2013), LA provides an innovative way of assessing and exploring the milestones of the learning progress for educators and learners (see table 2).

Table 2. Educational Use of Learning Analytics (Sharples et al., 2013, p.14)

Educators can use LA to:	**Learners can use LA to:**
• Monitor the learning process • Explore student data • Identify problems • Discover patterns • Find early indicators for success, poor marks or drop-out • Assess usefulness of learning materials • Increase awareness, reflect and self-reflect • Increase understanding of learning environments • Intervene, supervise, advise and assist, and • Improve teaching, resources and the environment.	• Monitor their own activities, interactions and learning process • Compare their activity with that of others • Increase awareness, reflect and self-reflect • Improve discussion participation, learning behaviour and performance • Become better learners, and • Learn.

Of the above, monitoring the learning process, in particular, monitoring individual learner performance and participation in a course is among the most prevalent type of learning analytics applications. Disaggregating learner performance by selected characteristics (e.g., major, year of study, ethnicity, etc.) and identifying outliers for early intervention are the next frequent use of LA applications. However, predicting potentials within a course so that all learners have optimal achievements; identifying and developing effective and efficient instructional techniques; and testing and evaluation of curricula are the least types of LA applications that educators prefer to utilize.

CHALLENGES and DEBATES

Theoretically, Learning Analytics provides interventions for the existing models and shortcomings of education and produces new insights what works successfully and what needs to be improved or developed in teaching and learning (Siemens, 2012). However, there are considerable challenges and uncertainties that educators face with especially having the potential impact of LA on education and learning. Ferguson (2012) identifies four significant challenges: i) integrating experience from the learning sciences, ii) working with a wider range of datasets, iii) engaging with learner perspectives and iv) developing a set of ethical guidelines. According to Ferguson (2012), the first challenge is that educators and/or researchers need to build strong connections with learning sciences as LA has emerged from many other fields (e.g., data mining, academic analytics). Another challenge is that researchers need to develop methods to investigate problems faced by learners in different learning contexts and to work with a wide range of datasets. Moreover, researchers need to develop analytics focusing on the personalized learning, that is, perspectives of learners rather than to the needs of institutions. Furthermore, researchers need to develop and apply a clear set of ethical guidelines for learners in relations to their data.

Buckingham Shum (2012, p.9) also put very much emphasis on the following challenges for applying LA in the field:

1. Learning Analytics are never neutral: they unavoidably embody and thus perpetuate particular pedagogy and assessment regimes in the educational ecosystem (primary/secondary/tertiary/workplace).
2. There is a pressing need to plug the widening analytics talent gap. Institutions should train staff and researchers in the design and evaluation of learning analytics.
3. Compared to many other sectors, educational institutions are currently 'driving blind'. They should invest in analytics infrastructures for two reasons: (1) to optimise student success, and (2) to enable their own researchers to ask foundational questions about learning and teaching in the 21st century.
4. The field is moving fast, with companies innovating to meet perceived markets. To keep up, the normally slower pace of educational research and professional development must be accelerated, or institutions are at risk of making purchasing decisions based on what's available, rather than what's needed.

In addition, although Learning Analytics provides performance indicators for learning and teaching, it does not essentially promote meaningful learning. Moreover, analytics making learners increasingly reliant on institutions, which are dependent on computational platforms to be able to provide learners with continuous feedback, rather than developing learners' own meta-cognitive skills and dispositions (Buckingham Shum, & Ferguson, 2011).

Along with challenges, there are critiques and debates on the utilization of LA around the following issues:

- Automating Research Changes the Definition of Knowledge
- Claims to Objectivity and Accuracy are Misleading
- Bigger Data are Not Always Better Data
- Not All Data Are Equivalent
- Just Because it is Accessible Doesn't Make it Ethical
- Limited Access to Big Data Creates New Digital Divides (Buckingham Shum, 2012, p.8)

CONCLUSION

In an ICT-enhanced learning environments, learners produce data trails which could be valuable for making interpretations about what is actually happening in the learning process and creating suggestions and possible ways in which educators can make improvements with learning and teaching. LA also provides learners with insights into their own learning behaviors and performances. Learning institutions make little use of data learners left behind in the process of their interaction with ICT-enhanced learning contexts. Within this kind learning contexts, huge amount of data is constantly being generated and storage and processing power of data are exponentially available in courses. LA promises to be an important lens through which to view patterns of relationships hidden in that data and plan for effective change in learning.

Learning analytics have undeniably a crucial role to play in the future of education. Especially, understanding the scope and uses of learning analytics in existing courses will open new areas in relation to innovative learning designs and new teaching methods and curricula. Not only does LA provide about past actions in the learning but also supports future learning outcomes. On the other hand, the relationship of LA with theories of learning, teaching, cognition and knowledge should carefully be made.

Empirical research studies should be conducted and then findings need to be applied into practice in real learning contexts to evaluate the potential of LA. There is also a need to address challenges that learners, educators, institutions are facing with. "These challenges currently involve the development of new tools, techniques, and people; resolving data concerns such openness, ethics, and the scope of data being captured; enlarging and transitioning the target of analytics activity; and improving connections to related fields." (Siemens, 2012, p.4).

However, LA as a new discipline has already captured a tremendous interest and gained a vast attention among stakeholders in education with its offers and potential in improving the learning process and providing interventions for current educational problems at individual learner, teacher, and institutional level. "Learning analytics can penetrate the fog of uncertainty around how to allocate resources, develop competitive advantages, and most important, improve the quality and value of the learning experience." (Long & Siemens, 2011, p.40).

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