

A Review on Learning Analytics Tools

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Abstract— This review paper gives an outline of the field Learning Analytics, which is the fast growing field. This paper focuses on the various tools that can be used for measuring, analyzing, collecting and will help in reporting the data. These tools will be helpful for researchers, academicians, teachers, students and many more.

Keywords— Big Data, Learning Analytics

- 2) Mid-scale analytics concerns with students to remove their problems, to improve various courses and their syllabi.
- 3) Large scale analytics also known as Academic Analytics and is mainly concerned with top level managements whose primary focus is to efficiency of the overall institution

I. INTRODUCTION

The revolutionary wave of big data has lead to the measurement of new techniques and tools to measure the effectiveness and deep insights of big data. The term “business intelligence” is used to describe this intersection of data and insight. The analytics are of two types when seen from the perspective of the education i.e Learning and Academic

Learning analytics (LA) 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. It helps in improving and achieving learner success. [2]

Academic analytics is the improvement of organizational processes, workflows, resource allocation, and institutional measurement through the use of learner, academic, and institutional data. It helps in improving and achieving organizational effectiveness. [10]

TYPE OF ANALYTICS	LEVEL OR OBJECT OF ANALYSIS	WHO BENEFITS?
Learning Analytics	Course-level: social networks, conceptual development, discourse analysis, “intelligent curriculum”	Learners, faculty
	Departmental: predictive modeling, patterns of success/failure	Learners, faculty
Academic Analytics	Institutional: learner profiles, performance of academics, knowledge flow	Administrators, funders, marketing
	Regional (state/provincial): comparisons between systems	Funders, administrators
	National and International	National governments, education authorities

Fig. 1: Learning and Academic Analytics [1]

Learning analytics is to improve education. It is not only meant for students but also for teachers, academicians, researchers, top level management etc. Learning analytics is seen “LA as a means to provide stakeholders (learners, educators, administrators, and funders) with better information and deep insight into the factors within the learning process that contribute to learner success. Analytics serve to guide decision making about educational reform and learner-level intervention for at-risk students.” (Simons et al. 2011)

There are three kinds of learning analytics:

- 1) Small scale learning analytics that is just another name for "awareness tools",

II. LEARNING ANALYTICS TOOLS

According to Wikipedia, retrieved 14:06, 2 March 2012 (CET). “Much of the software that is currently used for learning analytics duplicates functionality of web analytics software, but applies it to learner interactions with content. Social network analysis tools are commonly used to map social connections and discussions”

A. General Purpose Tools

There are variety of tools that are basically developed for other purposes but can be used for educational analysis, but have been particularly developed for education.

1) Web Analytics Tools:

Web analytics tools are both used for Search engine optimization, Interaction design, user experience and usability studies. For this we need to insert java script snippet in pages. With this some websites can track users. E.g. in this wiki, we use Google analytics (where users remain anonymous). Besides Google Analytics, there are many other tools. Most are commercial, but minimal services are often free.

E.g SEMRush, Yahoo site explorer, Userfly, Tynt, Kissmetrics, Mixpanel

2) Social Network Analysis:

Social network analysis [SNA] is the mapping and measuring of relationships and flows between people, groups, organizations, computers, URLs, and other connected information/knowledge entities. The nodes in the network are the people and groups while the links show relationships or flows between the nodes. SNA provides both a visual and a mathematical analysis of human relationships.

The most powerful Social network analysis tools are

- 1) SNAPP (Social Networks Adapting Pedagogical Practice) is “a software tool that allows users to visualize the network of interactions resulting from discussion forum posts and replies. The network visualizations of forum interactions provide an opportunity for teachers to rapidly identify patterns of user behavior – at any stage of course progression.

SNAPP has been developed to extract all user interactions from various commercial and open source learning management systems (LMS) such as BlackBoard and Moodle.

SNAPP is implemented as JavaScript booklet that is dragged on a browser's toolbar. It works with Firefox, Chrome and Internet explorer and for the visualization to

work, Java should be installed. In Moodle (tested), this tool can visualize forum threads that are displayed hierarchically. Data also can be exported for further analysis.

2) Pajek, is a program, for Windows, for analysis and visualization of large networks [9]

3) *Discussion/Forum Analysis Tools:*

The ACOEA Framework (Automatic Classification of Online Discussions with Extracted Attributes) This is not a tool, but a configuration and use scenario for the SIDE tool.

4) *Awareness Tools:*

They provide real-time analytics. Awareness is an understanding of the activities of others, which provides a context for our own activity. For example: presence (who is participating in the activity?), location (where are they working?), activity level (how active are they in the workspace?), actions (what are they doing? what are their current activities and tasks?), and changes (what changes are they making, and where?).

They are used in Computer Supported Collaborative Learning(CSCL) system which to improve teaching and learning with the help of modern information and communication technology but they are not found in various Virtual Learning Environments(VLE's) such as Learning management Systems(LMS),Content Management Systems(CMS) and Wikis[3]

5) *Text Analytics (Heavy Data Mining):*

- TADA-Ed (Tool for Advanced Data Analysis in Education) combines different data visualization and mining methods in order to assist educators in detecting pedagogically important patterns in students' assignments
- LightSide is an online service for automated revision assistance and classroom support. It also is available as free software that can be downloaded and user can train himself.
- Content Analysis-also called as textual Analysis .It is a standard methodology for studying the content of communication. It refers to the family of qualitative data analysis methods or various forms of quantitative analysis.
- Latent Semantic Indexing (LSI) is an indexing and retrieval method that uses a mathematical technique called Singular value decomposition (SVD) to identify patterns in the relationships between the terms and concepts contained in an unstructured collection of text. LSI is based on the principle that words that are used in the same contexts tend to have similar meanings. A key feature of LSI is its ability to extract the conceptual content of a body of text by establishing associations between those terms that occur in similar contexts."
- Latent Semantic Analysis (LSA) is a theory and method for extracting and representing the contextual-usage meaning of words by statistical computations applied to a large corpus of text. The underlying idea is that the totality of information about all the word contexts in which a given word does and does not appear provides a set of mutual constraints that largely determines the similarity of meaning of words and set of words to each other [1]

6) *Web Scraping, Visualization and App Building Software:*

- Various general purpose tools could be used, such as:
- Google trends-It is unique and useful tool for companies watching their brand health and customer interest. It allows to compare the popularity of search terms and trends
- Darwin Awareness Engine-Its aim is to accelerate discovery and insight through cutting edge analytics and cognitive technologies. It creates data exploration, pattern discovery and artificial intelligence solutions.
- Involver. It is a toolbox that includes: Conversation Suite to monitor the conversation across Facebook, Twitter and Google+; Application Suite to deploy apps; Visual Builder and Social Markup Language (SML™) for designing pages and social apps.
- Rapid Miner is the most popular open source data mining tool. It can import data from many sources (also perform web scrapping), analyze with over 500 operators and visualize, etc.[4]
- These tools are combinations of page scrapping (content extraction), text summarization, sorting, and visualization but their scope and ease of use seems to differ a lot.

7) *Data Visualization Software:*

Some data visualization software tools are:

- 1) Gapminder This software allows to show animated statistics from our own laptop. It can be used without internet access. It updates automatically when new data is available.
 - Gapminder measures ignorance about the world -It identifies the most ignored global facts by comparing what people think against the official statistics.
 - Gapminder makes global data easy to use and understand-It has data visualization tools to let people explore the vast treasure of global statistics.
 - Gapminder provides courses and certificates-It also develop teaching materials and knowledge certificates.
 - Gapminder promotes Factfulness, a new way of thinking- It promote a new way of thinking about the world and the society called Factfulness.
 - Gapminder collaborates with educators across the world[5]
- 2) Gephi It is the leading visualization and exploitation software for all kinds of graphs and networks. It is an open source tool and is freely available .It runs on windows, Mac OS X and Linux. It is used in Exploratory data analysis, link analysis, social network analysis, biological network analysis and poster creation.
- 3) NodeXL It is a free, open-source template for Microsoft® Excel® 2007, 2010, 2013 and 2016 that makes it easy to explore network graphs. With NodeXL, we can enter a network edge list in a worksheet, click a button and see the graph, all in the familiar environment of the Excel window. It offers additional features that extend NodeXL Basic, providing easy access to social media network data streams, advanced network metrics, and text and sentiment analysis, and powerful report generation.

NodeXL Pro can create insights into social media streams with just a few clicks.[8]

- 4) OpenDX It is an Open Source software Project Based on IBM's Visualization Data Explorer. It gives new control over your data and new insights into their meaning. It is easy to use because it lets to visualize data in ways we have never dreamed of--without getting bogged down in the technology. As it is an Open Source its license allows to freely create, distribute, and develop visualization solutions. It is a uniquely powerful, full-featured software package for the visualization of scientific, engineering and analytical data: Its open system design is built on a standard interface environments. And its sophisticated data model provides users with great flexibility in creating visualizations.
- 5) NetDraw It a Windows program for visualizing social network data. [1]
- 8) *Importing Data from Badges Systems:*

In education, badges usually are meant to provide recognition for a skill that has be learnt in some place. Such badges include links that provide extra information about the skill that is recognized, information about the entity that issues the badge, and the rules for getting the badge. i.e. a badge can be traced back to the institution that issued the badge and it should precisely tell what it is meant for. Educational badges have an issuer (institution that testifies), the earner (learner) and a displayer (site that displays a badge).

- Mozilla open Badges
- Moodle Badges etc

9) *Other Tracking Tools:*

Most educational systems have built in tracking tools.

- CoFFEE (Collabrative Face to Face Educational environment) system. It is a suite of applications to support collaborative problem-solving discussions in the classroom. Its main components are a series of tools for collaboration, shared work, individual work and communication. Around these core tools, several other components make it possible to plan, run or participate in a CoFFEE lesson [12]
- E-science environments have access to a wide range of data. It usually denotes data-intensive, IT-intensive and collaborative research, but it also can just refer to research that uses explicitly defined IT-support research workflows.

B. *Classroom Tools*

Tools like Metrix (working with any mobile device) allow teachers to define a skill set and then enter student data that allow to "track, analyze and differentiate" students.

C. *General purpose educational tracking tools*

Some institutions did or will implement tracking tools that pull in data from several sources. Some tools are designed for both teachers and learnings, others are in the realm of academic analytics (as opposed to learning analytics).

1) *UWS Tracking and Improvement System for Learning and Teaching (TILT):*

It is used to

- To prove quality – e.g. data can be drawn from different quantitative and qualitative data bases and, after

triangulation, can be used to prove the quality of what UWS is doing. Data analysis can use absolute criteria and/or relative (benchmarked) standards.

- To improve quality – e.g. data can be used to identify key improvement priorities at the university, college, division, course and unit levels.

This framework uses about ten data sources, mostly surveys (student satisfaction, after graduation) and performance reports. It includes time series, e.g. student satisfaction during, at exit and after obtaining a degree.

2) *Course Quality Assurance at QUT*

It is a combination of Individual Course Reports (ICRs), the Consolidated Courses Performance Report (CCPR), Underperforming Courses Status Update and the Strategic Faculty Courses Update (SFCU). "Individual Course Reports (ICRs) is to prompt an annual health check of each course's performance, drawing upon course viability, quality of learning environment, and learning outcomes data. In total, data on 16 indicators are included in the ICRs."

D. *Tools for Power Teaching*

Courses that aim at deep learning, e.g. applicable knowledge and/or higher order knowledge are usually taught in smaller classes most often uses software that is distinct from the ones used in so-called e-learning, e.g. wikis, learning e-portfolios, content management systems, blogs, webtops and combinations of these. Most creative power teaching, however, uses what we would call "street technology" and for these, analytics tool rarely exist. Ex Enquiry Blog Builder .Another example is StatMediaWiki, a tool that we use to learn about student contributions in the french version of this wiki.The main issue is not how to measure learning, but how to improve learning scenarios through tools that help both the learner and the teacher understand "what is going on" and therefore improve reflection.

1) *Analytics for E-Portfolios*

The current available data indicators - such as grades and completion rates - do not provide useable evidence in terms of learning achievements and employability such systems then should include mechanisms for self-management of learning that could feed into institutional learning analytics. To encourage students to reflect on and assess their own achievement of learning, the iPortfolio incorporates a self-rating tool based on Curtin's graduate attributes, "enabling the owner to collate evidence and reflections and assign themselves an overall star-rating based on Dreyfus and Dreyfus' Five-Stage Model of Adult Skill Acquisition. The dynamic and aggregated results are available to the user, the student can see a radar graph showing their self-rating in comparison with the aggregated ratings of their invited assessors.[1]

2) *Student Activity Monitor and Cam Dashboard for PLEs*

"To increase self-reflection and awareness among students and for teachers, SAM (Student Activity Monitor) a tool that allows analysis of student activities with different visualizations". Although SAM was developed for personal learning environments it can be used in any other context where the learning process is largely driven by rather autonomous learning activities. SAM is implemented as Flex software application and it is documented in the sourceforge .Its four purposes are Self-monitoring for

learners, Awareness for teachers, Time tracking, Learning resource recommendation

The Cam dashboard is an application that enables the visualization of usage data as a basis to detect changes in usage patterns. The purpose is to detect variations in the use of PLEs based on changes in usage patterns with widgets and services.[12]

3) *The Enquiry Blogger*

Enquiry Blog Builder provides a series of plugins for the very popular Wordpress bloggingware, the list includes:

- MoodView - This displays a line graph plotting the mood of the student as their enquiry progresses. The widget displays the past few moods and allows a new one to be selected at any time. Changing moods (a hard coded drop-down list from 'going great' to 'it's a disaster') creates a new blog entry with an optional reason for the mood change. The graph is created using the included Flot JavaScript library.
- EnquirySpiral - This widget provides a graphical display of the number of posts made in the first nine categories. A spiral of blobs appears over an image with each blob representing a category. The blobs are small and red when no posts have been made. They change to yellow for one or two posts, and green for three or more. In this way it is easy for the student to see how they are progressing, assuming the nine categories are well chosen.
- EnquirySpider - This widget works in the same way as the EnquirySpiral, except that the blobs are arranged in a star shape. They are associated with seven categories. (from nine to sixteen so they don't conflict with the EnquirySpiral).

4) *Learner Disposition*

It is a setup that collects learning dispositions through a questionnaire. Results then are shown to the students and teachers. "The inventory is a self-report web questionnaire comprising 72 items in the schools version and 75 in the adult version. It measures what learners say about themselves in a particular domain, at a particular point in time" The seven measured dimensions are: Critical curiosity, Meaning Making, Dependence and Fragility, Creativity, Learning Relationships, Strategic Awareness. Students are shown a spider diagram of these dimensions.

E. *Tracking in E-Learning Platforms*

By default, most so-called learning management systems have built-in tracking tools. There are tools which can be used for research or as additional modules in commercial systems.

1) *LOCO Analyst:*

LOCO-Analyst "is implemented as an extension of Reload Content Packaging Editor, an open-source tool for creating courses compliant with the IMS Content Packaging (IMS CP) specification. By extending this tool with the functionalities of LOCO-Analyst, it ensures that teachers effectively use the same tool for creating learning objects, receiving and viewing automatically generated feedback about their use, and modifying the learning objects accordingly." In LOCO-Analyst, "feedback about individual student was divided into four tab panels: Forums, Chats, Learning, and Annotations [...]. The Forums and Chats panels show student's online interactions with other students

during the learning process. The Learning panel presents information on student's interaction with learning content. Finally, the Annotations panel provides feedback associated with the annotations (notes, comments, tags) created or used by a student during the learning process."

"The generation of feedback in LOCO-Analyst is based on analysis of the user tracking data. These analyses are based on the notion of Learning Object Context (LOC) which is about a student (or a group of students) interacting with a learning content by performing certain activity (e.g. reading, quizzing, chatting) with a particular purpose in mind. The purpose of LOC is to facilitate abstraction of relevant concepts from user-tracking data of various e-learning systems and tools."

2) *Virtual Location-based Meta-Activity Analytics:*

Activities are conducted using strategies and performing actions using tools (instruments). Actions are performed using operators. In the context of education, both actions and operations can be either individual or collaborative (social). The study measures student activity (called meta-activity) through three dimensions: attendance, availability and involvement: All indicators are measured with respect to the most active student.

- Attendance: Number of connections (% of max.)
- Availability: Duration of connection (% of max.)
- Involvement: Number of actions performed (% of max., e.g. upload a document, go to virtual place, participate in group discussion)

3) *Blackboard Analytics for Learn:*

It is an "easy, self-service access to data that can help give you an enterprise-level perspective. It is used to Gain insight into user activity, course design and student performance data across departments. Following queries can be answered aslike How are my students performing on learning standards over time?, How can I easily find students who aren't engaged in their online courses?, Which tools are being used in courses the most? The least? etc.

4) *Moodle Analytics with MocLog:*

It is for Teachers, students, study program managers and administrators need feedback about the status of the activities in online-courses. MOCLog will realize a monitoring system, that helps to analyze logfiles of the Moodle LMS more effectively and efficiently thus contributing to improve the quality of teaching and learning.[13]

5) *Other tools:*

- Purdue Course Signals combines predictive modeling with data-mining from Blackboard Vista. It gives an overview of how student is performing in their current courses, making it easy for them to identify and reach out to students who are struggling in multiple courses, have risk factors such as low overall GPAs, or are first-generation status or transfer students. A real-time view of this data means advisors can act more immediately to help students before they abandon a program of study, or worse, leave school discouraged and unprepared for their futures.
- Teacher ADVisor (TADV): uses LCMS tracking data to extract student, group, or class models

- Student Inspector: analyzes and visualizes the log data of student activities in online learning environments in order to assist educators to learn more about their students.
- CourseViz: extracts information from WebCT.
- Learner Interaction Monitoring System (LIMS) [3]

III. CONCLUSIONS

This review paper gives an understanding of the most of the various tools and techniques used in Learning Analytics. But as the number is large, some could have also been left. As the field of Learning Analytics is growing and more tools are adding on at regular intervals. So this list of tools are always expanding in the number. With time, new tools can be added.

ACKNOWLEDGMENT

This review paper was followed from The Open Learning Analytics Proposal, Penetrating the fog (Educase), George Siemens Learning and Knowledge analytics Bibliographics and EduTech Wiki Blogs. So I am thankful for providing the relevant information.

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