Defining an agenda for learning analytics

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Learning analytics is an emergent field of research in educational technology where the use of large, passive datasets collected routinely by online learning systems can offer unprecedented insights into student learning and behaviour. These datasets provide objective feedback from students to teachers, allowing the latter to check the validity of assumptions and the influence of learning design decisions. This offers a new opportunity to inform learning design and enhance broad understanding of learning with technology. However, translating raw analytics data into meaningful information for teachers and learning designers currently requires a high level of technical expertise. This paper outlines learning analytics as an emergent field of research, and an agenda to advance understanding and promote development of appropriate methodologies for research in learning technology.

Keywords: learning analytics, learning technology research, research methodology, evaluation

Introducing learning analytics

Interest in the use of learning analytics data to understand student behaviour in online environments has grown considerably in recent years. Learning analytics research uses large, anonymous sets of passively collected data as an objective source of feedback on student interactions with online learning activities. The potential to use these data as a basis to explore the validity of assumptions about student learning and the impact of learning design decisions is a source of considerable optimism. Researchers are working to identify and develop easy ways for teachers and learning designers to access this information for use in their professional practice (see e.g. Lockyer, Heathcote, & Dawson, 2013). This typically involves automated translation of raw system data into meaningful and usable information. At least a conceptual understanding of the field is required for end users to be able to benefit from the findings of this type of research. This paper offers a summary of definitions, and outlines the current 'state of the art' for those potential users seeking to understand the possibilities to enhance learning, without the need to develop a high level of technical expertise to access relevant information.

Defining learning analytics

Various definitions of learning analytics have appeared in recent literature. The brief summary presented here highlights the key common elements of analytics initiatives that aim to promote the understanding of learning. The related fields of business analytics and academic analytics are identified only to explain their different aims.

Fournier, Kop, and Sitlia (2011) define learning analytics as "the measurement, collection, analysis and reporting of data about learners and their contexts for the purposes of understanding and optimizing learning, and the environments in which it occurs" (p.105). According to Elias, (2011, cited in Chatti, Dyckhoff, Schroeder, & Thus, 2012), it is an emerging field in which sophisticated analytic tools are used to improve learning and education. Improvement can occur when data on learners' online behaviour is processed through analysis models to allow teachers and researchers to discover information and social connections which they can use as a basis to predict and advise on learning (Siemens 2010, cited in Chatti et al., 2012). Campbell, DeBlouis, and Oblinger, (2007) note that "analytics marries large data sets, statistical techniques, and predictive modelling" and "analytics could be thought of as the practice of mining institutional data to produce actionable intelligence" (p. 42). A key factor is the ability to understand and act upon the data collected by online learning systems. At present, the field of study is too technical for most teachers and learning designers to engage with. However, as the current generation of elearning tools becomes increasingly sophisticated in terms of both affordances and functionality, they also become easier for end users to operate and understand. Many common elearning tools including the ubiquitous LMS, websites and communication tools, now come packaged with their own basic analytics tools. However, users still need to understand the potential benefits, at least at a conceptual level, before they will find an incentive to explore and make use of these features however accessible they may be.

Analytics in educational technology research

Learning analytics provide an objective and invaluable source of data that could advance the field of educational technology research. Functionally, learning analytics represents a point of convergence between business intelligence, web analytics, educational data mining, and recommender systems (Ferguson, 2012). Chatti et al. (2012) link learning analytics to action research, but note at least one fundamental difference. Learning analytics initiatives usually start with observations derived from available data, while action research begins with a question arising from teaching practice. The relationship is complementary however, as learning analytics tools contribute an objective data source to action research cycles where the aim is to link learning design intent with the resulting learner behaviour, learning process and outcomes. The addition of a theoretical grounding for learning design, and the aim to produce general as well as context specific findings will contribute to the broad understanding of learning with technology. To achieve this aim, educational design research (McKenney & Reeves, 2012) is a more appropriate choice than action research, which is typically a case specific approach.

The current focus of learning analytics research marks a maturing of the related fields identified above, and offers opportunities to apply established data collection, analysis and presentation techniques to a new area of inquiry. The new questions facing researchers are; what can be achieved with learning analytics, and what must be done to exploit the potential? Until now, extraction and interpretation of analytics data has remained a task for specialists, or been conducted at too general a level to produce more than numbers of page hits, time spent, location of users or patterns of navigation. This type of information is more useful to marketers than educators. However, it is both common and convenient for developments in an emergent field of technology to be driven by commercial motives, while also producing tools that are useful in education. For example, recommender systems use data gathered from previous interactions to present relevant choices to users. The same principles apply whether users are shopping online or working through course content and activities. In the area referred to as business analytics, performance data is used to inform institutional decision-making and for comparison within and across sectors (Buerck & Mudigona, 2014). Academic analytics allows at risk students to be identified in time for remedial action to be taken, and thus has an impact, if indirectly, on learning. The promise of learning analytics is that it adds to these capabilities the potential to gather and use data to promote greater understanding of learning than has been possible in the past. This can inform learning design and close a critical feedback loop from learners to teachers and learning designers. Chatti et al. (2012) offer a reference model for these converging fields of research, identifying common challenges and opportunities on four dimensions:

- Data and environments;
- Stakeholder interests;
- Rationale and objectives;
- Methods for data collection and analysis.

In the context of educational design research, application of the dimensions mentioned above would relate to the development of a theoretically grounded learning design (rationale and objectives), collection of data to test underlying design assumptions and to ascertain whether the stated learning objectives had been achieved (methods for data collection and analysis). Data would be gathered through qualitative methods as well as from system logs. Relating learning analytics to other data is an important step in the evolution of practice (data and environment). Starting with an outline of which analytics data can or needs to be collected also allows online systems to be adapted or built to capture it (stakeholder interests). A growing body of literature reflects the exploratory nature of this research, and the potential to develop greater understanding of learning through such investigations. The topic needs further attention, and with that aim in mind, this short paper proposes guiding principles for future research.

Analytics, evaluation and new modes of learning

The emergence of learning analytics as a field of inquiry more or less coincided with the quest for greater insight into networked learning. Retalis, Papasalouros, Psaromiligkos, Siscos, & Kargidis (2006) identified networked learning as substantially different from previous approaches to learning with technology. Siemens & Long (2011) and Siemens (2012) define this distinction as the concepts of connectivism and navigationism, which have emerged as a result of the affordances of social networking technologies. Previous approaches tended to focus more - though not exclusively - on learning by individuals. Contemporary approaches depend on learners' connection to, and learning through interaction with peers as well as with teachers and learning resources. It is reasonable to assume that the evolution of networked learning is still in its early stages, with more innovations in the pipeline. The wisdom of hindsight has proved many times that predicting an unknown future is no more reliable than guesswork (Mason, 1998), so focus on current trends and evidence that is

available now is the recommended approach. Researchers had not yet solved the problem of how to evaluate learner centric uses of educational technology, when the field of study moved on to new and complex challenges. Methodological questions remain unanswered as the quest for deeper understanding of networked learning gains momentum. The still emergent nature of methodologies and methods for learning technology research is an impediment to progress in this respect.

Evaluating the influence of networked learning activities and interactions is a challenging and resource intensive task that requires more technical expertise than most learning designers and teachers are equipped with. The range of integrated tools available to monitor learner behaviour and online interactions is growing. However, they are not yet mature and often require translation of raw data into useful information. The need for non-intrusive, automated data collection methods is part of a wider problem facing learning technology researchers. Gunn and Steel (2012) found a high percentage of published articles featured case studies with inadequate details of context as well as various other research design weaknesses. Gunn (2013) described a shift from quantitative to qualitative methodologies as a step towards establishment of appropriate methods for the field of enquiry. McKenney and Reeves (2012) proposed educational design research as a suitable methodology but did not define a full set of data collection methods. Learning analytics may prove to be a missing link in this complex equation.

Trends in learning analytics research

Early learning analytics initiatives, e.g. Retalis et al. (2006) focused on the capability of a learning management system (Moodle) to track and present data mined from web logs, and combined this with semantic descriptions of networked learning activities. The process was technically complex and thus unlikely to appeal to many academics. Further limitations included scalability, integration with institutional data collection systems and use with a range of elearning tools. The field has advanced considerably since this early study. Automated data mining and presentation tools are now available for use with different systems. Fournier et al. (2011) propose a "data driven computational social science based in an open academic environment for educators, administrators and learners, rather than a domain for private companies, e.g. Google and Yahoo" (p. 104) as their aims are commercial rather than to build a body of knowledge. Some analytics tools are system specific, while others are built to meet inter-operability standards and be usable across various networked learning platforms. The challenge now is to automate these tools to the point where non-technically minded teachers can access and interpret meaningful data about their students' progress as a matter of routine. Retalis et al. (2006) described this as non-intrusive ways to get feedback on learner progress and appraise the effectiveness of online courses. The question then is, what is required to develop automated systems with low enough entry barriers to become part of mainstream practice? No attempt is made to answer that question in this brief paper. Readers interested in the range of solutions in use and under development may refer to Greller and Drachsler (2012). The focus here is on learning analytics as one available option for systematic data collection for online and networked learning.

Evaluation is more than numbers

Phillips, Maor, Preston, and Cumming-Potvin (2012) noted that the aim to improve student learning would necessarily involve qualitative interpretation as well as quantitative analysis of learning analytics data. This may require collection of further data from teachers and learners, and include value judgments about their use of learning environments. The research design would thus be a true mix of qualitative and quantitative methods, and require collaboration between experts in computing, data mining and educational research. The emergent state of this field of enquiry means there are few protocols to guide such collaboration, or for gathering, integrating and interpreting the resulting combinations of data. Participative action research case studies may be a suitable way to explore the options. Continuing the trend of collaboration across professional roles in elearning in higher education described by Gunn, Hearne, and Sibthorpe (2011), learning analytics researchers need to work with teachers, learning designers and students as well as technology and IT systems experts. Input from these stakeholders is needed to guide the development and integration of tools that provide usable information to inform subsequent action by teachers, learning designers and students. A parallel for such evidence-based action may be found in the impact of the automated marking assistants that are increasingly common in universities. Speeding up the turn around of feedback on assignment has motivated students to pick up marked work and use feedback in the constructive manner intended. Prior to the introduction of these tools, hours spent on marking and providing feedback were wasted because assignments were returned too late for students to take action based on the information provided. It is reasonable to assume that the same principle applies to the opportunity for teachers to receive feedback on student learning and behaviour in the form of learning analytics data. Timely receipt of this kind of general and objective feedback will allow them to address learning challenges, design faults or wrong assumptions before student work is complete and assignments are submitted.

Guiding principles for learning analytics research

Perhaps the most important research question for learning analytics at present is: how can available raw data be converted into actionable knowledge for teachers and learning designers who are not technical experts? Chatti et al. (2011) reviewed literature from 2010 and 2011 and found few studies involving teachers in the monitoring of student activity. Most learning analytics research focused on technical aspects of data collection, extraction and interpretation. With the technical challenges appearing to be more or less solved, attention can turn to the use of learning analytics in combination with other data to increase understanding of student behaviour, and to study the influence of different learning designs and activities. The potential benefits of research in this area are clear.

The broad aims are to use evidence to promote deeper understanding of student learning in formal education contexts, and to use this knowledge to inform learning environment and activity design. At a practical level, studies need to identify the steps necessary to facilitate access to, and interpretation of learning analytics data by teachers who are not technically experienced. A range of user-friendly analytics tools has emerged, though these are not yet in widely used or understood. The use of theoretically grounded case studies from teaching practice will help to identify the insights to be gained, and complementary qualitative data collection methods required. Analytics data can reveal trends, connections and structures, which qualitative methods can be applied to further explore and explain. The technology tools used to generate learning analytics data are becoming generic, and the supporting qualitative methods well established. The research outputs produced should therefore be useful across a range of educational contexts and stakeholder groups. This is an exciting time for research in learning technology. New combinations of quantitative and qualitative data look set to advance understanding of learning in unprecedented ways, while the inclusion of passively collected learning analytics data may move the long outstanding search for suitable, systematic and reliable research methodologies forward.

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