BROADENING AND DEEPENING OF SOTL WITH LEARNING ANALYTICS

KOH Hian Chye
SIM University

Sylvia CHONG
SIM University

The last decade has witnessed the growing prominence of the scholarship of teaching and learning (SoTL) and the rise of learning analytics in higher education institutions. This is not surprising given the developments in technology, pedagogy, online/open learning and data availability as well as the increasing academic interest in various aspects of teaching and learning. Learning analytics applications have made possible customised and enhanced learning experiences for the learners, and improved student retention and success for the institutions. Learning analytics can be viewed as an integral part of the scholarship of teaching and learning (SoTL). This aligns with SoTL as a research domain that enhances students’ learning experiences. This article explores the educational potential of learning analytics and how it could be exploited for the SoTL in a higher education context. It examines the conceptualization and meaning of SoTL as well as Learning Analytics, followed by a discussion on how SoTL and Learning Analytics can support each other. An illustration to show that Learning Analytics can be an effective platform for educators to advance SoTL is reported.

Keywords: Learning analytics, educational data mining, scholarship of teaching and learning.

INTRODUCTION

Teaching and learning is clearly at the heart of any educational institution. With increasing access to higher education, there is also increasing academic interest in various aspects of teaching and learning (Murray, 2008). This growing interest for a positive higher education learning experience is long overdue. Scholars of teaching and learning today see their programmes, students and classrooms as key sources of queries about learning. They have studies that provide evidence in designing and enhancing teaching and learning. This last decade has also witnessed the rise of learning analytics and its application in higher education institutions. This is not surprising given the developments in technology, pedagogy, online/open learning and data availability. The 2013 Horizon Report, produced by the New Media Consortium and the EDUCAUSE Learning Initiative, reflected on the impact of "Learning Analytics" as an emerging technology, projecting its time-to-adoption as two to three years. In a more recent EDUCAUSE Review Online, ‘using analytics to help drive critical institutional outcomes’ has been identified as a top-10 IT issue for 2014 (Grajek et al., 2014).

Gathering and disseminating key evidence on the teaching and learning will enable units, faculties, and the university as a whole to make informed decisions. Learning analytics is commonly understood as the collection and analysis of data about learners and their learning patterns and behaviours in order to make improvements to curricula, learning environments, and student supports, as well as for institutional decision-making purposes. Learning
analytics applications have made possible customized and enhanced learning experiences for
the learners, and improved student retention and success for the institutions. Learning
analytics can be viewed as an integral part of the scholarship of teaching and learning
(SoTL). This aligns with SoTL as a research domain that enhances student learning
experiences.

This article explores the educational potential of learning analytics and how it could be
exploited for the SoTL in a higher education context. It examines the conceptualization and
meaning of SoTL as well as Learning Analytics, followed by a discussion on how SoTL and
Learning Analytics can support each other. An illustration to show that Learning Analytics
can be an effective platform for educators to advance SoTL is reported.

CONCEPTUALIZING SOTL

Boyer’s (1990) seminal volume “Scholarship Reconsidered” is the genesis of SoTL. Boyer
proposed four types of scholarship: discovery, application, integration and teaching. His
description of the fourth scholarship introduced the concept of “the scholarship of teaching”.
Here he made a strong argument that teaching in higher education must be treated as
seriously as disciplinary scholarships. The idea gained attention for giving higher education
teaching a place within a broader vision of academic scholarship. Under the guidance of
Professor Emeritus Lee Shulman, who succeeded Boyer as President of the Carnegie
Foundation for the Advancement of Teaching, the scholarship became widely known as “the
scholarship of teaching and learning” (Shulman, 2000; Shulman, 2011). In 1997 another key
development in the conceptualization of SoTL arose from Boyer’s work. Glassik, Huber, &
Maeroff (1997), developed a set of standards for assessing forms of the scholarship. The
proposed set of standards that embodies the hallmarks of scholarship had six criteria:

1. **Clear Goals**: Does the scholar state the basic purposes of his or her scholarship?
   Does the scholar identify key areas in the field?
2. **Adequate Preparation**: Does the scholar show an understanding of existing
   scholarship in the field? Does the scholar bring the necessary skills to his or her
   work? Does the scholar bring together the resources necessary to move the project
   forward?
3. **Appropriate Methods**: Does the scholar use methods appropriate to the goals? Does
   the scholar effectively apply the methods selected? Does the scholar modify
   procedures in response to changing circumstances?
4. **Significant Results**: Does the scholar achieve the goals? Does the scholar’s work add
   consequentially to the field? Does the scholar’s work open additional areas for further
   exploration?
5. **Effective Presentation**: Does the scholar use a suitable style and effective
   organization to present his or her work? Does the scholar use appropriate forms for
   communicating work to its intended audiences? Does the scholar present his or her
   message with clarity and integrity?
6. **Reflective Critique**: Does the scholar critically evaluate his or her own work? Does
   the scholar bring an appropriate breadth of evidence to his or her critique? Does the
   scholar use evaluation to improve the quality of future work?
SoTL becomes part of a broader transformation in the intellectual culture of higher education. The widening of the scholarship of teaching to include learning in SoTL has been growing steadily over the past years. The shift towards learning now includes the systematic and thoughtful investigation of student learning for purposes of improving practice and student success. Scholarships and investigations are conducted by faculty and increasingly by students within their own programmes or courses, sometimes in multi-disciplinary collaborations, with results being made public and often translated beyond local settings. Hutchings and Shulman (1999) advocated that this scholarship is to include not just knowledge of the discipline, but also “the latest ideas about teaching the field” (Hutchings and Shulman, 1999, p. 13). They have also called for SoTL scholars to:

- make their teaching and learning research available to the community at large,
- be open to critique and evaluation, and
- present findings in ways which others can build upon them.

Kreber and Cranton (2000) provided three perspectives on SoTL. The first is ‘parallel to the traditional conceptualization of scholarship’; in the second ‘teaching is equated with excellence in teaching’; in the third ‘scholars of teaching take a scholarly approach to teaching by applying educational theory and research to their practice’. These SoTL perspectives also provided educators with opportunities to converge their curricular, pedagogical and instructional knowledge. Kreber and Cranton (2000) conceptualized these perspectives to provide the educator opportunities to research, reflect, assess and refine their teaching practices.

Prosser (2008) defined SoTL as “evidence based critical reflection on practice aimed at improving practice”. Prosser positioned improving student learning as the fundamental purpose of SoTL that is anchored on the use of reflection on evidence about the teachers’ own practices. The scholarship is targeted on generic rather than specific issues or topics. This hinges on the context being the key focus for distinguishing between pedagogic research and SoTL. Prosser also acknowledged that findings and insights from educational/pedagogical research should support and inform SoTL inquiries. This provides evidence for a practitioner’s critical reflection on their students learning as well as their own teaching practices.

For me the main point of engaging in the scholarship of teaching and learning in higher education is to work towards improving our students’ learning. To do this we need to systematically reflect upon evidence of our own students’ learning within our own classes and disciplines. We need to draw upon the more generic research, but carefully situate that within our disciplines. We then need to monitor the success of our efforts to improve our students’ learning and then communicate the outcomes of those efforts to our colleagues. The scholarship of teaching and learning from this perspective is not research in the traditional sense. It is a practically oriented activity, conducted collegially, and increasingly being conducted alongside traditional research within the disciplines. (Prosser, 2008, p. 3)
LEARNING ANALYTICS: DEFINITIONS AND RELATED CONCEPTS

Learning analytics is a relatively new field, having emerged only in the last decade or so. It focuses on technology-enhanced learning and has been associated with terms such as educational data mining and academic analytics. It also draws from various other fields such as education, technology and the social sciences.

The First International Conference on Learning Analytics and Knowledge (LAK, 2011) defined learning analytics as “the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimising learning and the environment in which it occurs.” Ferguson (2012) has identified three major drivers behind the emergence and development of learning analytics as technology, pedagogy and politics/economics.

Firstly, educational institutions have been producing increasingly large sets of data from their systems (commonly referred to as “big data”). These include interaction data, personal data, systems information and academic information (Romero, Ventura, & Garcia, 2008) and they are getting too large for the typical database software tools to manage or analyse. Learning analytics provides the means to extract information from the learning-related big data.

Secondly, online learning has seen a great boost in the last decade. Well-known universities have put some of their courses online e.g. Coursera (led by Stanford University and 107 partners/universities as at December 2013) and edX (offered by Harvard University and MIT). However, online education is not without challenges – students may feel isolated, disorientated or unmotivated (Mazza & Dimitrova, 2004) and instructors may lack visual cues to interpret and evaluate students’ learning (Dringus & Ellis, 2005). At the same time, online learning generates voluminous amount of data (Ellen, 2012). Learning analytics can transform these data into information for both students and instructors, to facilitate students’ learning and guide instructors’ teaching (Romero & Ventura, 2010).

Thirdly, educational institutions are increasingly asked to measure, demonstrate and improve performance (EU Expert Group, 2010). In this respect, the US government is prepared to invest billions of dollars to increase the overall educational attainment of the population (Norris, Baer, Leonard, Pugliese, & Lefrere, 2008). Again, learning analytics can provide the necessary methodology and technology to improve education performance and achieve this aim. In addition, social network analysis emerged in 2003 to complement the data-driven approach to learning analytics (Aviv, Elrich, Ravid, & Geva, 2003). It represented a social and pedagogic approach to study collaborative and co-operative connections between learners, instructors and resources, in order to help learners learn (De Laat, Lally, Lipponen, & Simons, 2006).

With technology and online learning, the capture and interpretation of data in digital learning settings can help instructors and institutions tailor and optimise the teaching and learning process to individual students. Along the same line, Murphy (2012) has highlighted the importance and impact of technology and the digital media literacy of students in the new learning environment. Incorporating the data-driven as well as the social-/pedagogic-driven approaches, Siemens (2010) defined 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.” The underlying premise is that vast amounts of data have
been generated in learning and these data can be analysed to derive information to improve teaching and learning.

Although learning analytics and educational data mining are frequently used together, if not interchangeably, Ferguson (2012) differentiated them as follows. Learning analytics focuses on how to optimise opportunities for learning (an education focus), while educational data mining focuses on how to extract value from learning-related data (a technology focus). Further, Huebner (2013) suggested that academic analytics (which focuses on processes at a unit or university level, and hence is more macro in perspective) can be considered a sub-field of educational data mining (which focuses on details at a course level). According to him, “educational data mining is a broader term that focuses on nearly any type of data in educational institutions, while academic analytics is specific to data related to institutional effectiveness and student retention issues.”

SOTL THROUGH ANALYTICS AND VICE VERSA

The emerging field of learning analytics and the growing importance of SoTL are rapidly producing new possibilities for gathering, analyzing, and presenting data. SoTL is an important source of intelligence in terms of teaching and students learning. SoTL generates a rich data-set about how students engage in their learning. In the same vein, learning analytics and data mining have emerged in the wake of higher education’s ability to capture an increasing volume of data. Learning analytics is evolving quickly and is able to build appropriate systems for bringing SoTL data together. This SoTL-Learning Analytics relationship allows for the analysis of teaching and learning trends and themes, building unique practical understanding of student engagement, teaching excellence, and development of innovation in teaching in higher education. This can point towards a future of new evidence that can influence instructional decisions and serve as the basis for a broader and deeper SoTL paradigm.

As suggested by Van Barneveld, Arnold and Campbell (2012), SoTL "is the key transformative piece and at the heart of academic analytics”. In addition, ‘analytics can supplement the established theory and practice of the field’ and ‘iteratively feedback into SoTL, informing future directions". SoTL and learning analytics are closely intertwined. While SoTL focuses on theory, pedagogy and student learning research, learning analytics operationalises them. SoTL and learning analytics supplement and complement each other. Van Barneveld et al. (2012) have described the relationship between SoTL and learning analytics as symbiotic and share the following characteristics:

- Both have the opportunity to inform the other.
- Learning analytics can deepen our understanding of teaching and learning, while SoTL can inform the learning analytics community on important areas of focus.
- Both are collaborative processes that continually seek to improve pedagogy and learning theory.
- Both are inquiry-based disciplines that go beyond content knowledge into broader realm of student learning.

This SoTL-Learning Analytics relationship places critical emphasis not only on transmission but also on the transformed and extended knowledge. Continuous analytics can effectively
track the impact on students, faculty, and the institution. These data are used to inform stakeholders and impact policy to improve faculty development and other support structures necessary for success. Learning analytics search for patterns found in historical and transactional data to understand the teaching and learning and is focused specifically on students and their learning behaviours. This iterative loop of continuous quality improvement is augmented by the SoTL research.

As a field of scholarship and not grounded in any core discipline, SoTL struggles with validity and acceptance in the academic circle (McKinney, 2007; McKinney, 2012; Hutchings, Huber, & Ciccone, 2011). The need for robust methodological rigor is matched by the need to apply rigorously evaluated techniques. Learning analytics can incorporate the methods and evaluated techniques in SoTL studies to broaden and deepen the processes and conditions (and/or intervening variables) at work. Learning analytics are a means to the end, not the end in and of itself.

Conducting research to explore various dimensions of learning analytics is a fundamentally different undertaking from analyzing learning measures and outcomes to look for patterns that can inform decision making about improving student success. Data, by itself, does not improve student success. Although learning analytics offer great promise for transforming the accountability, personalization, and relevance of the higher education experience, that promise will not be fully realized until there are direct and explicit links to issues of teaching and learning. Learning analytics community can apply the technological and statistical skills to leveraging the kind of data that the SoTL community finds valuable. Both communities will learn a lot more about student learning and the teaching practices that promote it.

AN ILLUSTRATION

To demonstrate the close link between SoTL and learning analytics, an analysis of learning styles using clustering is described below. This learning analytics application is based on real but disguised data, with a simulated variable included. It shows how clustering can be used to group students into homogeneous groups, so that they can be assigned the most effective learning pedagogy. In the illustration, the IBM-SPSS Modeler data mining software (provided by Sift Analytics Group Private Limited, Singapore) is used. The clustering results are summarised in Figure 1.

This illustration is based on the premise that not all learners are the same. Hence, for a particular learner, some learning styles (or pedagogical approaches) may work better for him/her than other learning styles (or pedagogical approaches). For example, some learners may prefer (and learn better with) an interactive approach, while others may prefer (and learn better with) a more visual approach.

In the analysis, the following data are captured for a cohort of students: gender, age, prior knowledge of content, work experience, previous science score and previous non-science score, as well as their preference for one of three pedagogical approaches (namely, audio, visual and interactive) that they believe they can learn better with. The first six variables listed above (i.e., from gender to previous non-science score) are used to cluster the students. They are also referred to the clustering criteria. The objective of clustering is to group the students into homogeneous and heterogeneous groups based on the clustering criteria. Students belonging to the same cluster can be deemed to be similar with respect to their
gender, age, prior knowledge of content. Conversely, students belonging to different clusters can be deemed to be dissimilar in these respects.

To perform clustering with Modeler data mining software, the Two-Step clustering algorithm is used. This algorithm determines the optimal number of clusters within the data, and assigns the students in the sample to the particular clusters that they belong to, on the basis of the clustering criteria. The clustering results show an optimal solution of three clusters of students – with 37.1%, 32.3% and 30.6% of the sample belonging to Clusters 1, 2 and 3, respectively. A graphical summary of the clusters is shown in the centre panel of Figure 1. Students within the same cluster are similar. It is assumed that similar students are likely to have similar learning styles. Hence, they are likely to prefer and learn better with a particular pedagogical approach.

The next step in the analysis is to investigate the incidence of the dominant pedagogical approach preferred by each cluster. As shown in the bottom right panel of Figure 1, students in Cluster 1 (32.3% of the sample) generally prefer the interactive approach, those in Cluster 2 (37.1%) the audio approach, and those in Cluster 3 (30.6%) the visual approach. Based on the clustering results, profiles of the three clusters can also be developed. The relative distributions in the left panel show the profile of the students across the six variables (i.e., gender, age, prior knowledge of content, work experience, previous science score and previous non-science score). The relative importance of the variables in clustering the students is given in the top right panel and a graphical summary of the clusters is shown in the centre panel.

As an application in learning analytics, the cluster membership of, say, new students can first be determined by running their data (i.e., the six variables) through the clustering model. Then, the dominant (or preferred) pedagogical approach can be offered to them in the learning system based on their predicted cluster membership. This is expected to provide a pedagogical approach that is more aligned to the students’ learning style, which in turn, is expected to better facilitate their learning.

Further analyses can be performed on the data. For example, it will be useful to explore the relationship between the students’ preferred learning style and its effectiveness in terms of academic performance. Also, it is useful to study the factors (other than learning style) that may be associated with academic performance.
Figure 1

Clustering Results – Recommending Pedagogical Approaches

This figure is reproduced with permission from Sift Analysis Group Private Limited (Singapore).
CONCLUSION

While teaching-focused higher education institutions welcome the value of integrating SoTL into their focus and translating it into their evaluation, and tenure processes; many research-focused institutions are also looking to expand their area of inquiry to be included in their definition of academic and scholarly work. The broadening and deepening of SoTL with learning analytics provides the strength towards this expansion. Using data to diagnose problems is only part of the opportunity. Emerging evidence from both research and practice communities suggests that SoTL-learning analytics have the potential to help both instructor and learner toward more personal and more engaging more convenient learning experiences that may have a direct positive impact on student retention.

These opportunities and possibilities contribute to the growing importance of SoTL and the increasing interest in learning analytics. Although effective practices that leverage learning analytics are still in their early stages, the number of stakeholder groups interested in discovering more about how learning analytics can support SoTL continues to grow. This working relationship helps to make accountable and informed decisions based on carefully mined data. Stakeholders such as students, staff, faculty, administrators, and members of the broader higher education community are able to help deliver on the promise to enable student success.

However, this symbiotic relationship is not without challenges. To move to the next level, new theoretical frameworks from the learning sciences as well as more powerful analytical techniques will be needed, new sources and ways to collect and translate teaching and learning data will be useful. A broader focus beyond formal education to informal education and lifelong learning will be desirable. Finally, there is the question of ethics, privacy and ownership of data (Ferguson, 2012). Bienkowski, Feng and Means (2012) has also highlighted technical challenges (i.e., lack of technical resources and lack of data interoperability and consistency), institutional capacity (i.e., human resources) and ethical issues (i.e., privacy protection) as barriers to learning analytics and educational data mining.

Despite the challenges, SoTL and learning analytic are exciting areas to watch in the near future. More can be expected in the areas of learning analytics and educational data mining in the next few years. And in tandem with this, greater advances in SoTL can be expected too.

REFERENCES


Authors

Dr KOH Hian Chye is the Assistant Provost of UniSIM College and a Professor at SIM University. His teaching and research interests focus on business analytics. He has published in international journals and presented at international conferences. He has also served as a statistical and data mining consultant to several organisations.

Dr Sylvia CHONG is Associate Professor, President’s Office at SIM University. Her research interests are inter-disciplinary in nature and include substantive and methodological areas of higher education research. She was Principal Investigator for four successful Academic Research Funding (AcRF) projects and two MOE commissioned research projects. She has published in international journals and participated in various conferences.