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MOOCs, Learning Analytics and Learning Advisors

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Abstract

The advent of Massive Open Online Courses has been variously described as heralding the end of the modern university or alternatively, an over-hyped re-badging of existing online content whose advantages have already been realised. Appeals to ideology however, have typically characterised coverage of both polarities rather than hard evidence; in particular, there has been much less analysis on just how learning outcomes are impacted by either "face-to-face" interaction or online/digital environment. Less dichotomously and even more rarely addressed is perhaps a more pertinent question: What blending of the two learning modes works best and in what circumstances? In this paper we argue that the emerging field of learning analytics applied to "educational big data" contains the tools for answering such a question provided a university's data linkage problem can be solved. The authors, Learning Advisors in ECU's Faculty of Engineering, Health and Science, describe the initiation of a framework incorporating data on content usage in online learning systems, together with establishing a new system for collecting data on individual consultations and workshops (a "face-to-face" mode, for which data is less-commonly collected). These data are presented and even in isolation contain interesting features on ECU's current learning landscape; it is in their combination, however, that we argue the real potential lies and we conclude by covering the necessary steps needed for such a realisation.

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Introduction - Learning Analytics and Academic Support Services

The use of analytics in higher education is a relatively new field (Barneveld, Arnold & Campbell, 2012) but it has the potential to provide "valuable insights that can inform strategic decision making regarding resource allocation for educational excellence" (Macfadyen & Dawson, 2012, p. 149). The corporate world has adopted business analytics over a period of several decades (Goldstein, 2005; Barneveld et al., 2012) but higher education has been slower to embrace the field of analytics, collecting vast amounts of student data but demonstrably inefficient in the use of the data collected when compared with the business world (Siemens & Long, 2011). The higher education sector is currently undergoing a period of transformation, with growing pressure to deliver outcomes and demonstrate accountability in an increasingly competitive and crowded sector. Subject to funding and other institutional constraints, educational administrators and academics are faced with the challenges of maximising student retention rates in the face of a burgeoning, increasingly diverse student population. The rapid expansion of digital technologies and the recent emergence of Massive Open Online Courses (MOOCs) have created yet another set of challenges for universities which continue to operate in an historical but arguably outmoded paradigm. In the light of the challenges confronting the sector, the use of analytics is potentially transformative, providing a new mechanism for improving teaching and learning, organisational efficiency and organisational decision making (Siemens and Long, 2011).

Analytics in the higher education sector can be applied at two different levels, each with a different focus and purpose. 'Learning analytics' is described by Barneveld et al. (2012) as "the use of analytic techniques to help target instructional, curricular and support resources to support the achievement of specific learning goals" (p. 8) while 'academic analytics' is more "a process for providing higher education institutions with the data necessary to support operational and financial decision making" (p. 8). Academic analytics, therefore, is typically employed to address issues related to administration, finance and budgeting, human resources, research funding and planning in higher education institutions whereas learning analytics is concerned with the levels of learning of individual students, capturing and interpreting data with a view to improving teaching and learning outcomes (MacFadyen & Dawson, 2012).

Historically, the educational effectiveness of universities has been evaluated in terms of broad outcomes, i.e. graduation rates, mean GPAs, employment rates and progression to graduate studies and it is these areas which have provided the main focus for analytics in higher education to date (Bach, 2010). The use of analytics to improve face-to-face student processes however, provides an opportunity for growth in learning analytics as research indicates that student support and services have significant impacts on overall student success (Bach, 2010). Greller and Drachsler (2012) note the potential of learning analytics to become a powerful tool for informing educators and supporting students, providing a platform for better understanding and predicting student performance and learning needs.

The rapid expansion of interactive learning environments, learning management systems (LMS), e-portfolios and personal learning environments (PLE) provide vast amounts of tracking data but to date, the use of this data for improving teaching and learning has been limited (Greller & Drachsler, 2012). These e-learning environments store user data automatically, creating data sets which provide opportunities for investigating learner behaviour, developing feedback and support mechanisms, devising early warning systems, and developing future learning applications. Learning analytics is therefore becoming increasingly relevant to a number of key stakeholders in higher education including educators, funding agencies, governments, research institutes and software developers (Greller & Darchsler, 2012.)

How learning analytics can most benefit our students needs to be assessed from a number of perspectives: student success/learning outcomes, pedagogy, strategic goals of the organisation and ethics, to name a few. The comparative discussion and evaluation of traditional and online education is, therefore, a multi-faceted, complex issue for which data collection needs to be an incremental, ongoing process.

Our experience as Learning Advisors has highlighted an ongoing demand for face-to-face instructional delivery that focuses on student-centred approaches but equally, a sizeable proportion of ECU's cohort has adapted to and embraced online learning. Clearly, both modes of delivery should adhere to overall principles of sound teaching and learning including gradation of content difficulty, scaffolding of learning processes, formative assessment with feedback, collaborative and interactive learning, and valid and reliable summative assessment.

A critical question relevant to MOOCs remains however: Do we succeed in educating students when online classes are offered and does such a delivery align with university and student priorities (Rivard, 2013)? In-depth research is required to investigate whether traditional or online pedagogy is more productive and in which circumstances this may be the case. Some argue that online instruction saves lecturers' and learning advisers' time, allowing for more face-to-face student engagement while also accommodating students who prefer online interaction and facilitating the development of independent learners (Scheider, cited in Rivard, 2013).

One possible risk associated with online learning is that it could become a goal in itself, without a strategic purpose (Rivard, 2013) and designed to simply fit given circumstances, technology and cost structures (Buchanan, 2013). One important benefit of applying learning analytics, however, is that a purpose needs to be apriori identified and codified; hence, it can become an indispensable evaluation tool for gauging teaching and learning effectiveness across both academic courses and academic support.

Broad discussions regarding comparisons between traditional and online education invariably include concerns about the conception of a University – the one that "closes off rather than opens up the critical and cultural roles" (Cooper, 2013, p. 1). MOOCs have been criticised for narrowing the learning scope, removing a human element from the processes of teaching and learning, replacing reflection from the student learning process, manipulating the knowledge they present and consequently limiting the connection with social and cultural aspects of knowledge acquisition (Cooper, 2013).

Online education may also be limiting in terms of internalised learning, promoting a quick fix for gaining skills and knowledge in specific areas rather than sound enquiry. Knowledge exclusively presented by MOOCs could, therefore, be limiting learning to the transmission of information (Cooper, 2013, p. 13). Based on the outdated behaviourist pedagogy, MOOCs run the risk of reducing assessment to merely understanding concepts (Cooper, 2013); worse, its exclusive adoption could amount to substituting the expert/learner interaction used to develop critical analysis and creative thinking, an eventuality that, in the absence of true artificial intelligence, can but lead to poorer learning outcomes.

If MOOCs are to come close to usurping or complementing some of the roles traditionally assigned to Universities - producing citizens reaching their own potential while contributing to their community - then we argue that their long-term viability will only be to the extent they *enhance* not *detract* from capabilities traditionally instilled in a University setting and encapsulated in the following nine principles (James, Baldwin, Farrell, & Devlin, 2007, p.1): an atmosphere of intellectual excitement; an intensive research and knowledge transfer culture permeating all teaching and learning activities; a vibrant and embracing social context; an international and culturally diverse learning environment; an explicit concern and support for individual development; clear academic expectations and standards; learning cycles of experimentation, feedback and assessment; premium quality learning spaces, resources and technologies, and finally, an adaptive curriculum.

These nine principles are central to a University's core mission and can all conceivably be addressed to varying degrees by either face-to-face or online teaching or suitable combination thereof. While arguments in the literature and our impressions as Learning Advisors have been discussed in terms of the abilities and limitations of each mode, we return to our earlier theme that such arguments and impressions need to be clarified through the incremental use of educational data, the collection, interpretation and combining of which, we now address.

ECU's Educational Data

One of the main contributions of this paper is to initiate a systematisation of data relating to face-to-face interactions by way of balancing the existing data currently focused on more digital, online interactions. As alluded to earlier, the rise of Learning Management Systems and Adaptive Learning systems has invariably been accompanied by the capture of fine-grained information on *how* these systems are being used. This yields important and valuable data (that has been used in claims about the effectiveness of MOOCs-like instruction) but we argue that the importance and influence of personal interactions needs to also be captured with a view to evaluating the contribution these practices make to learning outcomes.

The data from online learning included here encompasses the use of the Blackboard LMS, Online Assessment and ALEKS Adaptive system (in numeracy) while the face-to-face interactions include all individual consultations and attendance at workshops delivered in the Academic Skills Centre in ECU's Faculty of Health, Engineering and Science. This represents however, only a small subset of the full gamut of learning experiences and support available at ECU, both online and in-person. It ignores, for example, a number of other learning systems currently in operation at the University, together with the range of personal interaction that occurs in tutorials, practicums, in 'Student Connect' and through the activities of Learning Advisors in other faculties. Nonetheless, establishing a framework even for this restricted selection is useful for discovering the challenges that need to be overcome in combining data from different systems and different learning modes. This opens the way for an incremental unification and leveraging of a University's complete data set; in short, it goes some way towards solving an institution's *record linkage problem*. The possible evolution of such an unfolding is described later but first we contextualise the data collection of the authors' work as Learning Advisors at ECU.

FHES Academic Skills Centre

The Academic Skills Centre attached to the Faculty of Health, Engineering and Science at ECU provides a suite of services to assist students and staff in a multitude of courses spanning a broad range of disciplines. A dedicated team of five Learning Advisors runs a series of workshops on academic skills, conducts drop-in assignment labs, offers individual student-consultations and maintains a Blackboard site with a wealth of information, advice, online workshops and video tutorials. Learning Advisors also liaise with academic staff in their upskilling, use of technology, curriculum design and in supporting those students identified at risk or unusually gifted. An important component of this collaboration is "embedding" whereby general academic skills taught from within the centre are tailored prior to their inclusion in an academic's unit. This embedding can take the form of guest lectures, workshops, tutorials, assessment or generating digital content and is becoming an increasingly important tool for ensuring minimal standards of literacy and numeracy as mandated by various regulatory bodies. The following data, its scope, usefulness and limitations for some of these activities will now be described.

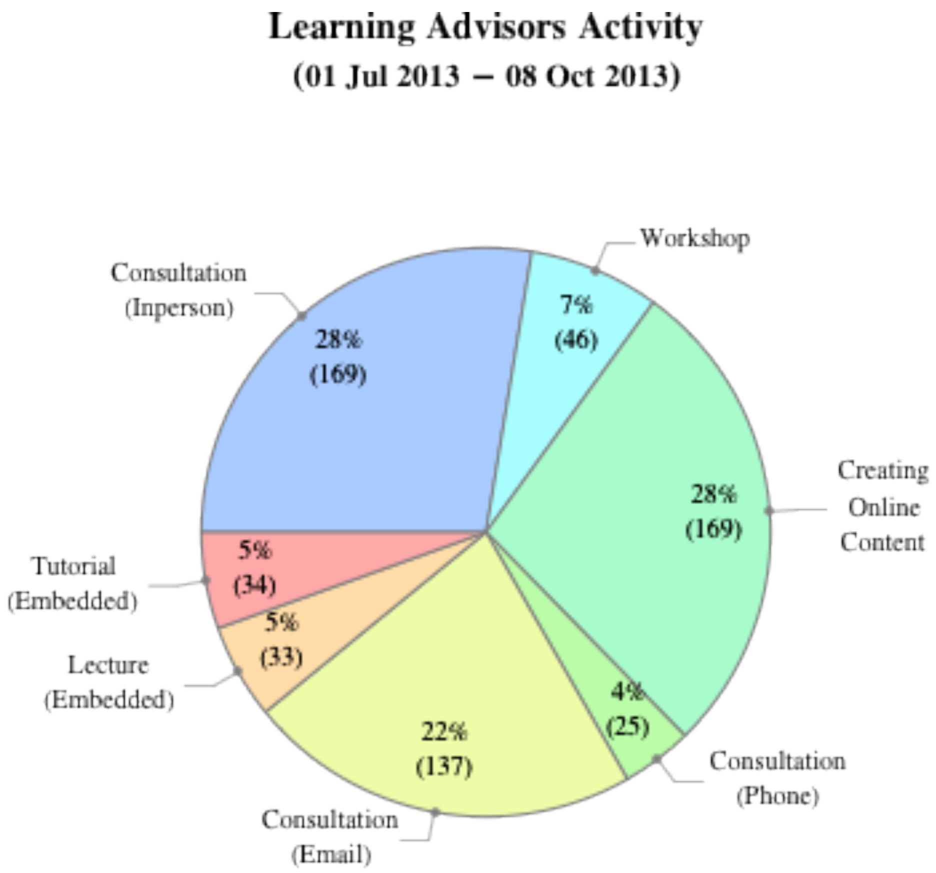


Figure 1: A task breakdown of the proportion of time (collectively) spent by Learning Advisors in the Centre for Academic Skills.

The broad range of activities related to direct student engagement by FHES's Learning Advisors is indicated in the pie chart of Figure 1. Each pie chart sector corresponds to the proportion of time Learning Advisors spend on the labelled activity (bearing in mind these are aggregated proportions from Semester 2 and hence will vary from individual to individual and over different dates). Driven essentially by demand, note that all but 28% of this activity is associated with some form of face-to-face interaction suggesting that, in spite of the trend towards digital delivery in higher education, the demand for personal interaction remains strong and confirms our anecdotal impressions.

It is also worth highlighting a "symbiosis" that occurs between different activities so that the potential value of each cannot be considered in isolation. As an example, about 28% of this engagement was spent preparing online content which whilst having the potential to reach many more students is also heavily informed by the personal interaction of Learning Advisors with both students (in consultations) and staff (in embeddings).

The teaching and learning of academic and generic skills we therefore argue, is more effective when contextualized, embedded and blended. Naturally, the exact proportions that ultimately produce "optimal learning outcomes" remains an open question but it is one that can at least start to be more evidentiarily framed with this systematisation – a process on which we later expand.

Individual Consultations

Individual appointments are available for ECU students needing assistance in a variety of ways including: help with deciphering assignment questions, implementing effective research techniques, planning and writing assignments, referencing, group work, presentations or as a lecturer referral having failed an assessment. Given the high demand, students are encouraged to first attend academic skills workshops, drop-in assignment labs and/or consult the Centre's Blackboard materials.

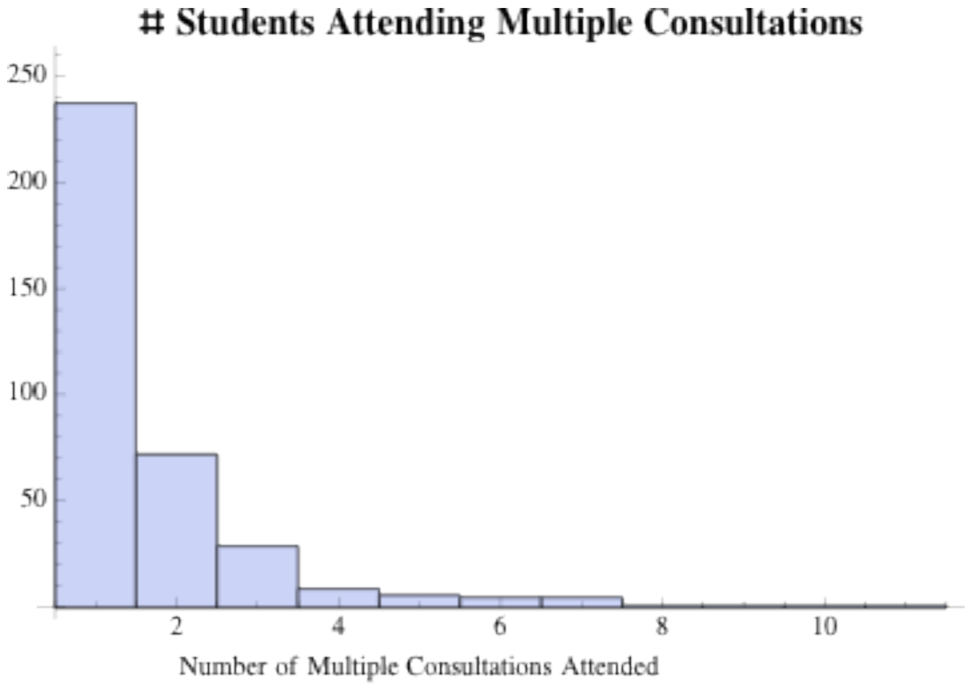


Figure 2: A count of the number of students attending between 1 and 10 individual consultations with a Learning Advisor.

Mostly, a single consultation appears sufficient to resolve a student's difficulty although sometimes follow-up consultations are required as indicated in Figure 2 where about 240, 70, 30, 10, 8 students required, respectively, 1, 2, 3, 4, 5 consultations while a handful of at risk, weaker, students booked consultations on between 8 to 12 occasions.

Workshops

The Academic Skills Centre offers a comprehensive suite of generic, academic skills workshops, covering a wide range of topics, throughout the semester. Topics include 'Starting Assignments', 'Reading and Note-taking', 'Writing Essays', 'Paraphrasing without Plagiarising', 'Critical Thinking and Logical Arguments' and 'Exam Preparation' and many more. As of 2013 a number of numeracy, mathematics and statistical workshops were also introduced.

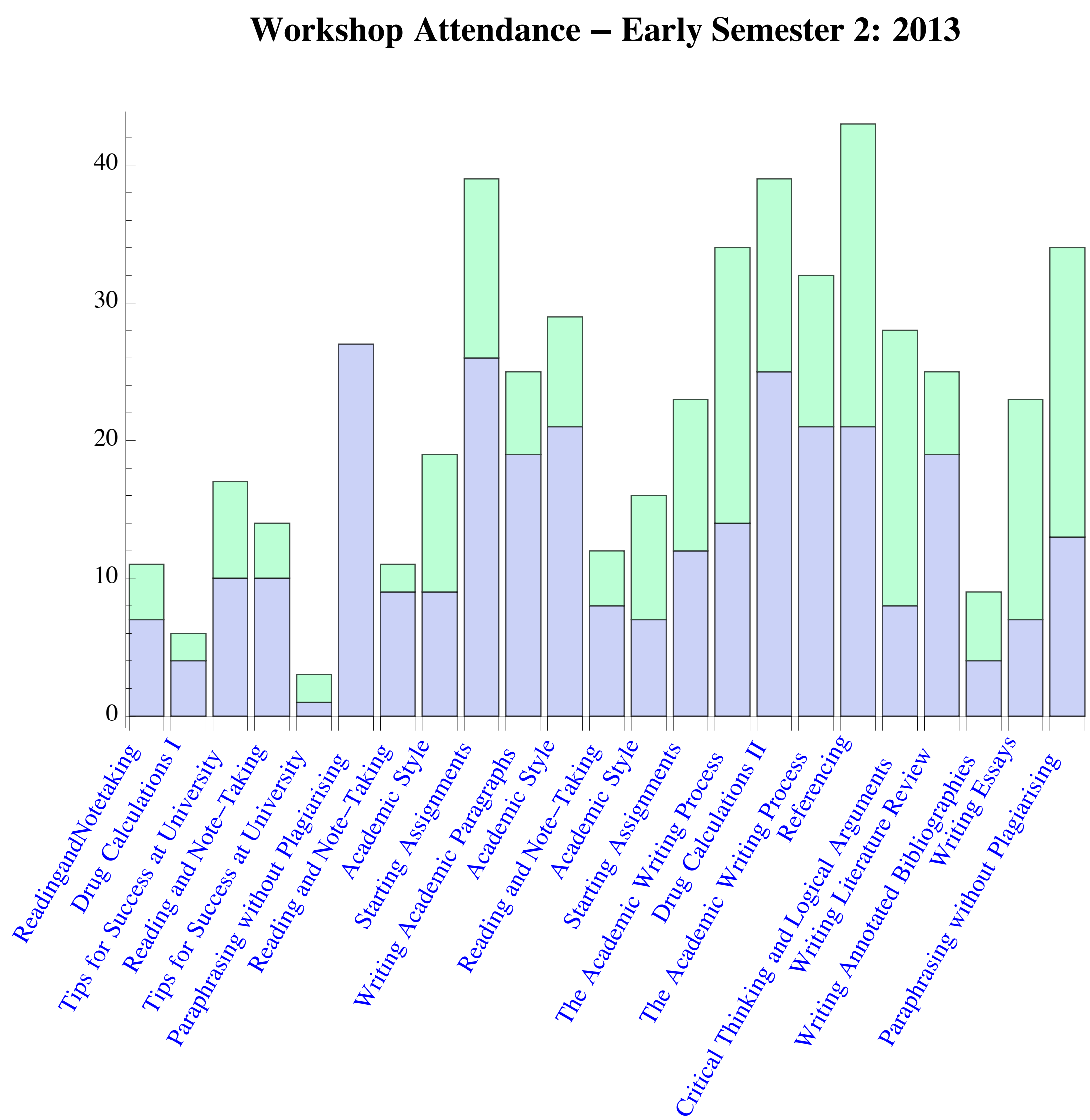


Figure 3: The number of students registering (in green) and attending (in blue) workshops offered by the Center for Academic Skills in the first part of Semester 2: 2013.

The Academic Skills Centre also conducts drop-in assignment labs whereby students in particular schools are able to come along to a workshop for guidance with specific assignments. Attendance for these assignment labs and workshops is open to all undergraduate and postgraduate students enrolled in the faculty and they are requested to register online through the University's Events Management system.

Attendance at these workshops is typically greater in the first half of the semester (many students are mid-year entries) as shown in comparing Figures 3 and 4 as might be expected given their greater utility for upcoming assessments. The figures also indicate many students registering but not attending workshops particularly in the second half of the semester as well as spikes matching certain assignment deadlines.

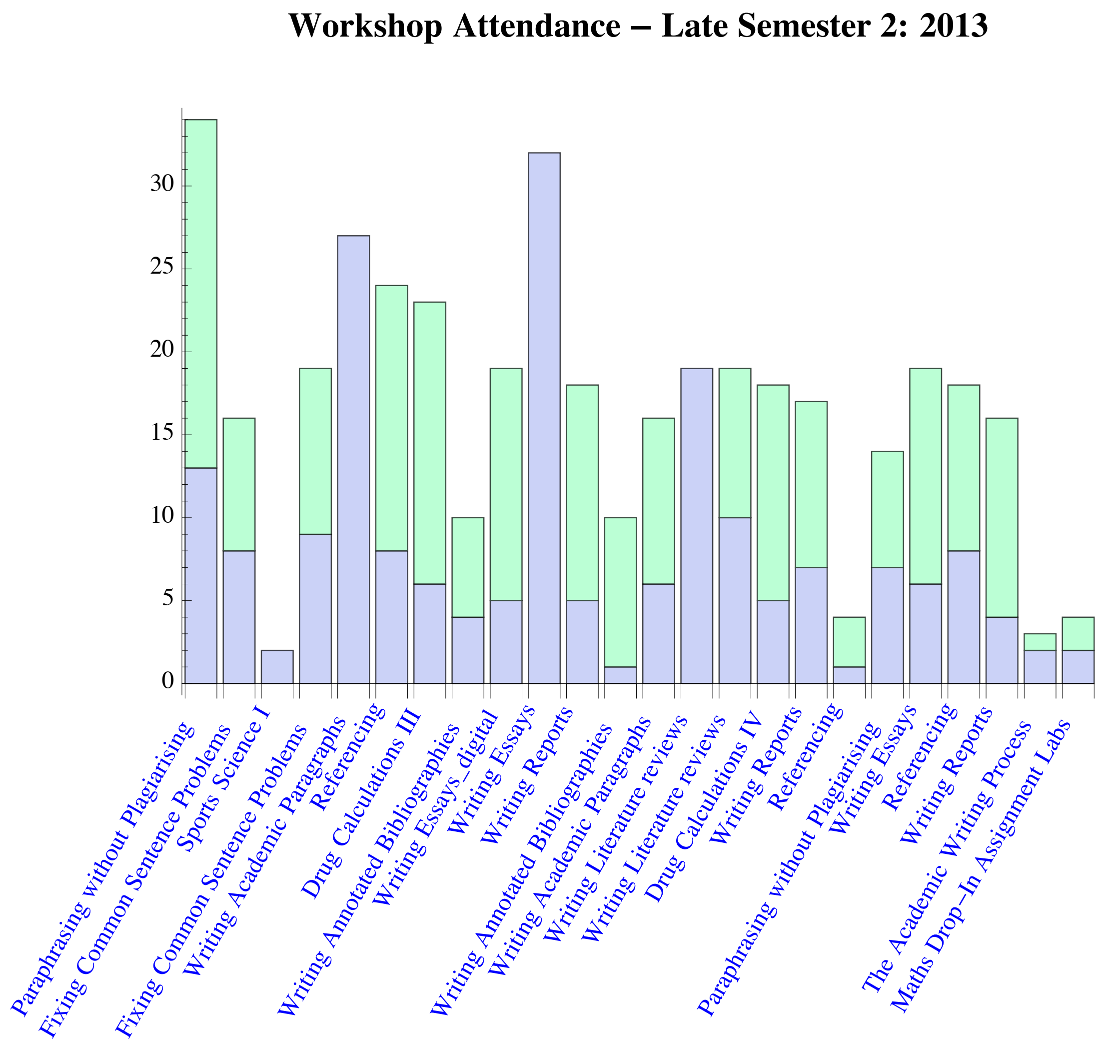


Figure 4: The number of students registering (in green) and attending (in blue) workshops offered by the Center for Academic Skills in the second part of Semester 2: 2013.

As for consultations, we can similarly measure attendance at multiple workshops with, for example, Figure 5 showing that 119 students attended a single workshop, 50 a second and over 20 attended 3 workshops. As observed for consultations there is also a small cohort of keen or weak students attending more than 6 workshops throughout the semester (or at least by the time of this submission – the end of September).

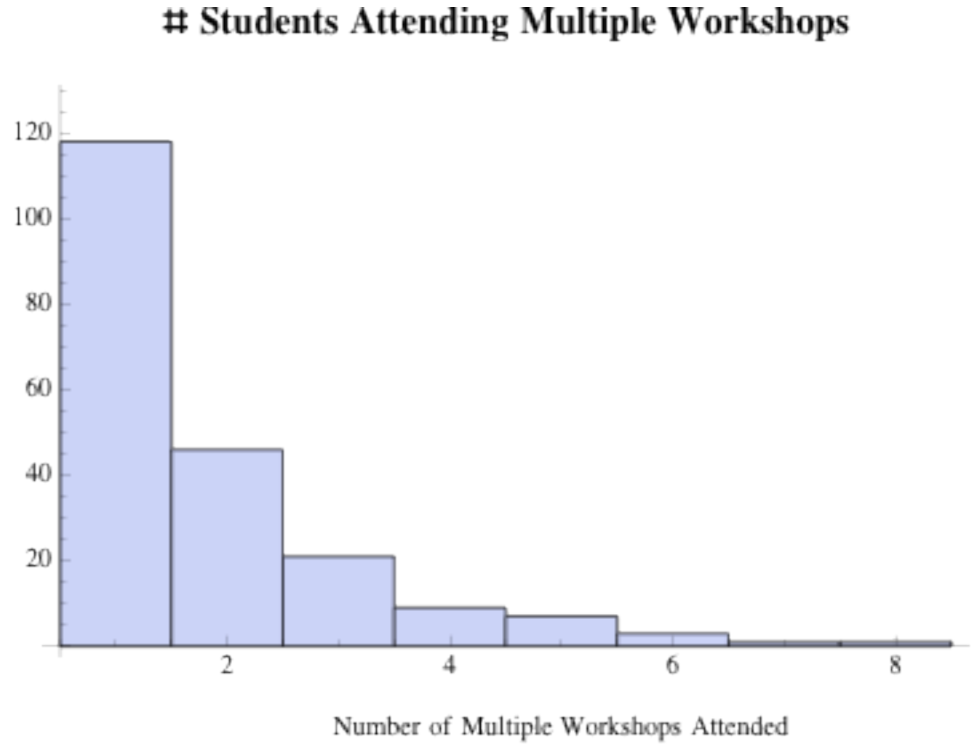


Figure 5: A count of the number of students attending between 1 and 8 workshops in the Center for Academic Skills.

Systematisation & Automation

The data-collection involved in measuring the use and impact of online material is a natural extension of its digital nature and delivery; doing likewise for face-to-face interactions however, is more challenging even for systematising the recording of an essential data-point - individual student attendance.

There is a tension between instigating data-collection protocols that generate sufficiently useful data but are not too burdensome that they become routinely ignored by busy educators. The previously illustrated data was collected by Learning Advisors using a minimal protocol (whose mechanics are recorded in a Camtasia presentation stored on the Centre's Blackboard site) that records the identity of individual students attending consultations and/or workshops. This was done by creating a series of categorizations in each Learning Advisor's Outlook Calendar as well as modifying the spreadsheets of workshop registrants as generated by the University's Event Management system. By following this protocol, information on each Learning Advisor's workshop and calendar events could be generated in a unified format, placed in a shared University drive and then analysed via computer code to produce the presented graphs.

The systematisation of this process is important for two reasons; firstly it means the process of generating descriptive statistics can be automated (and therefore of potential formative use instead of summatively at the end of each semester) but more significantly, it means that data on this "face-to-face" activity can start to be integrated with data from online learning systems as part of more powerful analyses on their combined and collective effect on student outcomes. This process is foreshadowed later but first we give two examples of such data from online learning systems in use at ECU – Blackboard and ALEKS.

ECU Blackboard

ECU uses Blackboard as its institutional LMS and the following diagram shows the result of a diagnostic test for evaluating the numeracy of nursing and midwifery students. The results of this test were used to direct students to Drug Calculation workshops and to the use of the online ALEKS system.

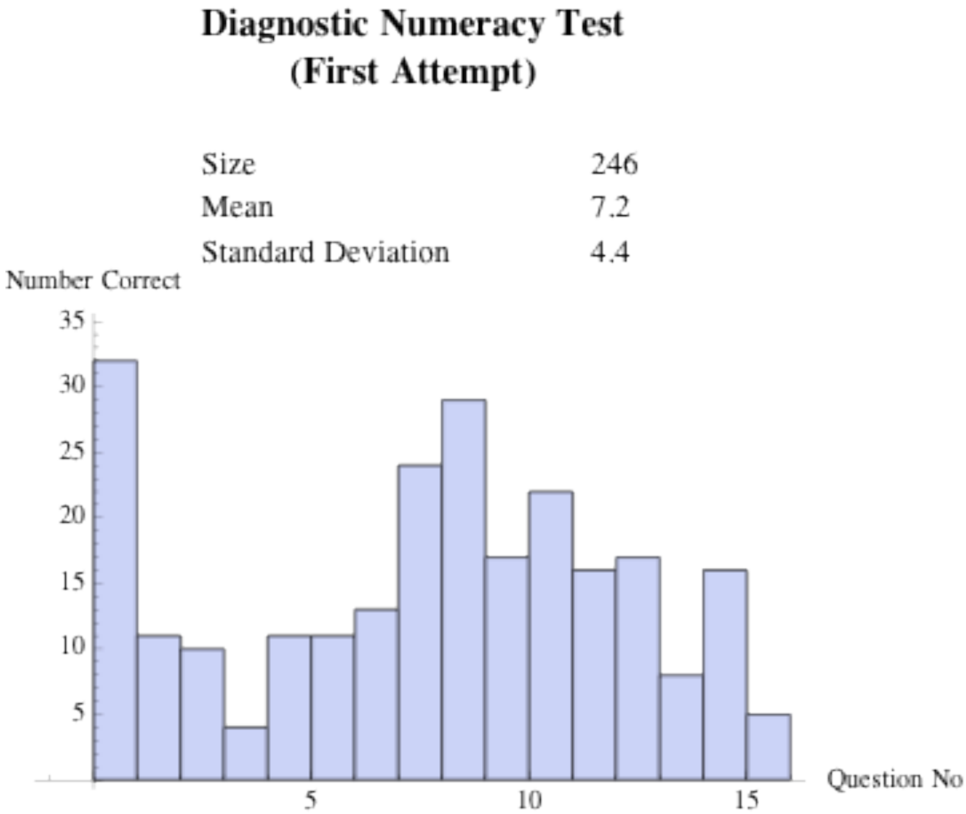
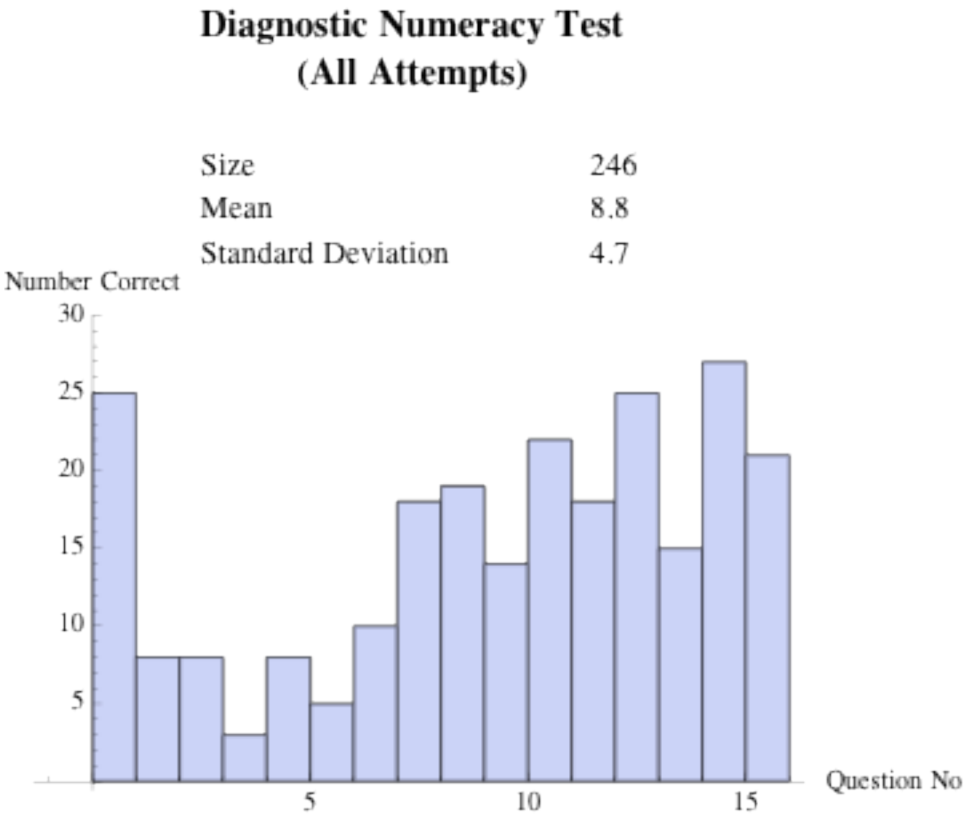


Figure 6: The percentage of nursing students obtaining the correct answer in their first attempt at questions from a diagnostic numeracy test.

Blackboard Quizzes provide the option for repeated attempts and the effects of students using this option on the success rate for each of the 15 questions can be observed in Figure 6 – a slight improvement in overall performance, particularly on the harder, latter questions.



ALEKS

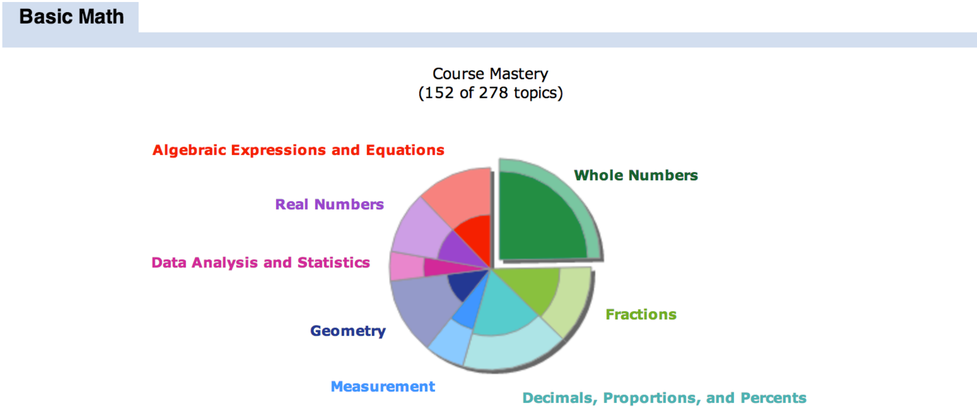
Figure 7: The percentage of nursing students obtaining the correct answer from all attempt at questions from a diagnostic numeracy test.

ALEKS is an online, adaptive learning system that enables students to improve their basic numeracy by independently working through a program of instruction based on an initial diagnostic assessment. It was introduced on a trial basis in Semester 2, 2013 at ECU in a range of schools but Figure 8 shows the collective performance of a Stage 1 nursing cohort while practising the numeracy skills required to perform Drug Calculations.

Record Linkage Problem

One of the primary challenges of harnessing the wealth of educational data currently stored in Universities' systems is to solve the *record linkage* problem. Systems designed in isolation generate useful data but it is often only when *linked* that their true collective worth is realised and, in the case of learning analytics, useful, actionable, educational lessons revealed. The critical record for linking such data sets is the *student identifier*.

Without a student identifier linking together multiple data sources, questions and analyses tend to focus on the systems themselves instead of how they combine to affect individual learning outcomes. So, for example, while the data previously presented provides insights into the activities of Learning Advisors; attendance in individual consultations and workshops; performance in Blackboard quizzes or overall numeracy levels based on ALEKS assessments, it does not address the more fundamental question - how do these systems and, in what combination, affect the learning outcomes of individual students?



ALEKS Table of Contents

View Course Content by ALEKS Table of Contents

View All Topics / Hide All Topics

Whole Numbers	82% Mastered
Fractions	58% Mastered
Decimals, Proportions, and Percents	55% Mastered
Measurement	48% Mastered
Geometry	29% Mastered
Data Analysis and Statistics	54% Mastered
Real Numbers	39% Mastered
Algebraic Expressions and Equations	40% Mastered

Figure 8: The percentage of students considered to have mastered certain areas of basic numeracy according to the online, adaptive learning system, ALEKS.

The collective value of all data stored on various University systems lies in the information it contains in relation to the impact on an *individual*'s learning. It is through linking the data sets from the various systems according to a student identifier that their relative influences on learning can start to be discerned. It might reveal, hypothetically, that strong students who spend three hours on ALEKS and attend between one and three workshops, improve their grade on a Drug Calculation Assessment by 10%, whereas weaker students viewing a relevant part of the Academic Skills Centre Blackboard site for over four hours, followed by participating in two consultations within three weeks improve their grade by 20%. It is this type of detailed, fine-grained analysis that becomes possible with such linkage and potentially leads to more fine-tuned, customised offerings by a University.

There is, in addition to a student identifier, one other component needed for the linking of disparate data sets and the impact of their generating systems on learning outcomes, namely a measure of these *learning outcomes*. Fortunately, both pieces of information typically reside on an administrative, student-records system which at ECU is currently the Callista system. This system contains student identification details (i.e. student ID numbers and email addresses that can be used to link data sets created by systems using only one of the two) as well as student grades for all units.

At the time of writing, Callista data is not available in “batch” form at ECU (i.e. only individual records can be accessed by staff from its web interface) for a variety of technical, ethical, privacy and political reasons, highlighting the fact that solving the record linkage problem represents not just a scientific challenge but also a social one. Even with the record linkage problem solved however, the question of what to do with all this linked data remains - how can it be used to positively change learning environments?

Predictive Analytics

As befitting an emerging field, Learning Analytics which concerns the use of digital trails to improve learning outcomes, does not yet suggest *how* these should optimally be performed. While inferential statistics and network visualisations are emphasised in the early literature (Ferguson, 2012), taking the cue from the evolution of business and health analytics, it is likely to be tools from *predictive analytics* that will ultimately prove to be the most decisive (Wagner & Ice, 2012). Epistemologically, the drivers towards this methodology seem even more pronounced in the educational sphere where the use of standard mathematical distributions to support an intuited and stated hypothesis seems less relevant than those evolved from a spirit of *data mining*, which entails identifying unintuited connections and predictions based on large, multi-dimensional data sets.

The aptness of predictive analytics for educational data is perhaps most clearly indicated by the complexity and variability in desired outcomes compared to the more concrete ones sought in health and business: The efficaciousness of administering a drug or deploying an advertising campaign often has an explicit and natural final measure - patient survival or profit - whereas successful learning outcomes are inherently more nebulous. Successful learning is directly measured using the traditional means of tests, essays or assignments all following subjectively designed marking keys, or indirectly using measures of student engagement, reported satisfaction levels, examination performance, graduate attributes or ultimate career success.

Further indicators for the putative role of big data tools in learning analytics stem from the sheer number and fluidity of variables that have the potential to influence an individual’s educational attainment. A small subset of these variables includes factors like a student’s socio-economic status, primary and (any) secondary languages, exposure to different educational systems, inculcation to technologies and interface idioms, age, sex and learning styles. Furthermore, even without the advent of potentially disruptive MOOCs, such is the flux of the modern, technologically-driven educational milieu that measuring a given teaching intervention’s long-term success is arguably going to be less repeatable than assessing the aptness of methods used to *predict* any intervention’s shorter-term effectiveness.

Conclusion

The recent emergence and potentially disruptive influence of MOOCs has led some educators and analysts to question the ongoing viability of the current University model while others have decried this as overblown hype given the well-documented shortcomings of MOOCs. Our stance, however, is that either position or a combination remains a possibility and a lot still depends on the response of the higher education sector.

In particular, we argue that it will depend on universities embracing the big-data-driven metrics that have demonstrated the learning potential of MOOCs but extending these to include the traditional activities of a University education. This involves three steps that we propose will be essential: collecting and collating data on learning activities involving face-to-face interactions; progressively linking data that measures face-to-face interaction together with data currently measuring the use of online learning systems; and analysing this collective information using predictive analytical techniques derived from Big Data. In this paper, we have initiated a program related to the first step before describing some of the parameters and challenges associated with the final two and whose completion, we argue, is a prerequisite for our students reaping the benefits of a truly blended learning experience.

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