

Intelligent Student Engagement Management - Applying Business Intelligence in Higher Education

Abstract

Advances in emerging ICT have enabled organisations to develop innovative ways to intelligently collect data that may not be possible before. However, this leads to the explosion of data and unprecedented challenges in making strategic and effective use of available data. This research-in-progress paper presents an action research focusing on applying business intelligence (BI) in a UK higher education institution that has developed a student engagement tracking system (SES) for student engagement management. The current system serves merely as a data collection and processing system, which needs significant enhancement for better decision support. This action research aims to enhance the current SETS with BI solutions and explore its strategic use. The research attempts to follow socio-technical approach in its effort to make the BI application a success. Progress and experience so far has revealed interesting findings on advancing our understanding and research in organisation-wide BI for better decision-making.

Keywords: Student engagement, business intelligence, decision making, higher education, socio-technical approach

1. Introduction

This paper reports a research in progress project aiming to advance the current research and practice in BI applications in the Higher Education Sector. More specifically, the research attempts to apply BI in student engagement management in a UK university.

With the increasing amount of data being collected and distributed from internal and external sources, organisations are constantly seeking new technical and managerial approaches to making better use of data and information available. The concept of “Big Data” is emerged to describe the volume, variety, and velocity of the data generated with Information and Communication Technologies (ICTs). Business and society are facing unprecedented challenges of big data and need to act swiftly for innovation and competitive advantages. Business Intelligence (BI) as a concept and technology has significant potential in transforming data from distributed and heterogeneous sources into an integrated enterprise view for supporting organisational decision-making, management and strategic planning. The concept of BI was introduced as a result of the need to aggregate, synthesise and report the data into an enterprise view for supporting decision-making and strategic planning. Theoretically, Simon’s (1965) decision-making process model provides good understanding on the intelligence concept. From the ‘intelligence-design-choice’ phases of decision-making, the ‘intelligence’ phase is of particular importance as it precedes the other two phases. The ‘intelligence’ phase is whereby the business environment is examined and problem areas as well as opportunities are identified. Key activity involved in the ‘intelligence’ phase includes classification of the opportunity or problem. BI system can encompass applications such as data warehouses, data mining, data marts and On-Line Analytical Processing (OLAP). The main purpose of BI is to enable interactive and easy access to diverse data, enable manipulation and transformation of these data, and provide business managers and analysts the ability to conduct appropriate analyses and perform actions (Turban et al. 2008).

Kelly (2005) points out that HEIs collect a large amount of data and knowledge, but individuals who work for HEIs cannot find an effective way to manage and utilize the information. With higher education institutions facing increasing pressures from social and economic change, student acquisition, engagement and retention becomes more critical than ever. It is believed that the success and development of university students has less to do with what they contribute or where they study but what they do during the course of their study as a student (Kuh 2001; Trowler 2010). Therefore, student

engagement is viewed as an important antecedent to student learning and achievement, as well as to institutional success. Trowler (2010) conducted a thorough literature review on student engagement for The Higher Education Academy. Coates (2010) argues that student engagement is useful for managers because by monitoring student engagement, institutions can identify areas of good practice as well as areas for improvement.

To manage student engagement in their academic study more effectively and efficiently, the University in this context valued the role of ICT and decided to look for better ways of managing student engagement using innovative ICT. As a result, the University and a BI vendor have jointly developed a Student Engagement tracking System (SES). The system aims to enable the users to spot a drop in engagement level before it becomes significant, thus allowing system users' to identify students at risk of disengagement, so to make early intervention to re-engage students. Data input comes from a number of online and offline sources as shown in Figure 1. Fixed Radio Frequency Identification Devices (RFID) have been positioned in various locations such as, library, lecture theatres and seminar rooms across university campuses. For example, before entering lectures and seminars, students are required to scan their student card, which identifies the time and the place or event attended. Events also include: library attendance, exam attendance and assignment submissions. Student online login information, such as BREO (Blackboard virtual learning environment and support system), University email and digital library are also collected by the tracking system. This information is then communicated back to a central database within the University. SES also interacts with other information systems including student database which consists of personal and academic information held by the University for each student.

Although the system went live in December 2009, it presently serves as merely an information source, rather than a decision support environment. Furthermore, users of the system have highlighted that the current systems' interface is fairly basic and have expressed a desire for enhanced functionalities. The University feels that the system has great potential and would like to build on the system further. Consequently, the University has expressed an interest in developing a BI solution in order to improve the functionality of the existing SES, so the University is able to monitor and understand student engagement behaviours at different levels (individual, group and cohort, etc).

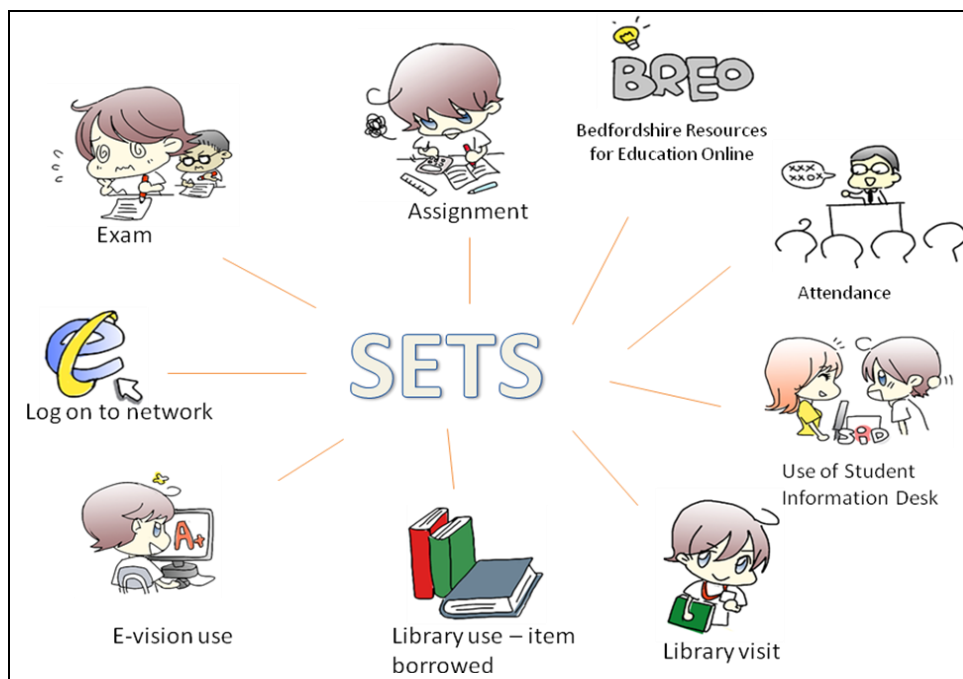


Figure 1. Data sources of student engagement tracking system

The concept of BI is steadily rising up the priority list within various Higher Education Institutes (HEIs) (JISC, 2011a). Some universities use BI to analyse class failure patterns to identify at-risk students and direct them to appropriate support services (Durso, 2009). Dekker *et al.* (2009) and Kotsiantis *et al.* (2003) use data mining tools to predict student's dropout. However, Chaudhuri *et al.* (2011) state that today it is difficult to find a successful enterprise that has not leveraged BI for its business. Yet, despite the potential and promise of BI solutions, most of them fail to provide timely, meaningful and relevant insights for decision makers. Wixom *et al.* (2011) argues that to create an enterprise-wide BI capability is a journey that takes time. Therefore, the project reported in this paper aims to apply BI in a UK university and develops better understanding on the critical issues surrounding the BI success from socio-technical perspective. Organisational, human and technical factors are examined and discussed in the context of BI applications in the Higher Education sector.

It is argued that Information Systems (IS) research is socio-technical by definition (Ghaffarian, 2011). The socio-technical approaches emphasise the interrelationship between social factors and technological factors in understanding an organization (Chai and Kim 2012). Since a socio-technical approach provides a useful framework to help us understand the way in which technology is adopted and used in an organization (Bostrom & Heinen, 1977), this study adopts this socio-technical approach in its effort to develop and deploy the BI solutions. The socio-technical approaches can complement mainstream information systems research by capturing the contextual dynamics and actors rationality, attending to relevant actors, their interests, and the logic of their negotiations (Callon, 1986)

This project is funded by the UK Joint Information Systems Committee (JISC) BI programme. JISC is a United Kingdom non-departmental public body whose role is to support higher education and research, by providing leadership in the use of ICT in learning, teaching, research and administration. Following UK JISC strategy 2010-12 to help institutions develop and use their corporate and business systems efficiently and effectively, JISC launched the Business Intelligence Programme (JISC 2010) in line with its aim to work with managers of higher education in the areas of BI and BI systems. This project aims to apply BI in managing student engagement in the UK HEIs. More specifically, this research explores how BI can utilise the multi-dimensional data set collected from the University's existing SES to enhance decision making and planning for managing student engagement. To achieve this aim, the first phase of the project is to benchmark the university BI maturity and identify users' needs for BI enhanced SES. The project concerns with the organization-wide development and deployment of BI from socio-technical perspective by involving a diverse range of stakeholders in the problem identification stage and considering both social and technical interventions of information systems. The intelligent SES has potentially profound impact on student behavior, student management, and evidenced-based decision making across the university's operational, managerial and strategic levels. The paper reports the research in progress and the preliminary findings on identifying and implementing users' requirements for developing BI solutions. More importantly, Informed with socio-technical arguments and employing action research methodology, the research attempts to report and reflect our experience in making BI work for UK Higher Education Institutions (HEIs).

2. Research Methodology

The tenets of the socio-technical approach were intimately coupled with action research (. The methodology of this research can be described as an Action Research (AR), which is an iterative process involving researchers and practitioners acting together on a particular cycle of activities, including **problem diagnosis**, **action intervention**, and **reflective learning** (Avison, Lau, Myers, and Nielsen, 1999). More specifically, it is a research focusing on change and reflection, involving researchers and practitioners actively participating in an organisation change situation whilst conducting research aiming to make contributions to theory and knowledge. In this case study, AR aims to influence BI design and deployment and maximize its impact. All authors are key actors as the project team members in the University's BI project.

AR stage one - Problem Diagnosis

The main objectives at the start of this BI project include benchmarking university's BI maturity level and identifying the BI toolkit requirements specification. From the socio-technical perspective, the human actor is integral part of BI system and their views and expectations should be thoroughly sought and considered. BI maturity level was assessed using the JISC infoNet BI Maturity conceptual framework. This involved an examination of the current and expected BI maturity level in the areas of student data and information from stakeholders' point of view. User requirements were identified using a number of methods including the survey, focus group and interview with existing and potential BI users.

A university wide BI survey was carried out with academic, administrative and management staff. The questionnaires were distributed through a number of channels. For example, they were distributed to administrative staff through faculty managers, to academic staff during the university's teaching and learning conference, and the business school's faculty conference. Forty two validated questionnaires were received. Survey respondents covered key representatives of staff, including all levels of academic staff, field administrators, faculty managers, course leaders, researchers and senior managers. Respondents also provided their comments and suggestions via open questions in the survey.

One focus group discussion was carried out with academic staff in the department of Business Systems in the Business School. The focus discussion collected views and opinions on how to make better use of SES and the potential applications of BI systems with SES data and the anticipated challenges. One "think tank" meeting was held with senior management staff and key SES users to discuss the future of SES and its improvement. A brain storming session was carried out with the think tank meeting participants to collect views and ideas related to the benefits, limitations and problems of the current SES.

Six interviews were undertaken. Three interviews were conducted with academic staff to understand their needs and requirement for the better use of SES data. Three faculty managers who have used SES in supporting their work were also interviewed to discuss their experience and opinions on the use of SES and the potential applications of BI systems.

AR stage two – Action Intervention

Having identified the gaps and problems with SES and established the user requirement for an improved SES with BI solutions, the project team has worked closely with internal and external key stakeholders to develop interventions. Equipped with a socio-technical understanding of IS applications, the project is not just looking for technological interventions, but those underpinned by the concept of technology-organisation-people working as whole in achieving the project objectives. Based on the notion of socio-technical approach, four of JISC's six strategic ICT enablers (JISC 2011b) are being considered as the main interventions. They include enterprise architecture, communications and engagement, system governance, and shared BI services.

AR stage three – Reflective Learning

AR is an iterative process, so the reflective learning should start from beginning of the project and improves along the process. Socio-technical approach of IS research is used as the main theoretical lens for reflective learning. Therefore, critical issues of technology-organisation-people surrounding the successful BI development and deployment will be examined:

- *Technology* – What emerging ICT are used or to be used? What are the technological challenges in managing the "big data"? In this case, technologies include IT hardware, e.g. RFID devices, Oracle database, etc.. and software, such as data warehousing, Oracle BI platform, bespoke BI tools, etc.
- *Organisation* – What are the strategies and processes involved in the university-wide student engagement management practice? How is SES perceived to be part of the student engagement management process to improve its efficiency and effectiveness? The primary objective of SES is to facilitate and support intelligent student engagement management process which is complex and dynamic in nature. Student tracking data are from almost all areas of student learning

activities. The value of the system outputs for the institution is enormous, but the realization of the system value is the significant challenge.

- *People* – who are the key human actors involved? What are their roles and what are the ways that they interplay? What is the impact of human behavioral issues? A diverse range of actors have been identified in BI development and deployment. Most importantly, as the student engagement management is organization-wide operation, particular attention will be paid to the managerial challenges and human behavior towards BI success from socio-technical perspective in our reflective learning.

Again, it needs to stress that technology, organization and people are seen as constitutively entangled and that we need to focus on their entanglement to understand how the BI system achieves its success.

3. Preliminary Findings

Works so far have been mainly focused on problem diagnosis and action intervention. The following sections share some of our preliminary findings.

Intuition BI Maturity assessment

According to JISC (2010), “A Maturity Model is a convenient way of describing an area of work, so that practitioners can communicate with one another, describe progress in diverse projects, and identify shared goals and problems”. The JISC BI maturity model describes six stages of BI implementation:

- *Stage 1 - Data are fragmented and distrusted - scattered among traditional, often locally held data sources; manual reports are available to departmental, faculty and institutional management*
- *Stage 2 - Information is increasingly coherent, held in centrally managed system(s) with clear local responsibility for data entry and data quality. Most reporting is still manual.*
- *Stage 3 - A Business Intelligence (BI) Project is started, and a vendor and system are selected.*
- *Stage 4 - An initial BI System is put in place which allow managers at each level to access data when they need to.*
- *Stage 5 - The BI system and its links to data sources are increasingly automated; reporting becomes more sophisticated and spreads to a wider user population.*
- *Stage 6 - Systems are used for evidence based decision making and for predictions, models and assessment of future options.*

Based on the evidence of our various investigations and assessments, it is evident that the University has moved forward from BI maturity stage 1, 2 and 3 to stage 4: an initial BI system (SES) is put in place allowing managers at each level to access data when they need to. However, the current SES project is still in its infancy in terms of realising its full potential as a data source to provide evidence based decisions and planning. The senior management team has demonstrated their strong support and provided appropriate financial resources for the improvement of the current SES to leverage its value. The university’s BI maturity level will be moved towards maturity level 5 and 6 in the near future. The BI project will play an essential role in promoting BI implementation in the university.

Across all the investigations by using surveys with 50 users, 2 focus groups and 6 interviews, there was a general consensus that the current SES is potentially very valuable in supporting institutional decision making on student engagement. The SES project has had profound impact on student behaviour especially in attending classroom based learning activities, such as lecture, seminar, and workshop. However, most users agreed that the SES requires further enhancement and development to be considered as usable. Summary of benefits, problems and limitations of current SES are outlined in Table 1 below.

Table 1. Benefits, problems and limitations of current SES

Benefits	Problems and Limitations
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<ul style="list-style-type: none"> ▪ Positive impact on student behaviour ▪ More effective and efficient student management ▪ Evidence based feedback to students ▪ Early Interventions ▪ Real time monitoring ▪ Meet UKBA & other legal requirements ▪ Inclusive, reliable data that can be used for comparisons across different student groups 	<ul style="list-style-type: none"> ▪ System speed - The sheer amount of data collected makes the current system unable to provide acceptable speed for user to use the system. This has been identified as the bottleneck for making further use of the current SES. ▪ User interface – the current user interface is not user friendly and flexible. ▪ Data output – this is regarded as not operational useful and action-oriented at the moment. ▪ Data sources and modes of engagement – nine engagement areas are used to collect student engagement data, but it may not provide a complete and true picture of the student engagement. Therefore, other important sources should also be included. ▪ Lack of the integration with other student data systems. ▪ Lack of ability for user customisation – users are not able to play with the data to suit their own priorities and needs.
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BI Toolkit Requirements Specification

Based on the evidence of our various empirical research methods, users and potential users of SES have highlighted three essential requirements for improving current SES with BI solutions.

Student engagement measurement index - Most users would like to have the flexibility for selecting engagement measurement criteria. They would like to have “*the ability to interrogate easily*”, “*be able to rank the importance of the information*”, and “*be able to prioritise the importance of different types of engagement*”. One faculty manager commented, “*I’d like to select and define my criteria for checking student engagement*”. Another faculty manager said that, “*I’m unaware of how it’s been set up, I mean the engagement criteria. I would like to change the criteria from time to time.*” The student engagement measurement index provides the ability for users to customise engagement measurement index (engagement KPI). Three functions can be provided for users to:

- Use default engagement measuring index – The index should be developed based on the common perception and definition which constitutes student engagement.
- Customise the index system with their selected engagement types. Users should be able to pick and mix different engagement data types captured by the system.
- Prioritise the importance of different types of engagement, e.g. class attendance is more important than others. Two options may be provided to users: one is to let users to define their own weighting parameters to reflect their priorities; another is to provide a tool to assist their decision making. For example, Analytic Hierarchy Process (AHP) can be incorporated.

Interactive and personalised dashboard for engagement reporting - Users are expecting an interactive dashboard for retrieving outputs from the system. Some comments are, “*Output to be useful, easy to read and understand*”, “*the ability to generate exception report*” and “*useful report based on pre-determined criteria*”. One manager expressed, “*I want quick, easy and user friendly & customisable report for starboards.*” One faculty manager commented, “*The output should be interactive, allows me to generate reports for different purposes.*” The interactive dashboard provides the ability to create recurring standard report and ad hoc (demand) reports through an interactive dashboard. These reports can be generated either by request of an end-user or refreshed periodically through an automatic scheduler (ie. weekly, fortnightly, monthly, quarterly). Users are allowed to modify and save their report parameters, such as frequency, date ranges, course and/or unit cohort.

Automatic risk alert system - Users find it useful to have some kind of alert functions in SES for monitoring disengaged students who are at risk. For example, the system will automatically flag out

individual students or groups at risk for early intervention. Some comments are, “*automatic report of students at risk immediately they trigger a threshold of failure*”, “*automation of alerts*”, “*make it easier for staff to identify students at risk*”. One academic staff expected the system to detect disengaged students by commenting, “... *to be able to pinpoint as early as possible an “at risk” student. ... because early indicator of engagement can help support/retain students.*” One faculty manager commented, “*If the system can trigger awareness of disengaged students, it will be useful.*” The risk alert function provides the ability to alert users of exception activity of student engagement, for example, disengaged students who are at risk can be identified early in a course. Users can be notified automatically through push mechanism, such as email, pop-up window. Key functionalities of alert function can be summed up as follow:

- User can define the thresholds of risk alter for individuals or groups.
- Ability to flag out individual students or groups at risk automatically.
- Exception data or push report can be pushed to the users’ email or through the pop-up window of the system.
- User can specify the email address and select different frequencies (weekly, monthly etc.) to run the push report.

Initial Assessment of the Improved SES

The initial assessment of the project shows that the project has transformed the University’s BI maturity to a higher level, whereby an improved student engagement system with BI solutions have been developed and implemented. Relevant student engagement data sources are now automatically and efficiently collected and processed for reporting through a number of interactive dashboards. These dashboards present various types of visualisation to users and allow users to make better informed decisions related to student engagement management and retention. The improved system also gives users the flexibility to customise the system and reporting based on their respective requirements. As a result, the number of active users have increased which leads to senior management buy-in for more user licenses and for installing more engagement monitoring equipments across the University.

4. Reflection and Future Work

This project concerns with the organization wide BI development and deployment for intelligent student engagement management which has potentially profound impact on student behavior, student management, and evidenced-based decision making cross the university’s operational, managerial and strategic levels. This action research attempts to understand the critical issues related to the BI success. Research so far has involved undertaking surveys, interviews and focus groups with existing and potential users to benchmark current BI maturity level and establish the problems and use expectations. Feedback collected from BI system stakeholders has demonstrated the significant potential and users’ high expectations regarding BI applications in managing student engagement, but the project has faced many challenges in making BI work.

In additional to the tangible benefits of the improved SES with BI technologies, intangible benefits so far include:

- Improved knowledge and understanding on BI benefits and impact among stakeholders.
- Raised awareness on the strategic usefulness of the information provided by the improved SES
- Positive change among students engagement behaviour, especially class attendance.
- Demonstrated the case for making informed and evidence based decisions on student engagement activities
- Improved acceptance by managers and tutors on better risk management by identifying students at risk at earliest stage and thus taking more proactive approaches for improving student retention.

Early reflection learning from socio-technical perspective provides useful insights into issues related to institution wide realisation of BI potential and impact:

Technology – At the early stage of the project, technology has been the bottleneck of the progress. Numerous problems with data collection devices and database system bugs have prevented the expected level of BI applications. One notable technical challenge is managing and monitoring the engagement data collecting devices to ensure the data reliability and accuracy. Another is how to manage the daily growth of overwhelming volume of data which affect the system speed.

Organisation – From the fusion and transformation point of view, it is necessary to raise awareness among senior managers on the importance of seeing BI as an embedded component of student engagement management system, thus needs systematic interventions from top management team. Organisation implementation strategy, guidance, and system ownership are also important issues to address. A clear system governance structure should be considered at the very early stage.

People – Most of challenges and inhibitors appear to be centered around human issues. Misunderstanding and mismatch of expectations among IT providers, managers, academic staff and faculty administrators can cause delays and affect the success significantly.

Next stage of our work will be action intervention by focusing on the wider BI deployment and final roll-out of the BI solutions within the University. More specifically, we will

1. Promote the wider use of SES in the University and continuously seek feedback from various users for further improvement.
2. Expand the current placement of attendance monitoring equipment and web based analysis software in all facilities and campuses.
3. Explore further opportunities to develop more advanced BI toolkits for student engagement analytics and strategic view of BI dashboard visualisation for senior management team.
4. Incorporate learning analytics and predictive tools into the BI dashboard. For example, develop tools to benchmark and predict student performance against their engagement patterns, to analyse and predict patterns of engagement of different groups (e.g. culture, ethnicity, age, etc.), and to support the strategic planning and improvement of students experience during their university lifecycle.

We hope that our experience and lessons learnt in making BI a success in student engagement management will help others in their endeavor of making successful BI applications.

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