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Conceptualising the systemic evaluation of dashboards in quality enhancement processes in higher education

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Abstract

The article highlights the need for improvement in the evaluation of dashboard implementations intended to support quality processes in higher education, and proposes a systems thinking framework for this improvement. A review of the literature on quality enhancement processes in higher education and dashboards research highlights that quality enhancement in higher education might be more appropriately understood through the lens of complexity management. The Viable Systems Model is argued to be useful for this purpose, and in terms of the role of dashboards in supporting these processes, encourages focus on their role in supporting communication and information flow for effective decision-making for adaptation. Some initial systems modelling is conducted to illustrate how the application of the model could guide evaluation, providing the foundation for case study evaluation and research.

Keywords dashboards, quality enhancement, systems thinking, higher education, IT evaluation

1. Introduction

In the UK, government has introduced measures to drive quality enhancement in higher education (HE) through increasing competition and the transparency of performance data (Higher Education and Research Act, 2017). However, the perception amongst HE leaders is that the use and effectiveness of technology to analyse data is lagging behind developments in other countries (e.g. US) and sectors, and therefore this is perceived as a priority for the UK sector (PA Consulting Group, 2016).

Dashboards are tools that help users visualise “*a relatively small collection of interconnected key performance metrics and underlying performance drivers that reflects both short- and long-term interests to be viewed in common throughout the organization*” (Pauwels *et al.*, 2009:177). An important underlying premise of this statement is that they play a role in reducing the complexity of data about the situation of interest for stakeholders and bring some consistency across an organisation in the standards and measures of performance and how these are communicated (Pauwels *et al.*, 2009).

Data dashboards are therefore now commonly used in business intelligence processes, which in the context of HE has been described as

“evidence-based decision-making and the processes that gather, present, and use that evidence base. It can extend from providing evidence to support potential students’ decisions whether or not to apply for a course, through evidence to support individual faculty and staff members, teams and departments, to evidence to support strategic decisions for the whole organisation” (Jisc, 2014).

Dashboard *research* has been described as aiming to “*identify what data is meaningful to different stakeholders and how data can be presented to support sense-making processes*” (Schwendimann et al., 2017: 30). The aim of this conceptual article is to contribute to this research by:-

- (i) highlighting the limitations of existing dashboards research as it pertains to informing improvement in quality processes in HE;
- (ii) proposing a conceptual framework, informed by systems thinking, to evaluate dashboard implementations intended to support quality enhancement (QE) processes in HE.

Systems thinking encourages the scope of inquiry to extend beyond the data and its visualisation and interpretation (although this is still an important focus), to systemic consideration of factors influencing the implementation, effectiveness and impact of dashboards in their organisational context. It therefore adds to very limited literature that applies the concerns and techniques of systems research and practice to the context of improving dashboard implementations in HE.

The paper begins with an overview of the relevant literature. This summarises the current quality landscape in HE, and debates in the literature about appropriate QE processes and business intelligence in this context. This sets the context for the challenges argued to be presented for QE strategy in HE and the role of analytics and data dashboards in potentially addressing some of these challenges. This section then goes on to review previous research into analytics and dashboard interventions, particularly in the context of HE, and examines the progress made with developing methodology for evaluating dashboard implementations for supporting HE QE processes. The penultimate section of the paper outlines a conceptual framework for underpinning evaluation of dashboard interventions in this context to lead to improvement in their support of users’ needs, and their influence on QE decisions and actions. The final section summarises the key conclusions drawn from the research so far, and the need to build on this conceptual framework through case study research in HE.

2. Background literature

2.1. Quality processes in Higher Education

The notion of quality for the UK HE sector has for over 20 years been framed by a quality code, with independent and periodic review of institutions to assess their compliance (QAA, 2018). More recently a Teaching Excellence Framework (TEF) has also been introduced as a “*measure to recognise and reward excellence in teaching and learning, and help inform prospective student choices*” (HEFCE, 2017), which at the time of writing this article is under independent review. Institutional participation in this has so far been voluntary, although it will be compulsory for providers in England registered with the Office for Students who have more than 500 students. For them the awarded status is connected to the tuition fees providers are permitted to charge, and established providers will need to perform well in relation to the measures defined by this framework to remain competitive.

It has been argued that there has been limited discussion about the complexity of interpreting the concept of teaching excellence, and how this influences enhancement practice in the context of a diverse range of institutions, disciplines, roles and responsibilities (Gunn and Fisk, 2013). The academic debate about the meaning of quality in HE, and how to assess and improve it (Harvey and Williams, 2010a, 2010b; Greatbatch and Holland, 2016; Gibbs, 2010) highlights in particular the

tension between quality assurance and enhancement, with criticism that the sector relies too heavily on driving improvement through quality assurance processes and the rather narrow range of quantitative metrics used for comparison against benchmarks or targets for these metrics. An illustration of this is that despite the guiding definition of quality for the sector being focused on a process of *“how, and how well, the higher education provider supports students to enable them to achieve their award”* (QAA, 2015:5), the focus of the TEF is still largely on quantitative metrics, for example on continuation rates, generic national survey results about student satisfaction with their HE experience and their employment or further study destination. It has been argued that this type of data is inadequate for developing an understanding of the complexity of how and why specific strategies work in specific contexts to inform enhancement efforts (Houston, 2008; Gibbs, 2010). The TEF does permit institutions to provide ‘additional relevant evidence’ to explain the context of the data and make the case for excellence. The guidance encourages examples of evidence of ‘impact’ and ‘effectiveness’ of strategies for improving the student experience, student outcomes and learning gain, even though the concept of ‘learning gain’ is still the subject of current debate and research (McGrath *et al.*, 2015; Office for Students, 2018). However, this does suggest that institutions do need to ensure they have appropriate evaluation and organisational learning processes in place to help them to understand how their own strategies are working in context, and how these strategies influence the common metrics being used across the sector. A decision making context is also required that enables findings about needed improvement to be actioned.

In terms of enhancing teaching practice to positively influence student experiences and outcomes, in the UK, HE practitioners are encouraged (or in many cases required) to engage in professional development that prepares them for continually improving their own practice. This still relies heavily on ‘reflective practice’ models (Schön, 1983; Kolb, 1984), which assumes improvement in an individual’s practice is informed by their mental models of how and why their strategies work, developed from their experience of iteratively implementing and evaluating them. This model has been argued to be inadequate as a strategic approach to change in HE, which instead requires a more collective approach to sense-making, developing theories of change, and action research at different levels of organisation in institutions and the sector (Biggs, 2001; Trowler *et al.*, 2005, 2013; Marshall, 2016). From this perspective quality processes are conceptualised as *“a process of engaging with complex and dynamic environments that provides organisations and their leaders with a flexible and agile model of the world”* (Marshall, 2016: 213). This is acknowledged to be complex due to situations being socially constructed and serving the diverse interests of multiple stakeholders. It has been argued big data and learning analytics can support development of new approaches to evaluation in an educational context, but this also requires appropriate institutional policy and planning approaches to ensure use of analytics *“for engaging stakeholders in discussion and facilitating change rather than as tools for measuring performance or the status quo”* (MacFadyen *et al.*, 2014: 22).

2.2. HE analytics and dashboards and their role in HE quality processes

The term HE analytics has been adopted in this article, to refer to HE specific context of data analytics. However, much of the background literature in this area derives from the US, where the research is more mature, and here a distinction is often drawn between academic analytics and learning analytics. In this context academic analytics *“reflects the role of data analysis at an institutional level ...”* (Long and Siemens, 2011: 36), and learning analytics is considered to be more specifically focused on *“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” (1st International Conference on Learning Analytics and Knowledge- cited in Siemens, 2013:1382). However, following an exploration of practice within the UK HE sector (Sclater, 2014), it was found that there was a reluctance to apply this distinction in the UK, with data being considered a “*continuum which can be used by people at every level of the organisation, from individual students and their tutors to educational researchers, to unit heads and to senior management*” (Sclater, 2014:4).

In the specific context of education, a dashboard has been described as “*a single display that aggregates different indicators about learner(s), learning process(es) and/or learning context(s) into one or multiple visualizations*” (Schwendimann *et al.*, 2017: 37). Its purpose can be to inform the decisions and actions of a variety of users both internal and external to the institutions, including staff, students, professional support staff, and prospective students. Making data and its analysis and presentation meaningful to the decisions and actions of its users is considered to be one of the current main challenges in the education sector (Schwendimann *et al.*, 2017).

In the previous section it was argued that quality enhancement in relation to student experiences and outcomes depends on HE practitioners learning about how their change strategies work in practice through implementing and evaluating their own theories of change. These processes need to be undertaken not only by individuals, but by groups, at different levels of the organisation and sector, and acknowledge the complexity of how situations are socially constructed. Therefore some researchers have argued that analytics and dashboards need to support practitioners in sense-making and more rigorous action research (Agpar, 2015; Dyckhoff *et al.*, 2013). From this perspective it is practitioners’ questions about how their implemented strategies are working in practice that guide decisions about data, data sources and methods that will generate information to help answer these questions. This may include both qualitative and quantitative data and methods (Dyckhoff *et al.*, 2013). Yet many teachers’ questions have been found not to be answered with analytics approaches (Dyckhoff, 2011), and learning analytics forms only a small part of the evidence used to assess the quality of teaching (Gunn and Fisk, 2013). Uncertainty about the associated legal and ethical issues is also being perceived as a barrier to wider adoption of analytics and dashboard approaches (Sclater, 2014; Ferguson, 2012).

Relatively recent literature reviews in the field (e.g. Ferguson, 2012; Papamitsiou and Economides, 2014; Chrysafiadi and Virvou, 2013; Peña-Ayala, 2014; Sclater and Mullan, 2017; Lester *et al.*, 2017) have also highlighted that existing research has largely been quantitative, focusing on approaches to analysing and reporting data, for example, to predict student performance and students at risk (e.g. Abdous *et al.*, 2012; Giesbers *et al.*, 2013; Mogus *et al.*, 2012; Lykourantzou *et al.*, 2009; De Freitas *et al.*, 2015). Typical purposes are to inform interventions to support students and/or improve satisfaction (e.g. Macfadyen and Dawson, 2010), to help students reflect on their learning behaviour (Fritz, 2011), and to create personalised recommendations of learning resources (Klašnja-Milićević *et al.*, 2013). Over 200 indicators have been found to be reported in use in various educational dashboard implementations (Schwendimann *et al.*, 2017). However, there is currently little evidence of the impact of dashboard technology on the behaviour and outcomes for learners (Scheffel *et al.*, 2014, Schwendimann *et al.*, 2017, Verbert *et al.*, 2014). Indeed, Dzuiban *et al.*, (2007, cited in Dzuiban *et al.*, 2012) found that alerting students to data indicating that they were at risk was, in many cases, insufficient to motivate modification in

behaviour. Barefoot *et al.*, (2016) also found it was unclear how dashboards presenting comparative institutional data to prospective students of higher education actually influenced their decisions about where to study.

Therefore quantitative analysis of narrow sets of data already collected may be contributing to QE processes by identifying trends and relationship of concern and suggest a need for change, but as correlation does not mean causation, it cannot identify strategies for success (Agpar, 2015). Literature reviews also identify that little attention has been given to qualitative studies able to provide insight into issues associated with representation, interpretation and impact on decision making and behaviour (Papamitsiou and Economides, 2014; Dyckhoff *et al.*, 2013; Lester *et al.*, 2017). Empirical studies of case studies of dashboard implementations using mixed method evaluations have focused on issues such as stakeholder perceptions of usability or usefulness to inform improvement of the dashboard design (Verbert *et al.*, 2014; Schwendimann *et al.*, 2017).

Gaps in knowledge that have been identified concern understanding what data is relevant to users and how to capture it, how the technology supports the stages of reflection and sense-making that informs action for different types of users (Schwendimann *et al.*, 2017; Verbert *et al.*, 2014; Lester *et al.*, 2017), and how to evaluate how this process is working in practice and having impact (Verbert *et al.*, 2014). Those that have attempted to study this conclude there is little impact where socio-technical issues were given insufficient consideration, such as the alignment with stakeholder requirements and cultural change (MacFadyen and Dawson, 2012). De Freitas *et al.*, (2015) attempted to address this to some extent by involving stakeholders in a participative approach to generating hypotheses about patterns and relationships in data already available and to discuss the findings in the analysis. This was found to be effective for engaging stakeholders and helping them to understand the findings.

In summary, an important perspective emerging from previous research is that analytics approaches are inadequate for informing decisions and actions in situations of complexity (Agpar, 2015; Dyckhoff *et al.*, 2013). How individuals and groups interact with data, and how this influences their decisions and actions, is complex. Isolating the influence of the use of analytics and dashboards from other initiatives aimed at quality enhancement is difficult (Sclater and Mullan, 2017). Successful initiatives require developing strategies for understanding and managing these interactions (Dzuiban *et al.*, 2012), and therefore developing a better understanding of the relationship between analytics and decision making and change in HE is an important area for future work (Lester *et al.*, 2017). A need has therefore been identified for longitudinal studies (Verbert *et al.*, 2014) and evaluation methodology to assess the impact of analytics and dashboards in this context (Verbert *et al.*, 2014).

There is also increasing recognition and interest in adopting more systemic approaches to analytics change initiatives in education (MacFadyen *et al.*, 2014; Lester *et al.*, 2017) that also “*addresses the social complexities of application, sense-making, privacy, and ethics alongside the development of a shared organizational culture framed in analytics*” (Siemens, 2013: 1391).

2.3. *Evaluating analytics and dashboards in HE quality enhancement processes*

One of the issues for assessing the evidence of impact of analytics and dashboards interventions in higher education is that there is still much debate about what ‘impact’ is understood to mean and how it can be evaluated (Bhola, 2000; Patton, 1996; White, 2010; Copestake, 2014). In particular,

White (2010) asserts that much of the methodological debate stems from different interpretations of the meaning of impact. For example, one interpretation is to consider the difference between identified outcome variables before and after an intervention, another is concerned with understanding the influence of intervention activity on outcomes in terms of the cause-effect relationships. Neither of these interpretations is right or wrong, but whichever is adopted does have implications for the appropriateness of methodology adopted. The starting point is therefore to clarify the meaning of impact in any context it is being used.

To this end, the meaning of 'impact' in this article is concerned with the influence of intervention on outcomes in context, i.e. understanding the change process, what it is, and how and why the intervention works. Here the intervention is that of implementing an analytics and dashboard initiative in higher education, which supports and has a positive influence on QE processes and outcomes for students.

Research to improve the evaluation of analytics and dashboards in HE has so far focused on developing evaluative frameworks that describe or characterise what success might look like, although they do take into consideration a broad range of socio-technical and contextual factors such as the technical infrastructure, policies, processes and practices, skills and values of stakeholders, culture, behaviour and leadership (e.g. Scheffel *et al.*, 2014; Norris and Baer, 2013). This sort of approach may provide a useful starting point for assessing the current capability and identifying a need for change. However, it is less helpful for assessing how and why specific analytics and dashboard strategies are working in practice to inform their improvement in a specific context.

In the evaluation literature, approaches that attempt to make this assessment reflect different philosophical assumptions about the nature of cause-effect relationships and complexity, the purpose of the evaluation, and the role of the evaluator (Blamey and Mackenzie, 2007). From a realist perspective, approaches aim to discover patterns in context, mechanism, outcome relationships to explain how interventions work (Pawson and Tilley, 1997; Westhorp 2012, 2013; Mayne, 2012). From a constructionist position, approaches attempt to accommodate the role that stakeholders' subjective motivations and perspectives play in influencing their involvement in an intervention, its outcomes, and interpretation of its 'success' (Guba and Lincoln, 1989; Connell and Kubisch, 1998). In operations research, these two positions are reflected in what have been described as expert or facilitated modes of intervention (Franco and Montibeller, 2010). It is not the intention to repeat the debates associated with these different approaches, which have been discussed more fully elsewhere (Blamey and Mackenzie 2007, Hart and Pacaur-Cacares 2017), but to explain the position adopted in the approach being advocated in this article.

The argument developed so far is that QE activity in HE should be informed by sense-making and action research approaches at different levels of organisation. As analytics and dashboards strategies are also strategies contributing to this enhancement activity, the argument applies equally to the approach to their improvement. In action research, evaluation is embedded in iterative cycles where the evaluation and sense-making informs improvement in implementation strategies. Practitioners use this approach to develop and continually revise their mental models, or 'theories of change' about how processes are working in their situations of interest (Argyris and Schön, 1996). It is therefore acknowledged that the primary purpose of the evaluation is to inform the decisions and actions of some primary user(s) of the evaluation findings who are responsible for the

intervention or strategy. Evaluation needs to be meaningful to their questions. A more appropriate approach is therefore one that is underpinned by a ‘utilisation-focused’ perspective on evaluation (Patton, 1986, 2012) and often associated with program evaluation (Funnell and Rogers, 2011). Specific methods are not prescribed, but need to be decided by evaluation users based on how they are likely to consider the findings generated as credible and actionable. Systems thinking, particularly cybernetic thinking, is also encouraged as a means of exploring how things are connected in complex situations of interest, with the emphasis on exploring how connections are socially constructed rather than determining causal relationships (Patton 1986, 2012).

There has been some discussion in the academic literature about the need to consider HE institutions as complex adaptive systems and the potential contribution of systems thinking for improving quality processes in HE (Radford, 2006; Houston, 2007, 2008; Davis and Sumara, 2005; Hart and Pacaur-Cacares, 2017). There have been similar calls for systemic approaches to HE analytics (Debusse, 2007; Siemens, 2013). Although the evaluation frameworks discussed earlier in this section are concerned with a broad range of socio-technical factors, they cannot be considered systemic. The concerns of systems, cybernetic and complexity research have been summarised as “*understanding communication and control, emergence, self-organization, feedback and interconnectivity*” (Ison and Blackmore, 2014: 123). At the time of writing, a literature search could not find any published academic research that has attempted systemic evaluation of dashboard implementations. This research therefore contributes to dashboard research in the specific context of quality processes in higher education.

3. Designing systemic evaluation of dashboard strategies

In this section, consideration is given to how the evaluation of a dashboard strategy could be enhanced by drawing from the Viable Systems Model, utilisation-focused evaluation, and theories of change approaches to conceptually underpin the evaluation.

3.1. Why the Viable Systems Model?

The Viable Systems Model (VSM-Beer, 1972, 1979) provides a set of conventions for diagnosing organisational structure for its viability (Beer 1985). This diagnosis informs decisions and actions aimed at improvement. Beer (1985) clarifies that although the meaning of viable is being able to “*survive in a particular sort environment*” (Ibid:1), this does not mean independent from other existences. He relates organisational viability, to ‘identity’, in the sense that an organisational unit may be recognised as a largely autonomous unit capable of survival in a wider supportive environment, which it co-constructs with other ‘viable systems’. The VSM describes a specific *recursive* pattern of connections exactly replicated at each level of organisational viability, i.e. between a viable ‘system-in-focus’ and the viable system in which it is embedded, and the viable sub-systems that together co-construct it. It is therefore a systems model that provides concepts for exploring how organisations learn, adapt and survive in their prevailing environment.

One of these key concepts is that of variety and how it can be managed. Where variety is a measure of complexity, its ‘control’ according to Ashby’s (1956) Law of Requisite Variety “*can be obtained only if the variety of the controller [] is at least as great as the situation to be controlled*” (cited in Beer 1981:41). In organisations, this is applied to the concept of management control in the sense that management functions need to be able to interpret all possible states (variety) of the organisation they manage and know and match with appropriate interventions for these states. In practice, it is impossible for the number of possible states and interventions to be known, especially

as managers are insufficiently involved in the operational process (i.e. the so called ‘black box’ effect). They therefore develop strategies to manage the variety they are handling, and organisational structure is an approach to supporting this, where decisions and actions are delegated to specific management functions operating at different levels in the organisation. These will have a defined scope of responsibility, and hence a narrower range of variety to understand and manage within the organisational context. The VSM is a metaphor that draws from the central nervous system in human anatomy and applies this to variety management in organisations. It is used to diagnose how this variety management is working in practice. Applying its concepts guides questioning the connectivity in socially constructed organisations in terms of communication and control between different levels of management and how this might be better organised for viability. In addition to the structural relationship between the organisational components and its environment, it also introduces other useful concepts about this connectivity which can be useful in diagnosing how the variety management process is working in practice.

This is particularly pertinent to the planned research into the role of dashboards in HE quality processes, as dashboards are tools which play a role in supporting the flow of data between decision makers in these management functions about some of the variables of their situations. Longitudinal trends in this data can provide some comparative measure of variety.

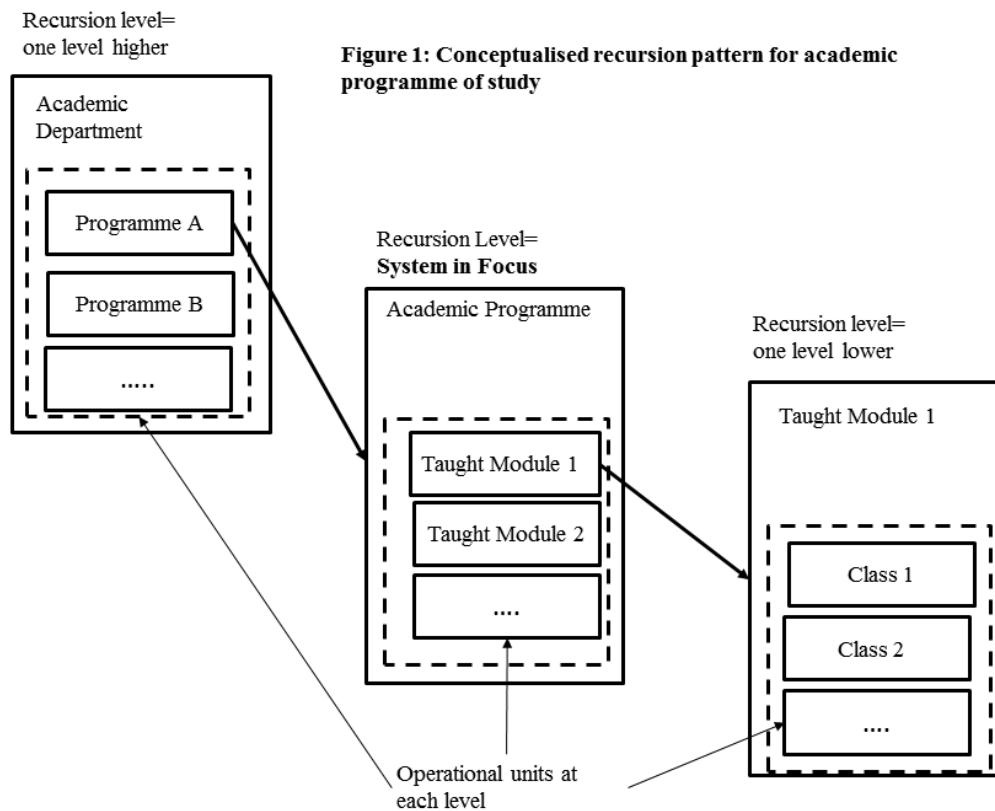
Repeating a full detailed generic description of the VSM and its justification falls outside the scope of this paper. For readers requiring more detailed background than provided in the previous section, useful summaries are provided elsewhere (e.g. Espejo and Gill, 1997; Preece *et al.*, 2013).

3.2. Applying the Viable Systems Model to diagnose dashboard implementations in the context of HE quality processes

The example context used is that of a programme of study in a UK HE institution. ‘Programme’ in this context is used to describe a package of taught units (or modules), which if successfully completed according to the assessment regulations of the institution, lead to an academic award of that institution (e.g. Diploma, Bachelors Degree, Masters Degree..in...[specified knowledge domain]). For an example of how these conventions have previously been applied to academic programmes as a lens for exploring their organisation for sustainability see Gregory and Miller (2014). The explanation and discussion here focuses on that which is relevant to illustrate how the model is relevant to framing the evaluation of dashboard strategies to support QE processes in HE. The model provided here has been produced by the author for discussion purposes, although in an actual evaluation the model development may be a collaborative endeavour involving participants. However, the VSM has been found to be quite complex for engaging stakeholders (Espinosa and Walker, 2013; Espinosa *et al.*, 2015; Preece *et al.*, 2013). This has been found more useful for providing the evaluation facilitator with useful concepts to guide their questioning of stakeholders/or exploration of evidence from other sources, and in the interpretation of data (Hart and Paucar-Cacares, 2017).

A starting point for modelling using the VSM involves making a boundary judgment about a ‘system-in-focus’ that is the viable situation of interest, embedded with in a higher level of organisation which it co-constructs with other viable systems, and comprised of lower level organisational units that together co-construct the situation in focus.

For a taught academic ‘programme’ modelled as the system in focus, its higher level of organisation might be considered to be an academic department, which manages a number of academic programmes. In terms of the lower level systems, these might be considered the modules that taken together comprise a defined programme of study. This relationship is illustrated by Figure 1.

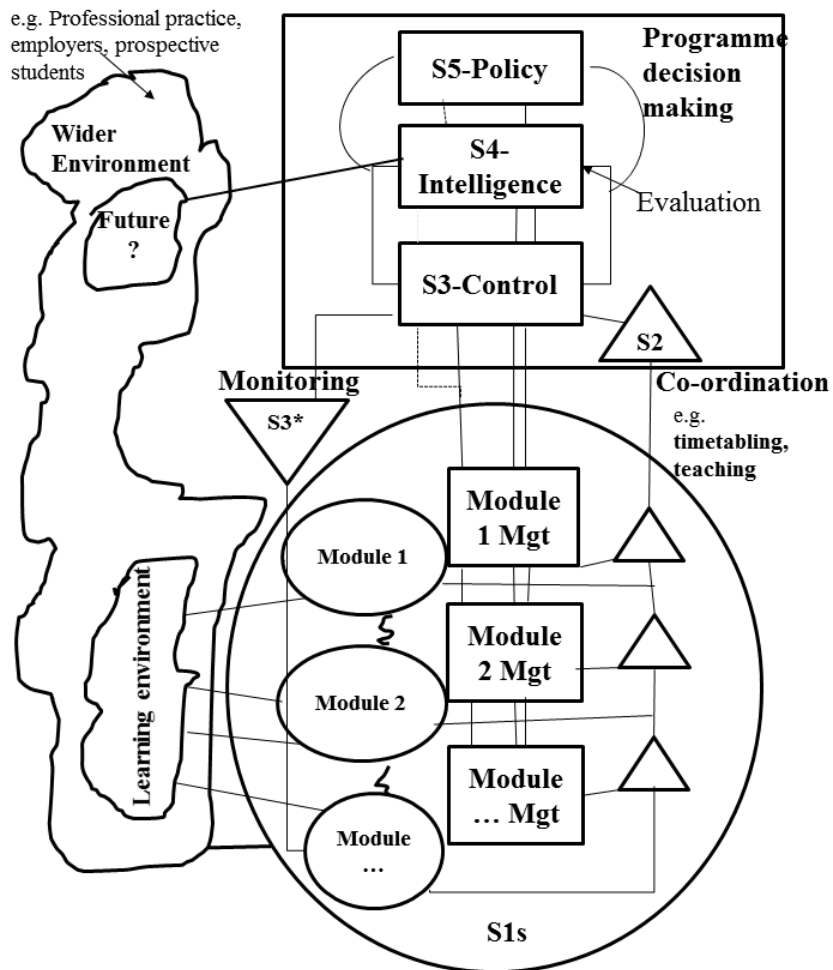


For any ‘system-in-focus’ the VSM describes management functions and their connectivity for learning, adaptation and viability. Figure 2 provides a simplified conceptualisation of how this can be interpreted for a taught academic programme of study (also similarly applied by Gregory and Miller, 2014). Using Beer’s (1985) conventions, this conceptually separates operational activity (circle) from its management (quadrangle) and from the environment (the amoeboid shape) in which it is embedded. The straight line connectors represent the mechanism for variety management, which are considered two-way interactions, hence why there are no arrows indicating direction (more detailed representations do include other modelling conventions, see Beer 1985).

Each of the operational taught modules (System 1s, S1s) are locally managed, albeit guided by policy set by programme level decision-making (System 5, S5). In practice, in the context of a HE programme of study, the S1 function is taken on by a ‘Module Leader’, making decisions for example about how the curriculum content for their module is logically organised and delivered, specific assessment tasks and criteria, methods and resources for engaging and academically

supporting students in their learning in this module. These modules also need to be co-ordinated to work together effectively in the programme. This function is undertaken by System 2s (S2s), and examples of this co-ordination activity is through timetabling, distribution of programme curriculum content between the modules, co-ordination of assessment deadlines to avoid ‘bunching’, and managing fair access to learning resources (e.g. library borrowing policies and

Figure 2: Simplified interpretation of Viable Systems Model applied to taught academic programme = ‘system in focus’



procedures). Systems 3 and 3* (S3, S3*) are responsible for performance monitoring and control of the whole programme. In order to be viable in its wider environment, the programme needs to be relevant to the needs of stakeholders. This also includes those from the wider environment, for example prospective students and employers. This means that the operational taught modules need to be logically coherent in terms of how the various stakeholders, both internal and external, perceive they construct the programme. System 4 (S4) is what can be considered as the business intelligence function, conducting appropriate analysis of the internal and external environment to

inform decision making and intervention at the policy making level (S5) and management control level (S3). Note these management functions are distinct in terms of their purpose and responsibilities, and do not necessarily correspond to different individuals undertaking these responsibilities. It is possible for an individual (e.g. academic staff/faculty member) to have some responsibilities at all these levels.

In terms of applying this to a case study to frame evaluation of a dashboard implementation in this context, this model is envisaged to be helpful in guiding the identification of relevant participant stakeholders that undertake different management functions and would be potentially using the dashboard to support their decision-making.

In terms of the straight lines representing the interactions for variety management, then there are some other useful concepts associated with these interactions which can help guide evaluation of how the dashboard is working in supporting the variety management process.

Amplification and attenuation: These are management strategies aimed at increasing and reducing the variety, within the domain of control, to achieve appropriate balance in the relationships represented in the model for the 'system' to be stable (not static) in its environment. To give an example to illustrate in the context of a programme of study, each module will involve students learning a relevant knowledge domain. In order to make learning manageable for students within a specific timeframe, and appropriate to their prior levels of learning, *and* to make the assessment of the achievement of learning manageable for those fulfilling the S1 management role, a number of strategies could be adopted. These include communicating learning outcomes, assessment tasks, and assessment criteria which set some boundaries on the learning and what is to be achieved. Factors such as admission qualifications, curriculum content, teaching methods and learning activities all influence students' abilities to achieve this learning, and hence decisions, communications and actions in relation to these are also important in maintaining a stable relationship in this interaction. For the relationship between S3s and S1s, examples could include documented procedures to ensure fairness, consistency and maintenance of standards in assessment, and teaching quality, and expectations of more general hygiene factors to promote student satisfaction. Planning, resource allocation and accountability for resources are also example strategies in this variety management process. This concept can therefore focus evaluation questions on how variety management processes are working, to understand the improvement context that the dashboard is intended to support.

Channel capacity: This concept directs questions towards how the channels for transmitting variety are working in practice. Dashboards play a role here in transmitting data/information, conveying expectations of performance, such as target student satisfaction scores from student feedback data, or targets for student achievement, or recruitment targets. They can also provide some contextual data to inform interpretation, e.g. by segmenting data for comparison, comparing with other data sets (same data for other modules), or providing trends over time. This concept directs questions to issues such as the relevancy, format, quantity, richness, timing of this to support the variety management process and appropriately inform decisions for adaptation and improvement.

Transduction: Concerns the process of coding/decoding information in a communication channel. In dashboard implementations, decisions are made about how data is presented based on assumptions about how it will be interpreted and used. However, this interpretation and use may be

influenced not only by the choices made in the design of the dashboard, but also by the relevancy of the data to the user's role and their subjective capability to make sense of the data. In the context of a dashboard implementation, this could direct evaluation to be focused on issues such as the usability, design and relevancy of the interface for supporting decision making, but also how users are motivated and engaged to use it, and the effectiveness of the approach e.g. through incentives, training, user guides, and the availability of other contextual information to support interpretation of dashboard data.

In summary, the use of VSM as a lens for evaluating dashboard implementations guides evaluation questions to focus on how the dashboard is supporting practitioners in improving their strategies for variety management. It enables consideration of the various management functions (not necessarily different individuals) and the structural arrangement for managing the variety of the organisation to maintain its existence in its environment. It is only through understanding this process and how it is working/could be improved, that evaluation can be undertaken of the role and effectiveness of dashboards as channels for transmitting data/information in this context to support the variety management process. This evaluation would therefore serve the purpose of not only identifying how the dashboard implementation could be improved, but also how this is/needs to be integrated with other strategies that improve channel capacity/transduction (e.g. meetings, briefings) in this QE context.

3.3. *'Theories of Change' in continuous improvement*

Where the VSM provides useful concepts to guide evaluation to diagnose how and why a dashboard implementation is working in HE quality processes, as stated earlier, the model has been found to be quite complex for engaging stakeholders (Espinosa and Walker, 2013; Espinosa et al., 2015; Preece et al., 2013). It is argued here that engaging stakeholders in a participative 'theory of change' could be more useful in underpinning a participative action research approach to continuous improvement of a dashboard implementation in the context of HE quality processes. This approach is well known in the field of community change initiatives (Connell and Kubisch 1998), but has also been gaining traction in other sectors (e.g. Sullivan et al 2002; Mason and Barnes 2007; Hart et al 2009; Mayne and Johnson 2015; Breuer et al 2016; Amundsen and D'Amico 2019).

In this approach a 'theory of change' model provides a framework for both action and enquiry, and in participative action research is developed and revised iteratively by participating stakeholders. It is a model of how participants believe their strategies work in practice, which can be formally implemented and evaluated to test and revise the theory. This can be related to the earlier discussion about how managers develop understanding of how their organisations work by comparing 'states' at appropriate intervals. Trends in these models over time to reduce uncertainty about the impact of their change strategies. Theories of change therefore form the basis of a heuristic approach to guiding improvement, providing an agile framework to support different stages of planning, implementation and evaluation. For the evaluation stage it frames the planning of data generation, analysis and interpretation.

The format and process of this modelling process is not prescribed. (For discussion on different approaches to representation see Funnell and Rogers 2011, and for example case study see Hart and Pacaur-Cacares 2017). Logic models are commonly used as a means of communicating

assumptions made about the connections between intervention activities and outcomes, and contextual and resource factors that may be influencing how this relationship is working in practice. In the charity sector, it was found that modelling of these relationships as linear and unidirectional was less helpful than adopting a more exploratory approach, although there was still a need to try and keep models fairly simple for effective communication between stakeholders (James, 2011). A ‘circular’ logic model has been suggested as being more compatible with systemic approaches. From this perspective “*every inter-relationship can be both –cause and effect- and does not only work one way*” (Hummelbrunner, 2011: 403).

The extent to which different stakeholders are involved in the evaluation will depend on the philosophical assumptions about the nature of change and the purpose of the evaluation. However, adopting a utilisation-focused perspective (Patton, 1986) prioritises the perspective of evaluation users in the initial modelling process, as a means of focusing the evaluation to answer their questions. These ‘users’ can be individuals or groups organised around some purposeful activity. This does not mean that other stakeholders’ perspectives are not explored in the evaluation and used as a basis for revising the evaluation users’ conceptual models of change. The models provide a means of boundary setting for the evaluation and highlighting connections to be explored. Systems thinking is therefore a compatible conceptual framework for this process, as the core concerns of systemic inquiry have been argued to be with guiding the exploration of how different stakeholders perceive boundaries (who and what is included) and connections in their situations of interest (Imam *et al.*, 2007; Hummelbrunner, 2011).

3.4. *Integrating VSM with a theory of change approach to improve dashboard implementations*

The two approaches described here are not incompatible and have the potential to serve different purposes for different stakeholders in the evaluation of dashboard implementations to inform their improvement.

Due to the complexity of the underpinning theory and concepts, the VSM modelling approach is more likely to be useful to the more experienced evaluator, the facilitator of the evaluation. In the first instance it would help them in advising about who to involve in the participatory development of theories of change, to ensure sufficient relevancy and diversity in the perspectives included (e.g. heads of department, programme leaders, module leaders). The model provides a means of conceptualising the relevant decision-making roles and relationships to stimulate discussion/interpretation of who is adopting these roles in practice.

The theory of change approach can be used to help managers articulate how the processes they manage work in practice, in terms of the connections they make between the drivers for their activity, activities, outcomes and contextual factors that may influence these. Facilitators will be able to conceptualise these in terms of the variety management processes in the VSM, which may further help their line of questioning to elicit relevant detail.

Table 1 illustrates some high level questions that can be used to guide stakeholders’ development of an explicit theory of change for a dashboard implementation, and these are linked to the various elements of a logic model that would form framework for the evaluation of how this is working in

Table 1: Typical questions for framing Theory of Change development for a dashboard implementation					
<i>Drivers for change</i>	<i>Contextual factors and resources</i>	<i>Activities</i>	<i>Outcomes</i>	<i>Longer term aspirations</i>	<i>Intended impact</i>
<p>Questions here explore stakeholder assumptions about the problems/opportunities underpinning a dashboard implementation.</p>	<p>Questions here explore stakeholder assumptions about the factors that may enable/constrain a dashboard implementation in its context of implementation.</p>	<p>Questions here relate to the core implementation activities for a dashboard</p>	<p>Questions relate to intended benefits of a dashboard implementation for its primary beneficiaries (users) within clearly defined period for development/improvement action.</p>	<p>Questions relate to anticipated longer term benefits and outcomes for primary and wider stakeholders, indicating progress to intended impact</p>	<p>Questions relate to stakeholders' vision of transformation guiding a dashboard implementation.</p>
<p>Who* are the users relevant to improving student experience and outcomes? (e.g. academic staff/faculty, professional services, students).</p> <p>What are their current and anticipated challenges for decision-making and 'improvement' in this domain? E.g. availability and relevancy of data**, timeliness, its presentation/format, usability of tools***, fit between various decision support resources and processes**.</p> <p>What internal/external factors may be driving change for an existing or new dashboard implementation? (e.g. technological developments, legislation, accountability, competitive advantage...)*</p>	<p>What resource is needed for effective dashboard implementation? (E.g. - Development resource/expertise? -Hardware/software? -User training/ support?**** -User time to engage with support/training...)</p> <p>What other contextual factors may affect the success of a dashboard implementation? ****(E.g. -Leadership support? -User awareness/skills/motivation? -policy/governance?...)</p>	<p>How are users' needs and expectations being identified and addressed in the dashboard development and implementation?**, ***</p> <p>How are users engaged and supported in using the dashboard? (e.g. awareness raising, user guides, training, reporting requirements etc...)**</p>	<p>How are users engaging with the dashboard? (E.g. When? How often? For what purpose?...)**</p> <p>How are users experiencing use of the dashboard implementation? (E.g. usability, design/format, presentation, responsiveness...)**</p> <p>What is the fit of the dashboard with users' decision/action needs and other decision resources and processes?**</p> <p>How are users engaging with and experiencing the support activities and materials associated with the dashboard implementation?****</p> <p>How useful do users find the support activities and materials for improving their dashboard use?****</p>	<p>How are users' attitudes, behaviour, practice changing in relation to the dashboard and its use in decision-making?***</p> <p>How are users' perceptions changing about how well they understand the effectiveness of their own strategies in practice?**</p> <p>How are users' perceptions changing about the quality of their decision making?</p> <p>How do other stakeholders affected perceive the quality of decisions/actions is changing?</p>	<p>How is dashboard use supporting continual improvement and organisational learning?</p> <p>How is dashboard use supporting stakeholders to address the internal/external drivers identified?</p>
<p>*The VSM can help facilitators conceptualise the range of participants needed to evaluate a dashboard intended to support a 'system in focus', to ensure it is inclusive of the different roles, and helps to direct questions that help to understand their scope of decision-making and action and their interactions/relationships with other roles.</p> <p>**The VSM concepts of variety management and amplifiers and attenuators direct the facilitator to explore with users the specific strategies they are adopting in context, their rationales for these, and therefore the data/information relevant to understanding how these strategies work in practice.</p> <p>***The VSM concept of channel capacity directs to questions that explore the role of the dashboard in conveying information needed for effective decision-making.</p> <p>****The VSM concept of transduction directs the evaluation to consider how users are equipped/supported to effectively interpret data to support their decision-making.</p>					

practice. The table also makes a connection with the concepts in the VSM discussed in section 3.2 (attenuation, amplification, channel capacity, transduction) and lines of questioning that these concepts can prompt. As the theory of change approach is intended to be participatory, to help participants articulate *their* theories, these questions are not prescribed, but reflect the variety that a facilitator could help to surface in the theory of change development, rather than a very narrow set of issues focused on the technology *per se*. The data, data sources and methods that the dashboard evaluation may draw on to generate appropriate evidence to help answer questions and provide insight into the connections stakeholders make between the elements in a specific context of application are also not prescribed, and would be dependent on the variety being articulated in the specific theory (e.g. institutional documented policies and procedures for quality assurance and enhancement, and role of the dashboard in these procedures, managers own experiences of using the dashboards to support their decision-making, system log data of access and use, dashboard user guides etc).

In an action research approach to improvement, this ‘theory of change’ for how a dashboard is working in practice can be iteratively evaluated and modified as a consequence of each learning cycle.

4. Conclusions and next steps

The argument presented in this article is that in the UK HE sector there is a perception that dashboard use and effectiveness as business intelligence tools in quality enhancement processes needs to be significantly improved. Previous analytics and dashboards research, more generally and in the HE sector, has made some progress in identifying current practice and characteristics of interventions that have been considered successful. However, particularly within the context of education, there remains uncertainty about what data is relevant to users; how to capture it; how technology supports stages of reflection and sense-making processes and influences users’ decision making and behaviour. Improving understanding of this is particularly important for improving their role in QE processes in HE, where these rely on reflective practice and action research of individuals and teams. There is similarly a need to apply action research approaches to improving dashboard interventions, and to improve evaluation in these approaches to acknowledge the complexity of the interventions in their support of QE processes.

The contribution of this paper has been to propose a conceptual framework for the evaluation of dashboard interventions in the context of HE quality processes. Using the example ‘system-in-focus’ of a programme of study in HE, it has been argued that the VSM provides useful concepts to help evaluators diagnose management structures for viable organisation, and therefore to also guide evaluation questions towards the role and effectiveness of dashboards as a source of business intelligence in supporting how this is working in practice. Adopting a systemic approach focuses the evaluation on the human activity, with the dashboard as a business intelligence resource with a purpose of supporting decision-making in this context.

The other key proposition within the article, is that in order to better understand the effectiveness of a dashboard for supporting managers’ sense-making about how well their strategies are working in practice, it is necessary to understand managers’ working theories of change, for their situations. This then enables appropriate questions (underpinned by VSM concepts) to be directed about how the dashboard is working in supporting decisions about improvement action in this context.

This application of systemic evaluation in the context of dashboard interventions for supporting QE processes in HE is believed to be a new application, contributing knowledge about how to approach evaluating dashboards to be more relevant to the decisions of those needing to improve them in this context.

This conceptual study provides the foundation for future case study research. The first step would be in the evaluation of a single dashboard implementation, to develop an initial ‘theory of change’ for how and why dashboard implementation strategies are working in this in this context. This in turn would form the basis for further development and improvement through action research, longitudinally within the same context, but also through further cases of dashboard implementations in HE.

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