

Sustainable e-Learning: Toward a Coherent Body of Knowledge

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ABSTRACT

This paper explores the concept of sustainable e-learning. It outlines a scoping review of the sustainability of e-learning practice in higher education. Prior to reporting the outcomes of the review, this paper outlines the rationale for conducting the study. The origins and the meaning of the term “sustainability” are explored, and prevalent approaches to ensure sustainable e-learning are discussed. The paper maps the domains of the research area and concludes by suggesting directions for future research that would improve current understanding of key factors affecting the sustainability of e-learning practice to develop a more coherent body of knowledge.

Keywords

Sustainability, Sustainable e-learning, Cost-effectiveness, Long-term benefits, Continued innovation

Introduction

Many e-learning initiatives fail. Transient as they are, these projects often exhaust the resources and degrade in their impact—and, therefore, are destined to be unsustainable. The lasting success of e-learning initiatives is a growing concern for educational institutions that rely on governmental funding or commercial benefits. Austerity measures have led to a renewed interest in the concepts of sustainability and sustainable practice in e-learning. There is also renewed interest by educational researchers in finding practical solutions to improve the sustainability of e-learning. These studies investigate the viability of integrated e-learning services and their cost-effectiveness, aiming to inform policy and strategic decision making. While many studies in the field of e-learning deal with issues of sustainability, such as cost-effectiveness and quality management, without explicitly using the term, we propose that “sustainability” is a useful umbrella concept because it helps bring together diverse terminology and various strategies addressing a range of interrelated issues in the area of e-learning. This paper provides an overview of predominant approaches to research on sustainable e-learning and outlines findings of a scoping study (Stepanyan, Littlejohn, & Margaryan, 2010) funded by the UK Higher Education Academy (HEA) through the “Supporting Sustainable e-Learning Forum” special interest group (SSeLF SIG). The paper also addresses a gap in the literature by providing synthesis of the empirical research on sustainable e-learning, outlining prevalent perspectives on the concept of sustainability, presenting and discussing the outcomes of the scoping study, and suggesting directions for future research.

Rationale for researching sustainable e-learning

Educational institutions face challenges in ensuring effective teaching and learning in a rapidly changing society. The education sector is constantly adapting to external drivers, including societal and technological changes, quality standards, and financial constraints. Information technologies are extending opportunities for learners to learn outside institutions, transforming conventional views on education (Collins & Halverson, 2010). These transformations require educational systems to adapt, to meet the needs and expectations of learners and other stakeholders. Hence, institutions have to anticipate, withstand and, where possible, capitalise on the present and future waves of change. Consequently, e-learning attracts the attention of educational administrators and policy makers. However, many e-learning initiatives are not sustained. There is a pressing need to seek explanation to this phenomenon in the context of the recent funding cuts.

One consequence of the global economic crisis of 2008 is the widespread cuts in government funding (Bates, 2010). The higher education (HE) sector across Europe is negatively affected, with most European countries reducing HE funding (EUA, 2010). For example, the UK Government plans to cut HE funding by 40% by 2014–15 (Morgan,

2010). Similar patterns can be observed beyond Europe, with comparable reductions in HE sector funding announced in Australia (Nicol, 2010), the US (Chea, 2009; Toope & Gross, 2010), and Canada (Cunnane, 2010). To deal with financial austerity, some universities have decided to invest in improving their international reputation, hoping to attract students and maximise their return on investment (Brown, 2010). International and domestic students alike, faced with the prospect of paying fees rather than receiving scholarships, are evaluating the value they receive for their money. Student opinion affects institutional ranking, stimulating universities to improve the quality of their provision and to enhance their reputation (Baty, 2010). To address some of these challenges universities are exploring ways to capitalise on emerging technological affordances.

Many institutions have introduced e-learning to improve cost-effectiveness. However, it is unclear whether return on investment is actually realized. Where return on investment is achieved, does this result in a sustained reduction in costs or an increase in benefits? Funding agencies increasingly demand guarantees for long-term maintenance of e-learning projects. Furthermore, sustainability and longevity remain a pressing concern for the users of e-learning resources and systems (Weibel et al., 2009). Therefore, a sound evidence base on the sustainability of e-learning practices and their long-term benefits is essential to the future development of universities. Critical reviews of the evidence around the sustainability of e-learning are vital for strategic decision and policy making. Yet, there is no literature synthesising the multiple perspectives related to the sustainability of e-learning. Given the gap in the literature, the need for conducting a review such as a scoping study becomes evident. The methodology of a scoping study enables synthesising a broad range of existing perspectives and outlining the existing knowledge. This study aims to provide a baseline in the current understanding of sustainability of e-learning by carrying out a review of research in this area. It synthesises existing literature that reports key factors affecting the sustainability of e-learning. The paper outlines a review of a broad range of literature in areas broadly associated with sustainable e-learning.

Methodology and data sources

This study uses a methodology known as a “scoping review” (Davis, Drey, & Gould, 2009). A scoping review is a broad, comprehensive study of the literature, which is augmented through consultation with key experts with knowledge of the area (Arksey & O’Malley, 2005). This method allows identification of themes and trends emerging from diverse bodies of scientific knowledge (Davis et al., 2009; Rumrill, Fitzgerald, & Merchant, 2010). The methodological foundations of a scoping review allow the synthesis and mapping of a broad empirical knowledge base into a single realm. The concept of mapping can be described as a process of interpreting and synthesising qualitative data by sifting and sorting material according to key issues and themes. The purpose of the mapping is to summarise the evidence uncovered by the review and to identify gaps in knowledge (Levac, Colquhoun, & O’Brien, 2010).

Scoping reviews provide a systematic method for critically appraising disconnected resources, creating an overview of current knowledge. Scoping reviews are conceptually different from systematic reviews or meta-analyses; Meta-analyses or systematic reviews are usually restricted to papers that employ specific methodologies. Scoping reviews are a useful method in situations where systematic reviews are problematic, for example within relatively new areas such as e-learning, where ideas and evidence are still emerging (op. cit.). A scoping review is particularly useful in providing an overview of the current knowledge around sustainable e-learning because it brings together the multitude of perspectives that contribute to this area. However, scoping reviews have some limitations in that they provide only narrative or descriptive accounts of broad research areas, rather than in-depth analysis. Therefore, the usefulness of a scoping study is linked to decisions on defining the breadth and depth of the review (Arksey & O’Malley, 2005). Despite this limitation, scoping reviews provide insight into complex areas, and the output from the review can be used to focus and refine future studies (Levac et al., 2010). This scoping review identifies and maps concepts relevant to sustainable e-learning, to provide a baseline for future research studies.

This scoping review is purposefully broad in nature to allow key concepts associated with sustainability to be mapped against primary sources of evidence. This is not an attempt to systematically review or perform a meta-analysis of sustainable e-learning. Future studies could adopt alternative methods to provide a more in-depth understanding of sustainable e-learning. This study aims instead to provide a baseline to inform future developments in the education sector.

To ensure a broad, yet systematic approach, this scoping review adopted a five-phase methodological framework proposed by Arksey and O'Malley (2005). This framework is a useful tool for the analysis, synthesis, and review of a range of broad, diverse research studies (Davis et al., 2009).

The first phase of the scoping study explored the concept of sustainability and operationalised it within the context of e-learning. This phase was divided into the following sub-phases:

1. conducting an initial review to gain an overview of the variety of approaches adopted in sustainable e-learning research
2. adopting a working definition of the term sustainable e-learning, based on the initial review
3. compiling a set of key themes common to sustainable e-learning research
4. compiling a set of search keywords associated with these themes
5. identifying electronic databases, web services and journals to carry out a literature search

The second phase involved an in-depth literature search to identify relevant studies around each of the operational domains. In the third phase, we defined inclusion and exclusion criteria applied to all the articles sourced through the literature review. The fourth phase involved data extraction, synthesis, and interpretation of the material. A spreadsheet summarising all articles that were reviewed was compiled for further analysis. Finally, in the fifth phase, articles were collated and analysed to abstract key issues and identify gaps in the literature.

The literature search made use of the library services provided via electronic databases available at Brunel University (which were accessible to the lead author at the time of the review) using the DialogDatastar service. British Education Index (BEI), Australian Education Index (AUEI), and the Education Resources Information Center (ERIC) databases were used for literature search. BEI covers over 500 English and European journals and includes over 150 thousand records to journal and conference papers, research reports, and electronic texts (Sheffield, 2005). Finally, the ERIC database index was used to search key articles (published by Elsevier, Sage, Routledge, and other key publishers). ERIC is a key database for education literature (Hertzberg & Rudner, 1999). The search was limited to publications between 2000 and 2010, covering a recent broad body of literature.

The inclusion criteria limited the reviewed papers to a) discussions of issues of sustainable e-learning practice in HE; b) studies of sustainable strategies and approaches applied and implemented in universities, and finally, c) case studies and empirical research reporting on issues of (un)sustainable e-learning practice. Papers focusing on education sectors other than HE, such as primary or secondary education or adult workplace learning, were not considered. The review includes both peer-reviewed and non-peer-reviewed grey literature. As part of the assessment, papers published in peer-reviewed journals were prioritized. However, articles from non-peer-reviewed sources were included when they pointed to new ideas or gaps in the literature. Literature that was not available as full text was not considered. Key studies referenced within texts were sourced where necessary.

The literature search was conducted in two stages. First, a set of generic keywords—"sustainable e-learning," "sustainable online learning," "sustainable technology enhanced learning," and "sustainable distance learning"—were used to explore the literature. The compound results of the queries around 500 papers, which were further filtered down. The process of initial filtering was based on assessing the title, keywords, and the abstract of the papers. The resultant papers were assessed against the inclusion criteria. The vast majority of papers did not satisfy the inclusion criteria reducing the number of papers selected in this initial stage to 15. The review of the selected papers pointed to a range of variations of research foci. The observed variations suggested extending literature search by using additional keywords identified from the reviewed literature. The use of additional keywords allowed consideration of studies that addressed issues of sustainability, without directly referring to the term. Among the identified keywords were, for example, "cost-effectiveness," "economies of scale/scope," "effective/innovative practice," "communities of practice," and "networks," used along with keywords such as "longitudinal" and "long-term," to identify studies focused on continuity over time. These keywords were used to extend the first stage of the literature search.

The second stage of the literature search focused on empirical works (as defined above by the inclusion criteria [b] and [c]) that matched the selected set of keywords. In addition to using educational databases, Google Scholar was used at this stage to enable scoping a greater pool of literature. A Google search purposefully broadened the domain of literature included in the review. A comprehensive review that covers all research areas associated with each of the chosen keywords is beyond the scope of this study. Nevertheless, the review was broad and around a thousand papers were retrieved and assessed.

To complement the literature search, feedback on the initial drafts of the review and references to other relevant sources were requested from eleven experts in the field, acknowledged at the end of the paper. As a result, a total of 46 articles that focus either on sustainable e-learning as a main topic or examine individual factors that contribute to improved sustainability were selected, reviewed, and discussed.

Results and findings

The concept of sustainability

The concept of sustainability spans a number of academic disciplines and is closely associated with environmental science. Sustainability has been considered from philosophical, historical, economic, political, social, and cultural perspectives (Becker, Jahn, & Stiess, 1999). Given the large number of perspectives and contexts in which the term *sustainability* is used, its meaning varies widely across the literature. Therefore, a clear definition is useful (Brown, Hanson, Liverman, & Merideth, 1987). Shearman (1990) outlines key factors, framed as key questions, required to bring about sustainability: Why is sustainability desirable? What form of sustainability is best? How should sustainability be pursued? An inquiry into the etymological as well as the lexical origins of the term *sustainability* provides a clearer understanding of the term.

The term “sustainable” is defined by dictionary references as: “able to be maintained at a certain rate or level” (*Oxford Dictionary of English* [Soanes & Stevenson, 2005]). The verb “sustain” is defined (*ibid.*) as: “cause to continue for an extended period” or “uphold, affirm, or confirm the justice or validity.” Regardless of the variations in the definitions of the term, there appears to be a common foundation: a property of continuity over time.

The concept of sustainability is frequently associated with the mandate adopted by the International Union for Conservation of Nature (IUCN) in 1969 and the United Nations Conference on the Human Environment in Stockholm in 1972 (Adams, 2006). Since then, sustainability has been discussed and debated across a range of contexts and from a range of perspectives. The notion of sustainability has penetrated political, economic, and social agendas and plays a major part in shaping the discourse on sustainable society, economy, energy, agriculture, and resource use (Brown et al., 1987). Sustainability is often described as the “goals or endpoints of a process called ‘sustainable development’” (Diesendorf, 2000, p. 22). The *Brundtland Report* (1987, p. 43) defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” This definition captures the complexity of the term by integrating a set of dimensions into a single concept. It appears, therefore, that the concept of sustainability brings together ideas from multiple disciplines to describe progress in different domains.

Sustainability in the environmental literature

The environmental literature provides insight into the origin, meaning, and development of the term *sustainability*. Analogies between educational and ecological systems and the growing interest toward studies of educational phenomena in their complexity of interrelated factors further justify this line of inquiry (Davis & Sumara, 2006; Mason, 2008). Lélé (1991) views ecological sustainability as a developmental process with three interlocking dimensions: economic, environmental and social. Mainstream thinking in the area of sustainability employs these dimensions as the so-called “three pillars” of sustainability (Adams, 2006). Ideas around sustainability are frequently based around the integration of these pillars into a unified system. As such the instantiation of sustainability is viewed as a long-term, perpetual process (Kemp, Parto, & Gibson, 2005).

Sustainability in an educational context

Discourse around sustainability in education has developed in two broad directions, focusing on either: a) education *for* sustainability or b) sustainability *of* education. Education *for* sustainability focuses on environmental sustainability through educational solutions (Bourn & Shiel, 2009; Dawe, Jucker, & Martin, 2005; Sterling, 2001). Sustainability *of* education focuses on the implementation of sustainable forms of “successful” practice through educational development, leadership, and innovation (Davies & West-Burnham, 2003). Despite these two differing

foci, the traces of environmental perspectives are evident in both views: sustainability *of* education and education *for* sustainability. Furthermore, sustainable education is commonly used throughout the literature regardless of the focus. In this paper, sustainability *of* education is the main focus.

Environmental perspectives on sustainability have diffused into the field of e-learning. A commonly used definition of sustainability, first outlined in Brundtland's report, has been adopted within the e-learning context. One example of this adoption of the term is Robertson's study, which defines sustainable e-learning as "e-learning that has become normative in meeting the needs of the present and future" (2008, p. 819). Articles on sustainable e-learning discuss a number of key factors that offer potential long-term improvements to e-learning practice (Arneberg et al., 2007; Bates, 2005; Littlejohn, 2003b). Variations of scale are also apparent in the literature, as studies discuss the issues and implications of sustainability on macro/global (Downes, 2007), meso/institutional (Hope & Guiton, 2005), and micro/project levels (Grossmann, Weibela, & Fislerb, 2008).

One definition, by the National Committee of Inquiry into Higher Education emphasises the balance between the costs and added value of employing technology, defining sustainable e-learning as "the adoption of technology to maintain teaching quality at reduced unit costs" (2003b, p. 91). Other definitions include the continuity of the advantageous positions defining sustainability as "the continuation of benefits after project funding has ceased" (Joyes & Banks, 2009); or similarly as "programmes being offered on a continuous basis and not phased out after a defined project period or after specific subsidies are terminated" (Arneberg et al., 2007, p. 6). Some definitions place emphasis on policy. For example, Meyer (2006, p. 1) defines sustainability as "policies and practices that improve the likelihood that an online educational program will be financially viable."

Some studies highlight impact and educational quality as an important element of sustainability. For example, the study by Bates (2005) identifies organisational factors that lead to sustained benefits of e-learning. Bates argues that an institutional culture geared toward continuous improvement and adopting a positive attitude toward personal development increases the sustainability of e-learning. Similar views are held by Hope and her colleagues (2005). However, despite the significance of sustainable e-learning in the literature, no generic framework or model for sustainable e-learning was identified. This gap in the literature may be explained by the fact that there are few studies that synthesise the knowledge in the area. This scoping study, and the research that may spawn from it, may contribute to addressing this gap.

Since this scoping review was exploratory, the study had to take a wide view of the concept of sustainable e-learning. Despite the diversity of perspectives on sustainable e-learning, "sustainability" is a useful umbrella term that brings together diverse terminology and various strategies addressing a range of inter-related issues such as effectiveness, efficiency, or progress in the area of e-learning. Therefore, synthesising reviewed definitions, a broad working definition of sustainable e-learning was adopted as follows: Sustainability is the property of e-learning practice that evidently addresses current educational needs and accommodates continuous adaptation to change, without outrunning its resource base or receding in effectiveness.

Domains and themes of sustainable e-learning

As part of the review, we collected information about the methods, keywords, and descriptions of the included papers (Stepanyan et al., 2010, Appendix 5, pp. 46–55). A number of themes regularly resurfaced from the articles reviewed. These themes were identified, coded, and abstracted, through an iterative process. All themes associated with sustainable e-learning were then inductively categorised and synthesised into a set of broad domains that capture all these themes. These three domains are: Resource Management, Educational Attainment and, Professional Development and Innovation. Each of the papers reviewed during this study were mapped against at least one of these domains, depending on their keywords, main contributions, approach, and primary focus.

Although each domain is distinct, there is overlap across the domains as illustrated in Figure 1. The numbers in each section of the diagram correspond to the number of papers reviewed and categorised.

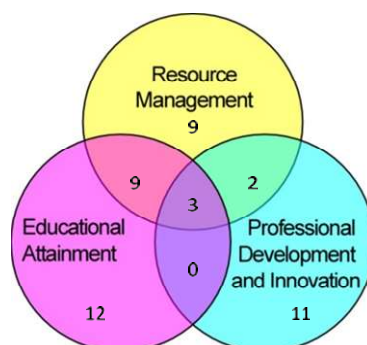


Figure 1. Domains of sustainable e-learning research and numbers of associated papers

These domains illustrate the foci of research in sustainable e-learning as abstracted from the literature. They are akin to the “three pillars” of sustainable development (Adams, 2006; Robertson, 2008, p. 819). Each domain allows integration of a range of competing factors influencing sustainable e-learning. The factors were analysed in line with each of the three domains to abstract common research themes within each domain and to discuss their contribution to the wider discourse on sustainable e-learning. In the next section we outline and discuss the results and highlight the potential impact of the studies in relation to sustainable e-learning.

Resource management

The domain of Resource Management focuses on the cost of e-learning. Articles that mapped against this domain include studies of the strategies and approaches adopted by institutions to improve the effectiveness of human and other resources. Resource Management studies examined cost-effectiveness, efficiency gains, and economies of scale and scope. The emerging themes included models and frameworks for resource management, cost-effectiveness of distance and blended learning, Open Educational Resources (OERs), and reusable learning materials.

Costs were considered in relation to strategic targets, for example, the quality of teaching/learning, the numbers of students, or technological and pedagogical innovation. Amongst the models proposed for improving the productivity and cost-effectiveness of HEIs is Molenda’s (2009) systems theory approach that rationally divides teaching and learning tasks. Nicol and Coen (2003) and Laurillard (2007) suggest more complex models to evaluate the benefits and costs of e-learning.

Some studies focussing on fully online e-learning practice (for example, Perraton & Naidu, 2006; Ramage, 2005) focused on problems with distance learning business models. Ramage (2005) focused on return on investment, identifying that 83% of the considered institutions were not cost-efficient. The more successful institutions recorded a return-on-investment of only 15%. Other studies examined reducing staff workload as a strategy to improve resource management. For example D. Nicol and Draper (2009) examined the redesign of course assessments to improve learning outcomes and reduce staff workload. Similarly, Loewenberger and Bull (2003) examined reusable question banks as a means of reducing staff time on assessment.

Another approach to reducing staff workload is reusing, rather than recreating, educational resources, to produce a so-called economy of scale of reusable resources (Littlejohn, 2003a). There are many studies and initiatives on Open Educational Resources (OERs) in the literature. Although OERs offer potential for cost-effectiveness, there is little empirical evidence on actual cost savings, due to systemic difficulties in calculating return on investment in universities (Friesen, 2009; Geser, 2007). An active “movement” has formed around developing and managing OERs, the Open Educational Resources Movement (D’Antoni, 2009). Business models are being developed to capitalise on the collaborative creation of content by large numbers of users (Bruns, 2006). However, tensions and contradictions exist between the release of resources within communities of practice and “open release,” which releases content to anyone who wishes to use it. This has been identified as a major barrier to the future development, release, and reuse of OERs (McGill, Beetham, Falconer, & Littlejohn, 2011). The potential of OERs to improve the sustainability of e-learning is significant, however reviewing this growing domain in depth is beyond the scope of this paper.

Educational attainment

Educational Attainment is another domain abstracted from the literature on sustainable e-learning. Discussions around Educational Attainment focus on measures of student achievement, retention rates, skill acquisition, and personal development. Emerging themes include evidence of benefits, perceptions of quality, usability of new technologies, and student performance.

Benefits rather than costs of e-learning are often considered. For example, Dyson and colleagues (2009) claim that mobile technologies offer affordable and effective solutions for mainstream teaching and learning. They identify the benefits of mobile learning as mobile-supported fieldwork, stimulation of interactivity in large lectures with mobile technology, use of mobile devices for learning about mobile technology, and use of podcasting. They claim that mobile technologies offer affordable and effective solutions that can be adopted for teaching and learning on a wider scale. Comprehensive assessment of the sustainability of mobile technologies, however, requires longitudinal studies, of which few exist.

Another group of studies focused on the benefits of using information technologies for teaching and learning (Clark, 2001; Means, Toyama, Murphy, Bakia, & Jones, 2009). Bernard et al. (2004) argued that the quality of course design is more important than the medium of learning. Two further studies, based on questionnaire data, focused on individual factors of successful educational practice, such as student retention (Levy, 2007) and student satisfaction (Lee, Yoon, & Lee, 2009). A key message emerging from this domain is that studies that prioritise sustained benefits rarely or only indirectly consider the associated costs of maintaining or improving effectiveness of e-learning practices.

Professional development and innovation

Some studies view sustainability as a commitment to continuous improvement and adaptation to a constantly changing environment. This perspective is evident in the third broad domain described as Professional Development and Innovation. Articles mapped within in this domain focused on strategies for adapting to change. Emerging themes within the domain include teacher training and development, institutional transformation, and educational leadership.

Restructuring educational institutions to adapt to the external constraints is viewed as important for sustainability. For example, a study by Gunn (2010) emphasised the importance of institutional restructuring, not just physically, but culturally as well through introduction of supportive organisational structures and adoption of a shared vision (ibid.). Similarly, e-learning policies (De Freitas & Oliver, 2005) and educational leadership (Garrison & Akyol, 2009) are considered important for institutional change, with key stakeholders (e.g., teachers and learning technologists) central to driving forward improvements in e-learning practice (ibid).

Despite limitations of formal training programmes, faculty development is seen as important to successful and sustainable applications of e-learning (Rovai & Downey, 2009). Lefoe et al. (2009) report the need for comprehensive faculty development and support programmes and offer a set of strategies that include developing shared understanding of philosophies and technological affordances; encouraging active practice; continuous reflection; and development of shared vocabularies. However, teacher training is not the only way of improving faculty expertise. Another approach is through communities of practice or professional networks.

There is a growing body of literature on strategies for developing and sustaining communities of practice (Russell, 2009). Professional networks have a less cohesive structure and different power dynamic compared to communities of practice. These networks can induce a qualitatively different form of professional development. The ubiquity of social platforms and readily available networking tools allowed Brouns and colleagues (2009) to explore perceptions of academic staff of their use of social network platforms for professional development. In summary, the literature on Professional Development and Innovation highlights the role of educational leadership and teaching staff in implementing sustainable e-learning.

Discussion and conclusions

This scoping study enabled initial mapping of the area of sustainable e-learning, highlighting the differences and limitations of the reviewed literature. By categorising and synthesising a selection of the current literature, the paper enables commenting on the state-of-the-art of sustainable e-learning research. This section outlines a number of broad observations arising from the scoping study.

First, the literature contains a number of studies that discuss Resource Management as part of sustainable e-learning. If educational research is to contribute to societal wellbeing, it should be grounded within current social, political and philosophical changes (Biesta, 2009). Reeves et al. (2005) call for “socially responsible” research, through which researchers position their work in relation to society as a whole. Yet, most research into the sustainability of e-learning practice is not framed within fundamental societal issues related to education. When sustainability is considered in a constricted way, for example by examining financial viability and return on investment without consideration of wider issues, contributions to the wider debate of public good may be limited or even distorted. This imbalance constrains the evaluation and questioning of educational practices.

Second, cultural and societal changes are challenging traditional educational practices. Institutions are being forced to adapt to ongoing change; harnessing the power of technology is an important step (Collins & Halverson, 2010). Thus, sustainable e-learning cannot be explored without consideration of the rapid and continual development of digital technologies. Technological affordances open up new, ubiquitous opportunities for people to learn in a number of ways using a variety of approaches. We identified a gap in the literature in relating educational attainment to technological change (within the Professional Development and Innovation domain). In other words, the knowledge base to support effective implementation is dispersed across a number of domains. The integration of key relevant research elements into a coherent body may lead to more effective adaptation within institutions.

Third, the inquiry into origins of the term sustainability and its use within educational literature reveals two independently developing streams of research, sustainability of education and education for sustainability. While there are arguments in support of the potential for bridging the gap between sustainable e-learning and wider concept of sustainability (Hall, 2010; Hopkins, 2009), the research into sustainable e-learning practice develops independently from that of environmental sustainability.

Fourth, through categorising and recording the methodological foundations of the studies we reviewed, we can conclude that *few studies combine and synthesise empirical work*. Meta-analyses or systematic reviews could give greater insight into Educational Attainment. However, we sourced only two meta-analysis studies within the domain of Educational Attainment. Consequently, it is difficult to translate and diffuse findings beyond the narrow contexts in which studies were carried out. Despite this limitation, many studies do try to transfer findings through “best practice” examples or case studies, when in fact the consequences of a particular e-learning approach is likely to be different in diverse settings. We found a shortage of long-term studies that explore key factors for sustainability and to distinguish these from short-term benefits. Furthermore, studies in Educational Attainment that rely on questionnaire data when analysing technology adoption tend to overlook the critical changes in mindset or culture that underpin successful adoption of e-learning (Collis & Moonen, 2008). A recommendation is to conduct long-term research studies.

Fifth, the distribution of the papers identified during the literature search across the domains (see Figure 1) suggests that few studies examine the tensions between the concepts of cost-efficiency, effective pedagogy, and continuous innovative practice. There are a limited number of studies on strategic approaches that reduce costs and improve the effectiveness of teaching. Future research must investigate the trade-offs. There are noticeable differences in the priorities within empirical studies, such as example costs versus benefits, or preferences such as teacher training versus opportunities to network. Improved understanding of these tensions, aligned with better insight into multiple stakeholder perspectives, could provide better pointers toward future e-learning sustainability.

Sixth, taking into account the balance of the studies sourced through this review, there is scope for developing sustainable business models for higher education, based on e-learning approaches. Few projects or initiatives have explored new business models (Nicol & Coen, 2003; Nicol & Draper, 2009). Interest in finding new ways of generating revenue and attaining return on investment has increased in the current period of austerity (Crossick, 2010). These business models range from reducing the time period of the degree, changing the costs/benefits of

conventional teaching approaches, to introducing radically new business models, such as Massive Open Online Courses (MOOCs), or drawing upon networks and collectives (Dron & Anderson, 2007). Research on the creation and release of OER is examining actual, rather than perceived, benefits around the release of resources, providing a more realistic view of return on investment (McGill et al., 2011). Investigation of these business models is important in ensuring return on investment is achieved, either through reduced costs or increased benefits to learners or institutions.

In summary, this scoping review identified significant gaps in the literature. The gaps were identified by assessing the limitations of reviewed papers and discussing future work. Within the Resource Management domain, gaps include the following:

- meta-analysis of e-learning costs (these have been restricted due to lack of available data)
- empirical research on economies of scope
- long-term longitudinal analysis on the effects of reducing costs
- empirical research on cost-effectiveness of OER

The Educational Attainment domain would benefit from further research in the following:

- student/teacher mindset toward e-learning and its change
- improvement of learning outcomes and retention rates without substantial increases in costs
- benefits of employing new technologies such as mobile devices or podcasting. Professional Development and Innovation would benefit from
- long-term analysis of leadership impact on change
- long-term analysis of faculty development on change

Overall, research on new business models for higher education, costs, and benefits, focusing on return on investment, are vital for future sustainable e-learning.

The major limitation of this study is the limited number of articles reviewed in comparison with the wide range of literature related to sustainable e-learning. However, this study provides a starting point and this future studies can build on these findings, adopting other methods (systematic reviews or meta-analyses) to allow in-depth analyses.

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