

Rising to the pedagogical challenges of the Fourth Industrial Age in the university of the future

McLinden, Mike; Greenway, Celia; Matthews, Adam

DOI:

[10.1080/23752696.2020.1866440](https://doi.org/10.1080/23752696.2020.1866440)

License:

Creative Commons: Attribution (CC BY)

Document Version

Publisher's PDF, also known as Version of record

Citation for published version (Harvard):

McLinden, M, Greenway, C & Matthews, A 2021, 'Rising to the pedagogical challenges of the Fourth Industrial Age in the university of the future: an integrated model of scholarship', *Higher Education Pedagogies*, vol. 6, no. 1, pp. 1-21. <https://doi.org/10.1080/23752696.2020.1866440>

[Link to publication on Research at Birmingham portal](#)

General rights

Unless a licence is specified above, all rights (including copyright and moral rights) in this document are retained by the authors and/or the copyright holders. The express permission of the copyright holder must be obtained for any use of this material other than for purposes permitted by law.

- Users may freely distribute the URL that is used to identify this publication.
- Users may download and/or print one copy of the publication from the University of Birmingham research portal for the purpose of private study or non-commercial research.
- User may use extracts from the document in line with the concept of 'fair dealing' under the Copyright, Designs and Patents Act 1988 (?)
- Users may not further distribute the material nor use it for the purposes of commercial gain.

Where a licence is displayed above, please note the terms and conditions of the licence govern your use of this document.

When citing, please reference the published version.

Take down policy

While the University of Birmingham exercises care and attention in making items available there are rare occasions when an item has been uploaded in error or has been deemed to be commercially or otherwise sensitive.

If you believe that this is the case for this document, please contact UBIRA@lists.bham.ac.uk providing details and we will remove access to the work immediately and investigate.

Rising to the pedagogical challenges of the Fourth Industrial Age in the university of the future: an integrated model of scholarship

Adam Matthews, Mike McLinden & Celia Greenway

To cite this article: Adam Matthews, Mike McLinden & Celia Greenway (2021) Rising to the pedagogical challenges of the Fourth Industrial Age in the university of the future: an integrated model of scholarship, Higher Education Pedagogies, 6:1, 1-21, DOI: [10.1080/23752696.2020.1866440](https://doi.org/10.1080/23752696.2020.1866440)

To link to this article: <https://doi.org/10.1080/23752696.2020.1866440>



© 2020 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.



Published online: 21 Jan 2021.



Submit your article to this journal [↗](#)



Article views: 917



View related articles [↗](#)



View Crossmark data [↗](#)

Rising to the pedagogical challenges of the Fourth Industrial Age in the university of the future: an integrated model of scholarship

Adam Matthews , Mike McLinden and Celia Greenway

School of Education, University of Birmingham, Birmingham, United Kingdom of Great Britain and Northern Ireland

ABSTRACT

A challenge for higher education, in the context of the 'Fourth Industrial Age', is to prepare students for uncertain futures. Proposed is a model of integrated scholarship drawing on, and developing, Boyer's scholarship (discovery, teaching, integration and application). We argue that such a model provides a connecting thread between the idea of a university as conceptualised in the 19th century, making links between the university of the past, present and future. Through reference of a case study example of the links between teaching and research presented in the 2017 UK Teaching Excellence Framework, we draw upon Boyer's scholarship as a conceptual lens to examine institutional texts which articulate teaching excellence. Our findings indicate that current judgements about effective linkages between teaching and research vary greatly with few examples or evidence. Our integrated scholarship model joins together institutional learning communities to discover, communicate and apply new knowledge across disciplines.

ARTICLE HISTORY

Received 21 December 2019
Revised 11 November 2020
Accepted 12 December 2020

KEYWORDS

Research-teaching nexus;
integrated scholarship;
teaching and learning;
scholarship

1. Introduction

The learning and teaching landscape in UK Higher Education (HE) is in a period of rapid change with far reaching implications for faculty and students. Recent developments include an increased emphasis on student voice, students as partners and higher education providers seeking ways to highlight their distinctiveness in an increasingly competitive market place. Further, the Fourth Industrial Age (4th IA) is promising the emergence of artificial intelligence and big data to bring together cyber and physical systems (CPS), also known as the internet of things (IOT) to bring about mass automation (4.0) (see [Figure 1](#)) to build on previous ages of steam (1.0), electricity (2.0) and information (3.0) (Xu, Xu, & Li, 2018). Such rapid developments thereby require a continual appraisal of the pedagogical approaches that will suitably equip undergraduate students for sustainable learning in an uncertain future.

Whilst the precise nature of how the 4th IA will transform higher education cannot be predicted with certainty, we can be confident that students' and employers' expectations

CONTACT Adam Matthews  a.matthews.3@bham.ac.uk  University of Birmingham, Birmingham, United Kingdom of Great Britain and Northern Ireland

This article has been republished with minor changes. These changes do not impact the academic content of the article.

© 2020 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

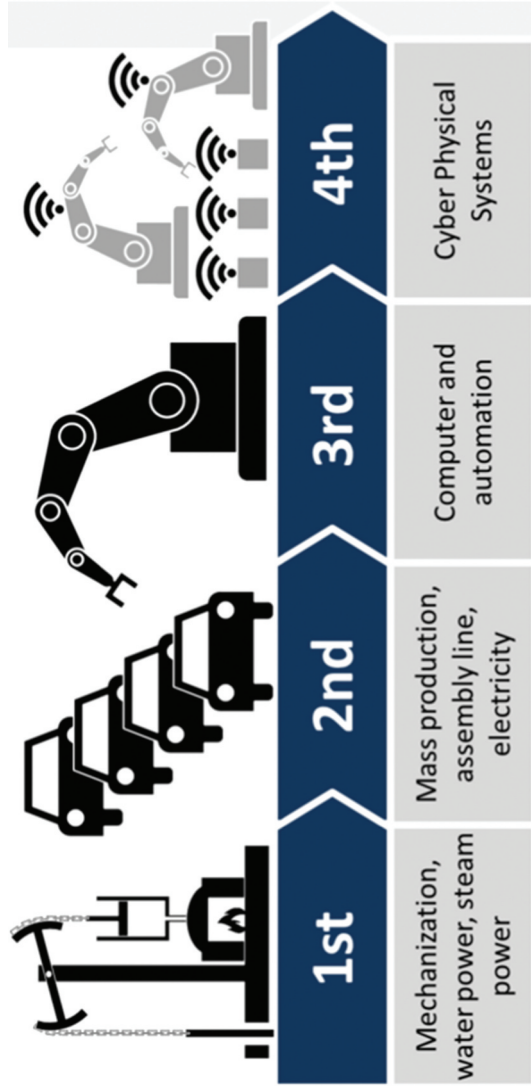


Figure 1. Industry 4.0 – creative commons licence https://commons.wikimedia.org/wiki/File:Industry_4.0.png.

of a university education, along with changing global societal issues will help to drive the agenda. A key challenge for the higher education sector therefore is to review the nature of the selected pedagogical approaches to ensure these align with the future expectations of students, employers, universities and wider society.

We start the paper with an overview of the 4th IA and its implications for pedagogy in higher education. We then revisit some of the key philosophies underpinning the ‘idea’ of a university in the 19th and 20th centuries with a particular focus on the relationship between teaching and research in the academy. We ground our analysis and philosophy of the university with ideas from 19th century Enlightenment thinkers and beyond from the university of yesterday and the early ideas of the nature of teaching and research in the modern university. This review takes us into contemporary thinking of the relationship between teaching and research and the ‘nexus’ between these two activities. This review serves to highlight the lack of consensus about the nature of these relationships as well as the limited evidence demonstrating the nature of any benefits at institutional level. We introduce Boyer’s model of scholarship (Boyer, 1997) and argue that given its explicit emphasis on the synergies between teaching and research in HE, it offers a helpful conceptual lens through which to view these linkages. The limited evidence at institutional level prompted us to explore the unique publicly available corpus of institutional texts provided by the 2017 Teaching Excellence Framework (TEF) exercise in the UK. As a case study example of how higher education institutions (HEIs) articulate the links between teaching and research we conducted a content analysis of seven university written statements in response to the 2017 Teaching Excellence Framework (TEF) using Boyer’s four aspects of scholarship as categories for directed content analysis. We provide an overview of the main findings of the TEF case study and outline new ways forward for the sector in determining the nature of the linkages between research, scholarship and teaching. We consider limitations of the analysis and propose potential areas for future research and policy developments. We conclude the paper with a conceptual response to the issues facing higher education in the 4th IA, building on Boyer’s model of scholarship to present an ‘integrated scholarship’ for a university community.

2. The Fourth Industrial Age, society and higher education

The rapid development of technology is raising questions within the field of education and in media discourse, as to the purpose of education in a rapidly changing technological environment. The university of tomorrow will need to adapt to these changes which have the potential to be far reaching, not only for higher education but for society, globally. Schwab (2016) outlines many of the implications for the future in the context of the 4th IA, stating that we live in a time of great promise and great peril. Thus, while the advances in artificial intelligence and other technologies have the potential, and the great promise of connecting billions of people and regenerating the natural environment, there is a great peril of organisations and governments failing to adapt to growing inequalities and fragmentation of society. Media reports have picked up on such utopian and dystopian futures, taking a more dystopian perspective with discourse around artificial intelligence and automation taking many of the jobs currently carried out by humans: ‘*Could a robot do your job?*’ and ‘*The 4th Industrial Revolution Is Here – Are You Ready?*’ dominate (Ahmed,

2018; Marr, 2018). Similar claims have been made about the coming of the previous digital age which promised a greater sharing of knowledge and digital artefacts globally. A notable example is the materiality of music before digitisation. The physicality of the vinyl record, the cassette tape and the CD had production and transportation costs. The MP3 has the possibility to be shared exponentially, globally with none of these costs, but music still remains behind similar paywalls (Mason, 2016). Peters (2020) looks at the extremes of some of the visions for how the digital could reshape society as on one hand, digital socialism and on the other, knowledge capitalism. By using this example of what has come before and the possibilities of technology we can see that the future is not yet written, despite corporate CEOs, futurists, state bureaucrats, technologists and administrations all predicting unprecedented change in higher education (Hamilton & Feenberg 2012).

Clearly education has a role to play in educating the leaders, workers and citizens of the future who will lead and shape this trajectory. Aoun (2017) calls for a new generation of creators to tackle the challenges and opportunities of technology and issues that are as yet unknown.

Figure 1 depicts the 4th IA building upon computers and automation to bring technology to objects in 'cyber physical systems'. Tegmark (2018) terms the next stage of human development as life 3.0, characterised by artificial intelligence dominating and questioning the role of humans, again seeing the opportunity of reducing poverty, through to the risk of autonomous weapons for mass warfare. Seldon and Abidoye (2018) mirror the development of education with that of industry and claim that developments in artificial intelligence will either liberate or infantilise humanity. They describe the first education revolution as organised education, learning from family and community to survive. The second education revolution as the institution: the school and the university, for the privileged few, education began to be more formalised to educate individuals in agriculture, law, civic society, technology and religion. The third education revolution was formed around the technology of the printing press and secularisation: with the industrial revolution in full swing, the masses were beginning to be educated around urban centres and religion was no longer as influential as it once was. The textbook became cheaper to produce and was widely used to distribute knowledge widely. Computers and the internet continued this advance with the digitisation of education (Orr, Weller, & Farrow, 2019). Xing and Marwala (2017) predict that the university of the 4th IA will teach, research and service in a different way, which is more interdisciplinary and 'virtual'. They trace the growth of higher education across a similar period as 'elite', 'mass' and 'post-massification'. Post-massification is characterised by many advanced countries enjoying over 50% participation rates in higher education and the international nature of university staff and students. Peters, Jandrić, and Means (2019) survey the part education may play in the future in the possibility of technological unemployment due to automation and what could happen if the link between education and work is severed. This is covered by three overarching issues: 1) the postdigital fragmentation of education and work, 2) what can places of learning really do about the future of work? 3) education in a workless society.

Avis (2018) explores the 4th IA as an ideological and rhetorical construction which has been presented as an inevitable historical trajectory to be managed and mitigated against, rather than shaped and designed. The field of Science and Technology Studies (STS) and philosophy of technology term the dominant discourse such as those described above as

‘sociotechnical imaginaries’ (Jasanoff & Kim, 2015). STS then can provide us with a conceptual lens to trace technology not as a neutral material artefact but as technological affordances for adoption in a variety of different ways, ways which are not inevitable but there to be applied, researched and integrated into society. Feenberg (2017) terms the dominant discourse of scientific rationality as the technosystem which is underpinned by markets, administrations and technology, thus technology is just one aspect of the 4th IA. Common discourse sees technology as a linear development with constant progress influencing society, this has been termed technological determinism by STS scholars (Dafoe, 2015). In direct contrast is the social construction of technological artefacts which are not linear but formed and shaped by society and culture (Pinch & Bijker, 1984). Technological determinism and social constructivism can be seen as two extremes of a continuum whereby technology either determines society or society determines technology (Matthews, 2020). STS analyses the social as well as the material realities of science and technology and theoretical and conceptual developments have emerged such as the postdigital (Jandrić et al., 2018) and posthumanism (Pepperell, 2009) to attempt to make sense and understand the blurring of the line between human and technology which is a key aspect of the 4th IA in that the computer and the human are potentially going to be closer or combined. We envisage a significant role for higher education in the 4th IA which draws upon a rich history and culture of research and teaching across and within disciplines. For example, as humans and computers become closer, interdisciplinary research and teaching between the humanities, social sciences and sciences will be important to understand the world in which we live. Having laid out the challenges and potentialities of the 4th IA and before mapping out possibilities for the university of the future, next, we explore the foundations of the modern university – the university of yesterday

3. Research and teaching nexus: Enlightenment revisited

The university has been established in different forms and with distinctive cultural influences for centuries. The university of yesterday has laid strong foundations which should not be dismissed but harnessed and developed for the university of the future. One of the most enduring and cited early philosophies of modern higher education was written by Cardinal Henry Newman in 1852 – *The Idea of a University*. Newman’s thesis, written under the backdrop of new and exciting ideas set out during the Enlightenment period was a blueprint for a new Catholic university in Ireland. This period of enlightenment influenced Newman to reject education as unquestioned religious beliefs, passed down from generation to generation and his blueprint for a university included critical scholarship and universal knowledge with no set disciplines. This was the emergence of a liberal education and Newman outlined that knowledge should be pursued for its own ends and not for instrumental purposes. Newman claimed that critical minds will be able to find their way in the world, inventing and innovating new ways of working and living. Newman did not believe that universities should be places of research, this should be undertaken by other specialist institutions with universities focusing on teaching (Newman, 1852). The Humboldtian model of higher education introduced the idea that teaching and research co-occur in universities, and was established at the University of Berlin in 1810 (Josephson, Karlsohn, & Östling, 2014). Ideas set out by

Willhelm von Humboldt were freedom of thought, students as free adults who should be free to study under any teacher they wanted and professors who should be able to lecture on any subject in the search for truth (regardless of politics and religion). The nature of the pedagogical frame within which students were educated is captured succinctly by Josephson et al:

At a university, a teacher could be part of a social and pedagogical context, and thus avoid the dangers of isolation. New knowledge could be tested and developed together with students. At the same time, the students would receive a better education because their lecturers would be able to follow and understand the latest developments in their fields. The search for knowledge should be a dialogic, organic process in which all participants are dedicated to seeking truth. (Josephson et al., 2014, p. 2)

The German term *Bildung* is closely linked and attributed to Humboldt and refers to the self-development of well-informed citizens and comes before a profession or craft which similarly to Newman, Humboldt thought individuals could master if they were first enquiring, informed citizens. Today the term is often the polar opposite of instrumentalised education for participation in the labour market (Koops, van den Kerkhof, Ostermeier, & van de Schoot, 2016). Whilst the Humboldtian ideas of research and teaching are still dominant throughout HE today, precisely what the nature of these relationships should be is a more contested and debated concern. The theory and practice underpinning these relationships has become known as the ‘research/teaching nexus’. This nexus has been conceptualised in a variety of ways and a systematic review of the research into the nexus (Tight, 2016) found that the current literature can be broadly categorised as, ‘advice’ (on implementing a successful relationship between research and teaching), ‘student and staff attitudes’, ‘how the research/teaching nexus is articulated’, ‘how to research the research/teaching nexus’ and ‘issues and critique’. In concluding the review, Tight (2016) argues that whilst the nexus can be viewed at one level as being ‘an idea’, it can also be termed:

...a theory, a practice or a catch-phrase. To call it a catch-phrase might sound dismissive, but it definitely qualifies as one of the most talked about terms in contemporary higher education policy and research. (Tight, 2016, p. 306)

The concepts underpinning this nexus have been debated, developed and refined extensively in the literature (e.g. Brew, 2003), and examined in relation to particular disciplinary activities (Spronken-Smith & Walker, 2010) and ontological and epistemological perspectives (Robertson, 2007). Further, whilst there have been a number of attempts to illustrate the multifaceted nature of the relationships between teaching and research within this nexus (e.g. Edwards & McLinden, 2017; Healey & Jenkins, 2009), the precise relationship between research and teaching is considered to be complex and indeed has been described as an ‘unstable terrain’ by Robertson (2007).

Given the uncertain future portrayed above with respect to the 4th IA, clarification as to what types of skills and knowledge students will require to work and live in an uncertain landscape is clearly highly pertinent to HEIs. To provide such clarification we draw next on the seminal, influential report written in the 1990s by the Boyer Commission in the USA. Boyer (1997) called for a new model of undergraduate education at a similar period in terms of major technological changes (i.e. the early development of home based computing, mobile technologies, the internet etc.). A key conclusion

of the report was that research should be the basis of all learning at university, from year 1 through to graduate, and that the *production* of knowledge should not be an exclusive activity, but rather one that *all* members of a university can participate in. The report has had far reaching implications since its original publication in 1990, it mapped out a direction of travel for the HE sector at the time when seeking to articulate the relationships between the core activities of research, scholarship and teaching. The report undertook a comprehensive review of the US HE landscape and proposed that undergraduates who enter higher education (with a particular focus on ‘research-intensive’ universities) should engage in discovery based activities as *active* participants, within a student-centred approach to teaching, with students provided with scope for intellectual and creative development, including opportunities to learn through inquiry as researchers rather than simple knowledge transmission. Further, the report proposed that undergraduates should understand the unique qualities of the university and the opportunities to engage in research themselves. The notion of scholarship was viewed as being a central tenant of promoting such an approach described through four distinctive but overlapping types of scholarship: *The Scholarship of Discovery* (the undertaking of original research); *The Scholarship of Integration* (connecting new knowledge to existing knowledge, across disciplines in order to solve real life issues faced by society); *The Scholarship of Application* (also described as the scholarship of ‘engagement’ in seeking to close the gap between values in the academy and the needs of the larger world) and *The Scholarship of Teaching* (involving the reflective analysis of the knowledge about teaching and learning). An important conclusion of the Boyer report was that these four categories should align and overlap, but that there is a risk that they may become divided and isolated. This disaggregation of functions and roles has been termed more recently as the ‘unbundled university’ (McCowan, 2017). The unbundled university sees specialists and external organisations carrying out specific tasks which once may have been the sole job of faculty academics. Boyer’s categories were aimed exclusively at the role and task of academic teaching staff throughout their career. Later we use this model to open up integrated scholarship to the whole university.

Whilst these types of scholarship have been drawn on extensively within the literature to examine different types of academic practice (Tight, 2016) as far as we can ascertain they have not been used to analyse the relationships between research, teaching and the notion of scholarship discourse at an institutional level, or within the HE sector. As we consider next, the 2017 TEF provides the first opportunity to examine the nature of this relationship in detail at an institutional level within a national context through the method of content and discourse analysis.

4. A Case study example of the articulation of links between teaching and research

As part of the requirements of the TEF in the UK in 2017 (Office for Students, 2018), all participating HEIs were required to submit a 15-page provider statement which describes their approach to teaching. Institutions in these qualitative submissions were measured against the following headings: *Teaching Quality*, *Learning Environment*, and *Student Outcomes* and *Learning Gain* (HEFCE, 2016). A final decision was then confirmed as to the institution’s award. The 15-page provider statement offered by each participating HEI

presents a unique and valuable corpus of data which provides the opportunity to look at various discourses. As an example, Matthews and Kotzee (2019) used a corpus-assisted discourse analysis approach to identify the key themes of all 232 TEF2 submissions.

The 2017 TEF guidance made reference to scholarship, research and/or professional practice with HEIs required to provide evidence of the extent to which:

The learning environment is enriched by student exposure to and involvement in provision at the forefront of scholarship, research and/or professional practice (HEFCE, 2016, p. 24)

These submissions are used alongside quantitative measures of answers to specific National Student Survey (NSS) questions as well as (non) continuation data and graduate destinations (further study and employment). Institutions are graded by a panel as gold, silver or bronze according to these measures with the 15-page qualitative submissions then taken into account.

4.1. Aims and objectives

Our analysis was undertaken by the co-authors of this paper in Spring 2019. The main aim of the study was to examine the nature of evidence provided by HEIs when discussing how they seek to promote positive relationships between research and teaching.

The objectives of the study were:

- Take a corpus of all 2017 TEF submissions (N = 232) and quantitatively identify a sample which talked most frequently about research in the context of teaching
- To analyse the discourse of our sample institutions using Boyer's four categories of scholarship as a conceptual framework.

Ethical approval was granted by the researchers' institution to carry out analysis of the publicly available TEF2 HEI statements from 2017. Institutions are reported anonymously in the article.

Content analysis uses texts and speech to quantitatively study textual data (Seale, 2004; Bryman, 2008). The objective nature of the research method is characterised by two definitions:

Content analysis is a research technique for the objective, systematic and quantitative description of the manifest content of communication. (Berelson, 1952, p. 18)

Content analysis is any technique for making inferences by objectively and systematically identifying specified characteristics of messages. (Holsti, 1969, p. 14)

The quantitative nature of content analysis as a research method requires systematic and objective analysis whereby any researchers views or biases are minimised as much as possible. The first stage of analysis used computer software to carry out this analysis. Our self-constructed corpus was analysed using Lancsbox software (Brezina, Timperley, & McEnery, 2018). This achieves the objectivity and bias required for content analysis. Follow up, second stage, human coding and content analysis is much more open to interpretative analysis. In order to minimise this as much as possible, coding identifiers were used (see Table 1 below) by all three researchers. Coding identifiers were developed from Boyer's (1997) descriptions of discovery, integration, application and teaching. This

Table 1. Coding identifiers.

Discovery	Integration
<ul style="list-style-type: none"> ● Research through disciplined enquiry ● Intellectual values ● Intellectual capital ● Advancing knowledge ● Emotional response ● Institution and researcher accomplishment ● Scholarly investigation 	<ul style="list-style-type: none"> ● Integrating facts ● Connecting disciplines ● Data illumination ● Insights ● New knowledge topologies (connected and integrated) ● Multidisciplinary ● Data in larger patterns ● Critical analysis
Application	Teaching
<ul style="list-style-type: none"> ● Practice and theory inform each other ● Scholarly service ● Applies and contributes to human knowledge ● Service to the nation and the world 	<ul style="list-style-type: none"> ● Inspires and educates ● Teaching is the highest form of understanding ● Teacher's understanding and student's learning ● Communal activity ● Transferring and extending knowledge

study moves between computational content analysis and human reading for practical reasons - the entire sample of available documents (described below) is $n = 232$ and over 1.5 million words. Purposeful sampling was used to identify seven texts from the whole corpus who wrote most frequently about research in the context of teaching. Webb and Wang (2014) describe this method as context-sensitive sampling which identifies keywords that are used to identify a sample with certain dominant words and phrases. This section continues with a description of this method as was applied by the researchers.

In order to find out about how HEIs in the UK seek to define the relationships between research and teaching and the potential benefits to students, we first quantitatively analysed all 2017 TEF2 statements ($n = 232$), totalling 1,742,438 words.

In order to find the statements which talked most frequently about research in the context of teaching, we undertook a keyword frequency search of the corpus for the word 'research*'. This method yielded 4,936 results. We used these 4,936 results to select just those uses which had 'teaching' five words either side of our keyword: 'research*'. This analysis yielded 778 results. Of these 778 instances we were able to calculate frequency and identify the seven HEIs which used the key term 'research*' most frequently in the context of teaching. These seven HEIs provided a sample of institutions for further analysis in Phase 2. An overview of this sample is presented in Table 2 to show the frequency of research collated with teaching, whether the HEI is a member of the Russell Group (a self-selecting group of UK research-intensive universities) and TEF result. As shown in Table 2, three of the seven HEIs were members of the Russell Group

Table 2. Frequency of Boyer's Scholarship categories occurring in provider statements.

Sample HEI	Discovery	Integration	Application	Teaching	frequency of research collocated with teaching	Russell Group institution?*	TEF Result
Submission A	2	5	2	3	13	No	Silver
Submission B	5	7	5	4	18	Yes	Gold
Submission C	2	5	1	5	15	No	Gold
Submission D	3	4	3	9	14	Yes	Silver
Submission E	2	1	2	5	17	No	Bronze
Submission F	3	0	0	10	16	No	Bronze
Submission G	5	8	5	8	17	Yes	Gold

*a group of 24 research-intensive UK universities

highlighting the complexity of attempting a binary divide between ‘research’ and/or ‘teaching’ focused HEIs in the current UK landscape. This finding confirmed our view that a broader lens through which to view the nature of the relationships between teaching, research, and scholarship, at an institutional level is worthy of further examination. The sample of seven HEI TEF2 provider statements which quantitatively talked more about research in the context of teaching allowed us to undertake a more interpretative analysis drawing on the conceptual lens of Boyer’s four types of scholarship. The frequency of findings for each aspect of Boyer’s Scholarship are reported in [Table 2](#).

Coding of the sample of TEF provider statements was undertaken using directed content analysis. This type of content analysis can be drawn upon when using existing theory or prior research and involves researchers beginning the coding process by identifying key concepts or variables as initial coding categories in a deductive approach (Potter & Levine-Donnerstein, 1999). For the purpose of our content analysis we drew on Boyer’s four types of scholarship. See [Table 1](#) and descriptions above for an elaboration of these four areas and their coding.

A reliability check was undertaken by each researcher re-coding one transcript from another researcher’s sample. Data that could not be coded into one of the categories derived from the scholarship model were re-examined to describe different ways in which the relationship between research and teaching can be understood for discussion between researchers. We indicated on the submission document a colour for each of the 4 categories and made a note where a sentence or paragraph was viewed as describing both research and teaching co-occurring. A summary of this analysis is presented in the [Table 2](#).

We treated this assembled data as an opportunity to analyse how HEIs describe the integration between research and teaching as well as integration and application. It is important to note however that these written submissions were written in line with a pre-assigned template against a regulatory framework with which HEIs write in response to. Thus, whilst the analysis sheds light on how HEIs describe the relationships between teaching and research, the context in which they are constructed and how the findings are reported require explicit acknowledgement. As we discuss below, despite this context, we found that the provider statements offer valuable insights into the discourse used by HEIs to describe the relationships between their teaching and research.

Looking at the distribution across the four types of scholarship presented in [Table 2](#), there is a fairly inconsistent picture across the HEIs. As an example, Sample F (Bronze award) has a focus predominately on the *Scholarship of Teaching* and based on the analysis undertaken does not include examples of all four types of scholarship. In comparison, HEP G (Gold award) has an even distribution across all four categories. Submission A (Silver award) has an even but relatively low occurrence of all categories. In all submissions the *Scholarship of Application* is the least frequently occurring category. It was an expectation that the *Scholarship of Teaching* would be the most frequently mentioned category (in the *Teaching Excellence Framework*) which was confirmed in the analysis. [Figure 2](#) provides an example of a provider statement that we identified as having the broadest alignment with all four types of scholarship. This is example is rare in our sample and is the only passage of text which we deemed to cover all four aspects of scholarship as articulated by Boyer (1997).

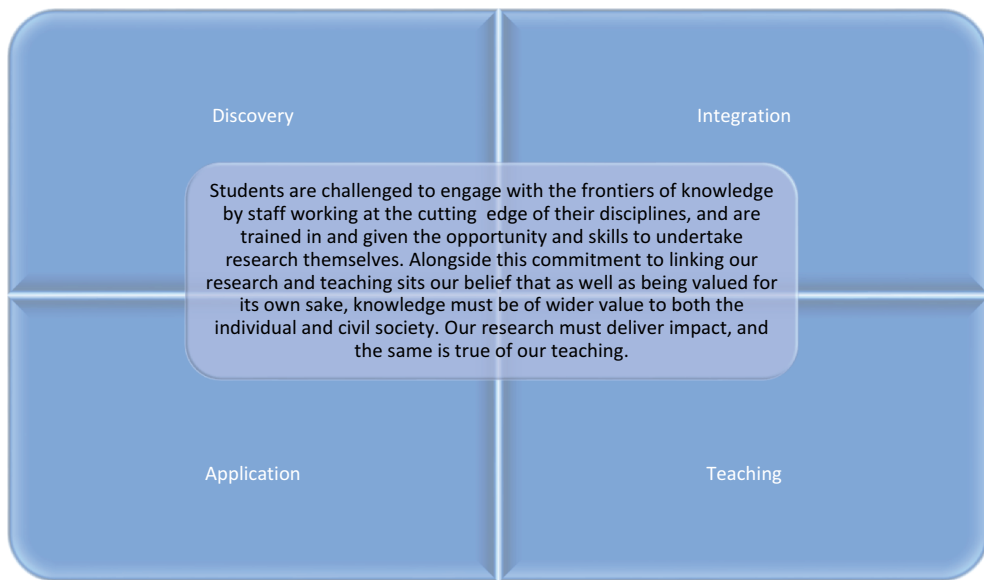


Figure 2. An example of text which encapsulates discovery, integration, teaching and application from submission B.

More specific examples describing teaching and research include, one HEI reporting being a ‘research intensive university that prides itself on providing an education and wider student experience that is second to none’ with ‘world-leading and world-changing research across all academic departments’. These commitments were reported as being ‘interwoven and mutually reinforcing’ with students benefiting from ‘cutting-edge research, both directly through their participation in research projects, and indirectly through our focus on research- and enquiry-led learning within the curriculum.’ Further, the HEI claimed that its status as a ‘research institution’ means that students are ‘taught by world-leading researchers, and exposed to cutting-edge ideas and methodologies in their disciplines, from the outset of their studies’. The research and teaching relationship is reported in a further example through undertaking teaching which is ‘research-led and intellectually challenging to students’. Whilst such an alignment *may* well be of benefit to the student experience, no specific evidence is offered however by the HEIs to substantiate or evidence these broad claims. A further example of the varied and diverse ways of describing research in the context of teaching excellence can be found in the frequency and diversity of terms in the TEF corpus which hyphenate research – a common way for institutions and research literature (i.e. Brew, 2006) to describe the relationship between teaching and research. A search of the TEF corpus for ‘research-*’ found 422 instances of 25 different terms. These are (with frequencies): research-led (112), research-informed (94), research-based (56), research-intensive (44), research-rich (37), research-active (32), research-engaged (6), research-inspired (6), research-enriched (4), research-oriented (4), research-related (4), research-stimulated (4), research-focused (3), research-only (3), research-focussed (2), research-teaching (2), research-/enterprise-informed (1), research-connected (1), research-dedicated (1), research-excellent (1), research-grade (1), research-in-practice (1), research-intense (1), research-involved (1), research-orientated (1).

Similarly, there is evidence from the analysis that some HEIs claim to focus on supporting learners to discover knowledge through providing a nurturing intellectual climate that involves staff who are engaged in research. There was limited direct evidence provided however, of the benefits this offers to the students both within their studies and as part of developing skills and knowledge. Further, there was no evidence of students then having opportunities to be involved in integrating, applying and potentially disseminating this as scholars in their respective academic communities. This is perhaps not surprising given their level of the studies (undergraduate) but suggests scope for future developments in how students can be engaged as scholars in academic communities with opportunities not only to discover knowledge but also to be involved in the broader integration and application of that knowledge.

The lack of distinct articulations of how HEIs described how their research benefited their teaching and vice versa, and the integration and application of knowledge provides an opportunity to build upon on Boyer's categories of scholarship with a broadening view of this model: an integrated model of scholarship for the university of the future.

5. An integrated approach to scholarship

Peters (2017) argues that the challenge to higher education for the 4th IA is that:

The digital revolution in and of itself will not transform education and if it does, it will not be entirely for the good. What is required in addition to new digital technologies and the emergence of massive digital systems that operate to centralise power is both political will and social vision to respond to the question: What is the role of higher education in the digital age when technological unemployment becomes the rule rather than the exception? (Peters, 2017, p. 5)

We examine the findings of our empirical case study of UK HEI institutional discourse (the university of today) and consider how a model of integrated scholarship, building on Boyer's Discovery, Integration, Application and Teaching can offer a conceptual response to the question of the role of higher education in an uncertain future. In constructing a model for the 21st century we do not seek to re-invigorate the idea of the university as originally conceptualised in the nineteenth century (in what we broadly term the university of yesterday), but build upon this idea and repurpose it for the world in which we now live (the university of today) and most significantly for the desired university of tomorrow. In the UK, this includes several regulatory frameworks within which HEIs have to conform and perform in to ensure they are successful in league tables and funding. One of these we have already explored, the TEF, alongside which is the more embedded Research Excellence Framework (REF) and with plans to introduce the Knowledge Exchange Framework (KEF) (Jackson, 2018). Law (2019) outlines some of the international perspectives on regulation citing the public and private divide and the complexity that this presents for governments and students. For HEIs themselves, they are faced with differentiating themselves from others in a 'market' environment.

Alongside regulation and funding are new technologies in education, work and society being developed and implemented at an increased pace. As described above, the future is not a linear, fixed trajectory but one that is technological, political and social. With this in mind we propose an integrated scholarship for universities, graduates and society to

prosper in an unknown future. The University of Yesterday has laid the foundations for the HE sector as we see it today – but as indicated by our empirical study there appears to be an inconsistent picture with respect to the relationships reported between teaching and research. This analysis therefore frames the backdrop for a more integrated framework that draws on Boyer's four types of scholarship and shows how these can offer a valuable link between the university of the past, the present and the future. Indeed, a distinguishing feature of the analysis was the lack of clarification not only of terminology, but also the evidence base that was drawn upon to substantiate claims. Thus, we found limited *explicit* evidence within this analysis to support claims that engagement in a research focused environment can be beneficial to the student experience with an assumption that a strong HEI research reputation will feed in to better student learning.

Boyer's *Scholarship Reconsidered* (1997) broadened a focus on nebulous individual terms such as 'research' and 'teaching' to highlight the relationships between these core activities – in other words, a focus on student engagement in learning within the broader 'nexus' of scholarship. Such a structured approach, we argue will aid not only submissions to regulatory excellence frameworks but also for missions of universities to show closer synergies between research and teaching and knowledge exchange as well as teaching practice. Drawing on these types of scholarship would potentially allow institutions to articulate and demonstrate to key stakeholders the distinctive nature and quality of their original research (Scholarship of *Discovery*); how this work draws on collaboration between different disciplines (Scholarship of *Integration*); the impact they have as an institution (both academics and students through the Scholarship of *Application*); all brought together as higher education (through Scholarship of *Teaching*) to inform practices of research, teaching and knowledge production within a university. Also mapping student activity to this would allow for students themselves, employers and government to identify skills and knowledge that graduates have for employment and citizenship in the face of risk and uncertainty under the backdrop of amongst other things the 4th IA. Such a model could also help the sector to move away from the traditional research and/or teaching divide and rather to view institutions as learning universities guided by a more integrated notion of scholarship in which there is a clear ethos of discovering, integrating, applying and sharing, and within which students are considered to be very much part of the broader academic community. Next, we build upon Boyer's *Scholarship Reconsidered* in response to these challenges and broaden out the university of yesterday and today into an integrated scholarship for the desired university of tomorrow.

Figure 3 takes Boyer's four cross-cutting elements of scholarship and 1) opens up the model of scholarship and integrates it with the university as a whole (students and academics) and 2) builds upon this with further detail as a suggested model for integrated scholarship for the 4th IA. The structure of Figure 3 is inspired by the famous 20th century Bauhaus art and design school, founded in 1919. The Bauhaus influence lives on in many design fields for its progressive and interdisciplinary approach to bringing together art, design, enlightenment science, technology, research, teaching and practice (Forlano, Steenson, & Ananny, 2019). Ehn (1998) describes a coming together of various disciplines for a re-invigoration of the Bauhaus School to include new constructive knowledge and competence related to science and new technologies, aesthetic knowledge and competence from art, design, architecture and the creative disciplines along with analytical-critical knowledge and competence from philosophy, social sciences and media and cultural studies.



Figure 3. An integrated scholarship based on Boyer's scholarship reconsidered.

This philosophy rings true with work of Boyer and our speculative conceptualisations of the university of tomorrow. The famous Bauhaus pedagogy was depicted by founder of the School, Walter Gropius in 1922 in a circular diagram representing the interdisciplinary curriculum. DiSalvo (2019) explores new invigorated diagrams inspired by the original. These new versions include artificial intelligence, robotics, algorithms, data, sensors but also information and communication, culture, politics and ethics. Figure 3 takes inspiration from these works, along with Boyer to create a diagram for integrated scholarship for the university of tomorrow.

5.1. Teaching [and learning]

Boyer (1997) linked teaching closely with his other three aspects of scholarship – application, integration and discovery. Here, we expand this out across academic teaching staff and the university as a whole. Whilst introducing students to existing domain knowledge is vital to be inducted into that particular community of practice and body of knowledge (Ashwin, 2020), our widening of *Scholarship Reconsidered* brings an aspect of teaching and learning as a culture of communicating and collaborating.

The very subject of teaching and learning in the 21st century is one which has had the potential to be divided as students have been positioned as consumers and academics as producers (Nixon, Scullion, & Hearn, 2018). Here, we propose that this is brought together into a teaching and learning culture across the whole university. This, within integrated scholarship is teaching and learning from other domains of knowledge with integration of disciplines, teaching and learning through the discovery of knowledge and the application of doing and evaluating this application through both assessment and wider work in communities. Those who see themselves as teachers as well as learners and create this habit will become lifelong enquiring learners, being able to understand and communicate new and existing knowledge.

5.2. Discovery

Boyer argued that:

“No tenets in the academy are held in higher regard than the commitment to knowledge for its own sake, to freedom of inquiry and to following, in a disciplined fashion, an investigation wherever it may lead” (Boyer, 1997, p. 69)

We propose that research should be opened out as with other aspects of scholarship to faculty and students. Universities are places of excitement where academics are breaking new ground in their field, making new disciplines and new discoveries across the sciences, social sciences and humanities. The idea and quest to discover knowledge for all at the university, from the first-year undergraduate being introduced to a discipline and its vast array of existing knowledge as well as forming the habit of discovery whether that be great works of the past, the present or their own discovery. Roudaut (2019) describes a case study of ‘research-led’ teaching which puts research at the forefront of teaching. This approach encourages critical thinking and epistemological criticality which when habituated can result in a constant search for enquiry and analysis of knowledge in all forms of life. For this discovery to be embedded it needs to be linked with teaching and learning which also then feeds into integration of disciplines, bringing together different world and epistemic views in solving real world meta-issues in application.

5.3. Application

Shanghai Tech University introduced ‘design thinking’ to all students underpinning all disciplines to encourage innovation in creating real-world solutions. Design thinking looks at wicked problems, problems which have not one solution but the potential to have many which cross disciplines to include both the sciences and the humanities, design has the potential to bridge these disciplinary divides and bring new ways of doing with the sciences, humanities and social sciences (Cross, 1982).

It turns out that planting the innovation and entrepreneurship seed meant challenging students’ thinking modalities and inspiring them to believe they could make a difference in society’s future well-being by creating solutions to wicked problems (particularly social issues in China). (May Lee & Yuan, 2018, p. 110)

Innovative approaches to creating and working with real world problems can happen in and across a variety of disciplines, for example business innovation (Foster & Yaoyuneyong, 2016) and in STEM curricula (Loudon, 2019) using approaches taken from design disciplines. The applied nature of this aspect of application scholarship adds praxis (the application of theory to change and shape the world) (Mulcahy, 2016) to the endeavour of the university, be that with students working on real-world problems with authentic assessment (Scott & Unsworth, 2018) to the university as a whole involved with the shaping of society as well as researching it. Embedding the practice of creating and creativity will enable students and the university as a whole to form the habit of applying teaching and learning and discovery of knowledge across the integration of disciplines.

5.4. Integration

The biggest challenges do not often sit neatly within one discipline - climate change, global economic inequality, global pandemics, technological unemployment to name just a few require a large and diverse sets of skills, knowledge and research capability. Transdisciplinary and interdisciplinary working allows for faculty and students to recognise epistemological frameworks, question division of knowledge, comprehend complex phenomena and address complex problems (Evans, 2019).

Transdisciplinary research draws upon disciplinary methods of knowledge-making as means to generate and synthesize new knowledge, but transcends the disciplines in its drive to approximate the complex reality of its subjects of study. Transdisciplinary work is integrative, socially relevant, and oriented toward problem solving. Therefore, transdisciplinary work engages with human values in producing knowledge and identifying avenues for action. (Evans, 2015, p. 240)

A note of caution here should be made on terminology where multi/inter and transdisciplinary are used and the different understandings of working across and within disciplines - we broadly articulate integration as a collaboration between disciplines and the forming of new fields of teaching and research.¹ At the heart is a collaboration and working together across students, faculty, universities and societies. This can then feed into teaching and learning, discovery of knowledge and application of doing. Foster and Yaoyuneyong (2016) perceived that business students lacked skills under the areas of innovativeness, interdisciplinary collaboration and real-world experience and new pedagogic approaches involving integration of disciplines and new ways of working improved these skills. Integration of knowledge across different disciplines may well be the most important aspect of integrated scholarship as we move into the unknown of the 4th IA. The Covid-19 pandemic was not foreseen and while attention was focused on climate change and the 4th IA, the global pandemic may well have jettisoned many changes socially and in particular for education. Jandrić et al. (2020) look to the future and whether the pandemic will be a bump in the road or a big 'reset' with an opportunity to reshape education. A move towards seeing the human, natural world and technology as an interconnected ecology is put forward to see global issues from a variety of perspectives.

Interdisciplinary education as an abstract concept looks to investigate the world, including the human, the cultural and natural environment and is a structural change which holds promise. The theory holds strong, but the practice is complex. (Jandrić et al., 2020, p. 5)

The practice with which to achieve such diverse perspectives requires structural change in universities and education more broadly so as not to be confined to disciplinary echo chambers. The university as an institution is perfectly placed to be the site of interconnected disciplines and the model of integrated scholarship presented here offers a theoretical concept with which to use in achieving what posthumanism (Braidotti, 2013) calls affirmative politics, combining critique and creativity for alternative visions of society.

6. Conclusion

Barnett (2012) takes up the task of 'learning for an unknown future' by arguing that the future has always been unknown, but nevertheless is a question that requires more attention as we shape the university of the future. Barnett calls for an ontological turn that moves away from knowledge and skills and further towards human qualities and dispositions. This is described as a pedagogy that engages students as 'persons' and not merely as 'knowers'. Whilst not specifically referencing the 4th IA, Barnett's conceptualisation of learning for the future can be seen as a reaction to the uncertainty of the present, characterised by both great promise and conversely, great peril of technological developments. The future society and university discourse sketched out above is a future that is not yet written, and is uncertain from a technological development perspective but also a wider society conceptualised by risk (Beck, 1992) and fluid liquid modernity (Bauman, 2000). Clearly higher education has a part to play in these futures and we have revisited some of the original ideas of the university of yesterday along with the contemporary, university of today, in particular the activities of research and teaching and the nexus of these activities. We argue that the key tenets of the modern university set out in the 19th century are still relevant and should not be forgotten as we face the future. The foundations of enquiry and critical thinking still hold promise to explore and lead alternative futures for universities and society.

We highlight here some limitations, we have selected two that whilst are outlined as limitations also suggest some areas for future research. First, a key limitation of analysing the HEI TEF provider submissions is the nature in which they are written. They are writing to a clear brief in order to obtain a high award. Further research in this area should compare other texts and perspectives such as marketing materials, other regulatory documents, as well as student, staff and public perceptions of the university and its purpose. Secondly, we acknowledge that whilst we have adopted a distinctive model of scholarship as a conceptual lens to examine the provider statements, this model was not a driver for the TEF in 2017 nor were HEIs expected to write to descriptors that distinguish the model. Despite these limitations we argue that the analysis presented in this paper begins to illuminate not only how we might begin to think about teaching excellence in future iterations of the TEF, but also how as a sector and as institutions, clarity can be provided in both discourse and practice when articulating the key activities of a university with a wider framework such as the model of integrated scholarship proposed here. Just one outcome of this then might seek to focus on ensuring the various quality frameworks as well as other communications are more explicitly aligned so as to show students and other stakeholders the value of integrated scholarship within the HE sector and to the wider public. [Figure 3](#) offers a starting point to structure frameworks

and strategies which integrate scholarship around teaching and learning, discovery (research), integration and application.

This article highlights the challenges HEIs face in gathering evidence at an institutional level of teaching excellence in a research institution and the benefits that a research ethos may bring to the undergraduate degree. Our analysis highlights that current judgements about effective linkages vary greatly and there is a reliance on subjective analyses from institutions. This work demonstrates the need for disciplines, institutions and indeed the sector as a whole to define more precisely what is meant by the key activities and the relationship between the diverse activities of universities. We propose an extended and broadened model of integrated scholarship based on the work of Boyer (1997) which can bring together universities as communities of teaching and learning, discovery of knowledge, integration of disciplines and application. These interconnected and linked activities offer a framework and opportunities for departments, institutions and the HE sector to plan, deliver and evaluate their functions under the current discourse of rapid technological development in the 4th IA in which universities have a key role in researching and working with students who will shape and lead in an unknown future. This offers a valuable conceptual reference point for further developments in this area. This starting point provides scholars, leaders and practitioners in the academic community (teachers, researchers and students) an opportunity to review their policy and practice to align the distinct activities that constitute scholarship into an integrated mutual benefiting ecosystem which is robust to the uncertain future in the face of increased technological and social change.

Note

1. Stember (1991) offers some clear consensus: crossdisciplinary views one discipline from the perspective of another, multidisciplinary is researchers from different disciplines working together, each drawing on their disciplinary knowledge, interdisciplinary integrates knowledge and methods from different disciplines, using a synthesis of approaches and transdisciplinary creates a unity of intellectual frameworks beyond the disciplinary perspectives

Disclosure statement

No potential conflict of interest was reported by the authors.

ORCID

Adam Matthews  <http://orcid.org/0000-0003-4013-0232>

References

- Ahmed, K. (2018). Bank warns on AI jobs threat. BBC News. 20 August. Accessed 8 November 2019. <https://www.bbc.com/news/business-45240758>
- Aoun, J. (2017). *Robot-proof: Higher education in the age of artificial intelligence*. Cambridge, MA: The MIT Press.
- Ashwin, P. (2020). *Transforming University education: A manifesto* (1st ed.). New York: Bloomsbury Academic.

- Avis, J. (2018). Socio-technical imaginary of the fourth industrial revolution and its implications for vocational education and training: A literature review. *Journal of Vocational Education & Training*, 1–27. doi:10.1080/13636820.2018.1498907
- Barnett, R. (2012). Learning for an unknown future. *Higher Education Research & Development*, 31(1), 65–77. doi:10.1080/07294360.2012.642841
- Bauman, Z. (2000). *Liquid modernity*. Cambridge, UK; Malden, MA: Polity Press; Blackwell.
- Beck, U. (1992). *Risk society: Towards a new modernity*. London; Newbury Park, Calif: Sage Publications. (Theory, culture & society).
- Berelson, B. (1952). *Content analysis in communication research*. Michigan: Free Press.
- Boyer, E.L. (1997). *Scholarship reconsidered: Priorities of the professoriate*. Carnegie Foundation for the Advancement of Teaching.
- Braidotti, R. (2013). *The posthuman*. Cambridge, UK; Malden, MA, USA: Polity Press.
- Brew, A. (2003). Teaching and Research: New relationships and their implications for inquiry-based teaching and learning in higher education. *Higher Education Research & Development*, 22(1), 3–18. doi:10.1080/0729436032000056571
- Brew, A. (2006). *Research and teaching: Beyond the divide*. Palgrave Macmillan: New York
- Brezina, V., Timperley, M., & McEnery, T. (2018). #LancsBox v. 4.x [software]. Available at: <http://corpora.lancs.ac.uk/lancsbox>.
- Bryman, A. (2008). *Social research methods* (3rd ed.). Oxford University Press.
- Cross, N. (1982). Designerly ways of knowing. *Design Studies*, 3(82), 221–227. doi:10.1016/0142-694X(82)90040-0
- Dafoe, A. (2015). On technological determinism: A typology, scope conditions, and a mechanism. *Science, Technology, & Human Values*, 40(6), 1047–1076. doi:10.1177/0162243915579283
- DiSalvo, C. (2019). Diagrams for Another Bauhaus. In L. Forlano, M.W. Steenson, & M. Ananny (Eds.), *Bauhaus futures*. Cambridge, Massachusetts: The MIT Press.
- Edwards, C., & McLinden, M. (2017). Cultivating student expectations of a research-informed curriculum: Developing and promoting pedagogic resonance in the undergraduate student learning pathway. In C. Brent & D. Fung (Eds.), *Developing the higher education curriculum: Research based education in practice*. London: UCL Press.
- Ehn, P. (1998). Manifesto for a digital bauhaus. *Digital Creativity*, 9(4), 207–217. doi:10.1080/14626269808567128
- Evans, T. L. (2015). Transdisciplinary collaborations for sustainability education: Institutional and intragroup challenges and opportunities. *Policy Futures in Education*, 13(1), 70–96. doi:10.1177/1478210314566731.
- Evans, T.L. (2019). Chapter 5 transdisciplinary engagement with enforced dependency: A platform for higher education to address crises in employment, sustainability, and democracy in technological society. In M. Peters, P. Jandrić, & A.J. Means (Eds.), *Education and technological unemployment*.
- Feenberg, A. (2017). *Technosystem: The social life of reason*. Cambridge, Massachusetts: Harvard University Press.
- Forlano, L., Steenson, M.W., & Ananny, M. (2019). Introduction. In L. Forlano, M.W. Steenson, & M. Ananny (Eds.), *Bauhaus futures*. Cambridge, Massachusetts: The MIT Press.
- Foster, J., & Yaoyuneyong, G. (2016). Teaching innovation: Equipping students to overcome real-world challenges. *Higher Education Pedagogies*, 1(1), 42–56. doi:10.1080/23752696.2015.1134195
- Hamilton, E., & Feenberg, A. (2012). Alternative Rationalisations and Ambivalent Futures: A Critical History of Online Education. In (Re)Inventing the internet: Critical case studies. Sense Publishers. <http://site.ebrary.com/id/10546411>
- Healey, M., & Jenkins, A. (2009). Developing undergraduate research and inquiry. *The Higher Education Academy*.
- HEFCE. (2016). Teaching excellence framework year two additional guidance. http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/2016/201632/HEFCE2016_32.pdf
- Holsti, O.R. (1969). *Content analysis for the social sciences and humanities*. Reading, Mass: Addison-Wesley.

- Jackson, A.J.H. (2018). REF, TEF, and KEF; and the “Research-Informed” Teaching and co-production traditions in local history: Analysing provincial newspapers. *International Journal of Regional and Local History*, 13(1), 68–85. doi:10.1080/20514530.2018.1451447
- Jandrić, P., Jaldemark, J., Hurley, Z., Bartram, B., Matthews, A., Jopling, M., ... Tesar, M. (2020). Philosophy of education in a new key: Who remembers Greta Thunberg? Education and environment after the coronavirus. *Educational Philosophy and Theory*, 1–21. doi:10.1080/00131857.2020.1811678
- Jandrić, P., Knox, J., Besley, T., Ryberg, T., Suoranta, J., & Hayes, S. (2018). Postdigital science and education. *Educational Philosophy and Theory*, 50(10), 893–899. doi:10.1080/00131857.2018.1454000
- Jasanoff, S., & Kim, S.-H. (2015). *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power*. Chicago: University of Chicago Press. doi:10.7208/chicago/9780226276663.001.0001
- Josephson, P., Karlsruhn, T., & Östling, J. (2014). Introduction: The humboldtian tradition and its transformations. In P. Josephson, T. Karlsruhn, & J. Östling (Eds.), *The humboldtian tradition*. BRILL. doi:10.1163/9789004271944_002
- Koops, W., van den Kerkhof, M., Ostermeier, C., & Van de Schoot, R. (2016). A Bildung-psychological investigation into student motives: McKinsey- or von Humboldt-oriented? *European Journal of Developmental Psychology*, 13(6), 756–774. doi:10.1080/17405629.2016.1230056
- Law, D. (2019). International comparisons. *Perspectives: Policy and Practice in Higher Education*, 23(1), 1–4. doi:10.1080/13603108.2019.1534710
- Loudon, G. (2019). Integrating ideas from design disciplines into the STEM curricula. *Higher Education Pedagogies*, 4(1), 284–286. doi:10.1080/23752696.2019.1599688
- Marr, B. (2018). The 4th industrial revolution is here - are you ready? Forbes. Accessed 8 November 2019. <https://www.forbes.com/sites/bernardmarr/2018/08/13/the-4th-industrial-revolution-is-here-are-you-ready/>
- Mason, P. (2016). *PostCapitalism: A guide to our future*. UK: Penguin Books.
- Matthews, A. (2020). Blurring boundaries between humans and technology: Postdigital, postphenomenology and actor-network theory in qualitative research. *Qualitative Research in Sport, Exercise and Health*, 1–15. doi:10.1080/2159676X.2020.1836508
- Matthews, A., & Kotzee, B. (2019). The rhetoric of the UK higher education Teaching Excellence Framework: A corpus-assisted discourse analysis of TEF2 provider statements. *Educational Review*, 1–21. doi:10.1080/00131911.2019.1666796
- May Lee, R., & Yuan, Y. (2018). Innovation education in China: preparing attitudes, approaches, and intellectual environments for life in the automation economy. In N.W. Gleason (Ed.), *Higher education in the era of the fourth industrial revolution* Singapore: Springer Singapore. doi:10.1007/978-981-13-0194-0.
- McCowan, T. (2017). Higher education, unbundling, and the end of the university as we know it. *Oxford Review of Education*, 43(6), 733–748. doi:10.1080/03054985.2017.1343712
- Mulcahy, C.M. (2016). *Pedagogy, praxis and purpose in education*. Taylor & Francis. Place of publication not identified.
- Newman, J.H. (1852). *The Idea of a University*. London: Longmans, Green, & Co.
- Nixon, E., Scullion, R., & Hearn, R. (2018). Her majesty the student: Marketised higher education and the narcissistic (dis)satisfactions of the student-consumer. *Studies in Higher Education*, 43(6), 927–943. doi:10.1080/03075079.2016.1196353
- Office for Students. (2018). *Get the data - Office for students. TEF data*. Accessed 11 August 2018. <https://www.officeforstudents.org.uk/advice-and-guidance/teaching/tef-data/get-the-data/>
- Orr, D., Weller, M., & Farrow, R. (2019). How is digitalisation affecting the flexibility and openness of higher education provision? Results of a global survey using a new conceptual model. *Journal of Interactive Media in Education*, (2019)(1), 5. doi:10.5334/jime.523
- Pepperell, R. (2009). *The posthuman condition consciousness beyond the brain*. Bristol: Intellect.
- Peters, M.A. (2017). Technological unemployment: Educating for the fourth industrial revolution. *Educational Philosophy and Theory*, 49(1), 1–6. doi:10.1080/00131857.2016.1177412

- Peters, M.A. (2020). Digital socialism or knowledge capitalism? *Educational Philosophy and Theory*, 52(1), 1–10. doi:10.1080/00131857.2019.1593033
- Peters, M.A., Jandrić, P., & Means, A.J. (eds.). (2019). *Education and technological unemployment*. Singapore: Springer Singapore. doi:10.1007/978-981-13-6225-5.
- Pinch, T.J., & Bijker, W.E. (1984). The social construction of facts and artefacts: Or how the sociology of science and the sociology of technology might benefit each other. *Social Studies of Science*, 14(3), 399–441. doi:10.1177/030631284014003004
- Potter, W.J., & Levine-Donnerstein, D. (1999). Rethinking validity and reliability in content analysis. *Journal of Applied Communication Research*, 27(3), 258–284. doi:10.1080/00909889909365539
- Robertson, J. (2007). Beyond the “research/teaching nexus”: Exploring the complexity of academic experience. *Studies in Higher Education*, 32(5), 541–556. doi:10.1080/03075070701476043
- Roudaut, A. (2019). Bridging the gap between teaching and research: A case study for engineering & applied science. *Higher Education Pedagogies*, 4(1), 209–225. doi:10.1080/23752696.2019.1605836
- Schwab, K. (2016). *The fourth industrial revolution* (First U.S. ed.). New York: Crown Business.
- Scott, M., & Unsworth, J. (2018). Matching final assessment to employability: Developing a digital viva as an end of programme assessment. *Higher Education Pedagogies*, 3(1), 373–384. doi:10.1080/23752696.2018.1510294
- Seale, C. (2004). *Researching Society and Culture* (2nd ed.). London: Sage.
- Seldon, A., & Abidoye, O. (2018). *The fourth education revolution: Will artificial intelligence liberate or infantilise humanity*. Buckingham: The University of Buckingham Press.
- Spronken-Smith, R., & Walker, R. (2010). Can inquiry-based learning strengthen the links between teaching and disciplinary research? *Studies in Higher Education*, 35(6), 723–740. doi:10.1080/03075070903315502
- Stember, M. (1991). Advancing the social sciences through the interdisciplinary enterprise. *The Social Science Journal*, 28(1), 1–14. doi:10.1016/0362-3319(91)90040-B
- Tegmark, M. (2018). *Life 3.0: Being human in the age of artificial intelligence*. UK: Penguin Books.
- Tight, M. (2016). Examining the research/teaching nexus. *European Journal of Higher Education*, 6(4), 293–311. doi:10.1080/21568235.2016.1224674
- Webb, L., & Wang, Y. (2014). Techniques for sampling online text-based data sets. In W.-C. Hu & N. Kaabouch (Eds.), *Big data management, technologies, and applications*. IGI Global. doi:10.4018/978-1-4666-4699-5
- Xing, B., & Marwala, T. (2017) Implications of the fourth industrial age for higher education. *The Thinker* Issue_73_Third_Quarter_2017. <https://ssrn.com/abstract=3225331>
- Xu, L.D., Xu, E.L., & Li, L. (2018). Industry 4.0: State of the art and future trends. *International Journal of Production Research*, 56(8), 2941–2962. doi:10.1080/00207543.2018.1444806