FECs, innovation, and skills: A literature review

Authors:
Jen Nelles[x]
Oxford Brookes University
Kevin Walsh[x]
Oxford Brookes University
Michalis Papazoglou[x]
Oxford Brookes University

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[x] Innovation Caucus

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Authors' contacts:
info@innovationcaucus.co.uk

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More information can be found on The Productivity Institute's website. Contact us at theproductivityinstitute@manchester.ac.uk

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The Productivity Institute, headquartered at Alliance Manchester Business School, The University of Manchester, Booth Street West, Manchester, M15 6PB.

Abstract

There has been a widespread understanding that the Further Education system in the UK needs enhancement in order to improve the match between skill needs by businesses and what schools and colleges in the UK currently provide. Many members of the eight Regional Productivity Forums in The Productivity Institute report that skill mismatches are a key factor in inhibiting productivity growth in their areas. With the rising challenges of labour shortages across a wide range of occupations, the need for developing the right skills, for the right occupations and industries, and at the right time is even more critical to tackling the UK's productivity shortfall.

The first phase of research presented in this report reviews the literature on Further Education Colleges (FECs) in the UK and internationally and their role in skills provision to the local and regional economy. This work is a precursor and provides a foundation for the next phase, which assesses FEC needs and their performance in those ecosystems. This subsequent research will interrogate FEC understandings of the skills needs and ecosystem performance. This review explores what FECs are and how they have emerged as one of the focal points for innovation ecosystem development. It then turns to what they do and highlights the main pathways through which they contribute to the skills profiles of their regions.

In each of these, we present some international comparisons as a contrast to the UK experience. FECs can also play other roles in innovation ecosystems and this report explores the interplay between those roles and their skills provision mission. Finally, it reflects on the diversity of possible experiences of FEC ecosystem engagement and proposes a conceptual framework to structure analysis of FEC strategies and opportunity sets.

Innovation Caucus

FECs, innovation, and skills: A literature review

Report prepared by:

Jen Nelles (Innovation Caucus, Oxford Brookes University)
Kevin Walsh (Innovation Caucus, Oxford Brookes University)
Michalis Papazoglou (Innovation Caucus, Oxford Brookes University)

www.innovationcaucus.co.uk

UKRI Economic and Social Research Council

UKRI Innovate UK

Authors

The core members of the research team for this project were:
Dr Jen Nelles (Innovation Caucus, Oxford Brookes University)
Dr Kevin Walsh (Innovation Caucus, Oxford Brookes University)
Dr Michalis Papazoglou (Innovation Caucus, Oxford Brookes University)

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About the Innovation Caucus

The Innovation Caucus supports sustainable innovation-led growth by promoting engagement between the social sciences and the innovation ecosystem. Our members are leading academics from across the social science community, who are engaged in different aspects of innovation research. We connect the social sciences, Innovate UK and the Economic and Social Research Council (ESRC), by providing research insights to inform policy and practice. Professor Tim Vorley is the Academic Lead. The initiative is funded and co-developed by the ESRC and Innovate UK, part of UK Research and Innovation (UKRI). The support of the funders is acknowledged. The views expressed in this piece are those of the authors and do not necessarily represent those of the funders.

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Executive Summary

There has been a widespread understanding that the Further Education system in the UK needs enhancement in order to improve the match between skill needs by businesses and what schools and colleges in the UK currently provide. Many members of the eight Regional Productivity Forums in The Productivity Institute report that skill mismatches are a key factor in inhibiting productivity growth in their areas. With the rising challenges of labour shortages across a wide range of occupations, the need for developing the right skills, for the right occupations and industries, and at the right time is even more critical to tackling the UK's productivity shortfall.

The first phase of research presented in this report reviews the literature on Further Education Colleges (FECs) in the UK and internationally and their role in skills provision to the local and regional economy. This work is a precursor and provides a foundation for the next phase, which assesses FEC needs and their performance in those ecosystems. This subsequent research will interrogate FEC understandings of the skills needs and ecosystem performance. This review explores what FECs are and how they have emerged as one of the focal points for innovation ecosystem development. It then turns to what they do and highlights the main pathways through which they contribute to the skills profiles of their regions. In each of these, we present some international comparisons as a contrast to the UK experience. FECs can also play other roles in innovation ecosystems and this report explores the interplay between those roles and their skills provision mission. Finally, it reflects on the diversity of possible experiences of FEC ecosystem engagement and proposes a conceptual framework to structure analysis of FEC strategies and opportunity sets.

Key findings:

- **The evidence base on FECs and innovation is relatively thin.** Research in this area is complicated by different nomenclature, typologies, and different international policy approaches. This reinforces the need for rigorous and sustained empirical research to effectively populate an evidence base to support public policy.

- **FECs operate in a layered policy environment which prioritizes skills delivery**. However, FECs have experienced numerous changes in their policy environments and are now being asked to do a lot of things. It is unclear whether public support has kept pace with demand.

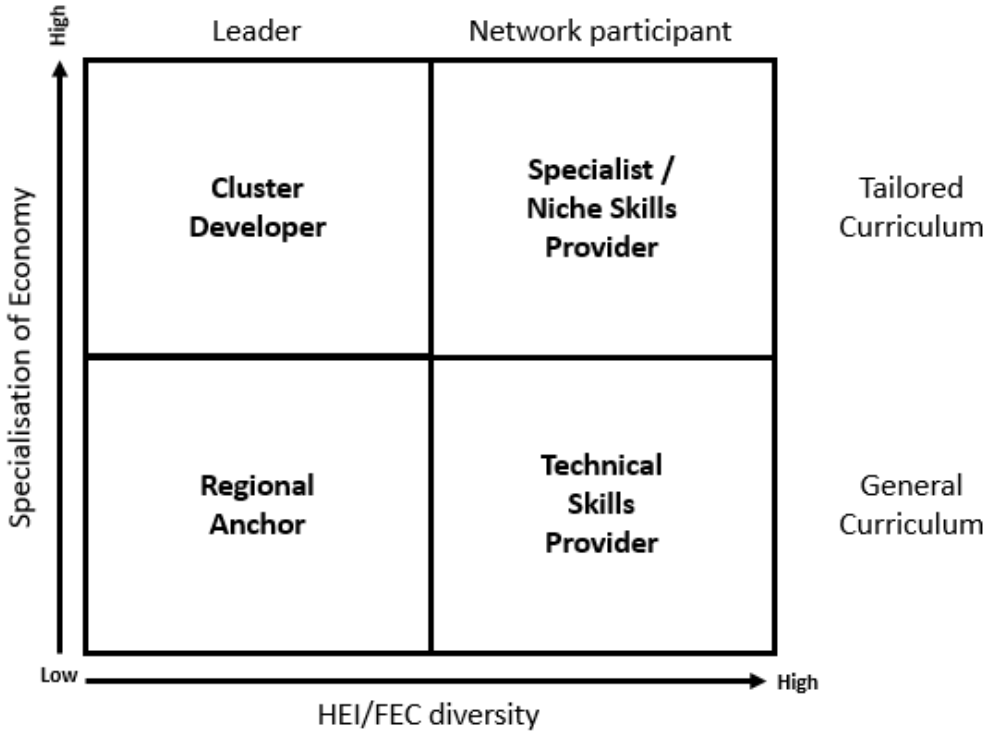
- FECs primarily contribute skills to the innovation ecosystem through courses, apprenticeships, and enterprise and entrepreneurship education.
    - **Courses are overwhelmingly the most significant vector through which skills are transmitted** to the economy in terms of completions. FECs provide skills at all levels but overlap with higher education in providing Level 4 and 5 courses. We also observe regional variations in what subject areas dominate, suggesting that offerings may be somewhat responsive to localised contexts.
    - **Apprenticeships can be effective training mechanisms** but vary substantially in quality and outcomes and tend to have lower completion rates than courses.
    - **Entrepreneurship education is offered at almost a third of FECs**. It aims to produce individuals with developed enterprising capability. These programmes have potential but very little evidence exists tracking the impact of these skills.

- **Evidence suggests that links between the UK Further Education Sector and employers on skills development, especially smaller firms, are weak although examples of good practice exist**. On the one hand there is potential to increase the proportion of courses with employer input and on the other, there is potential for employers of apprentices to supplement work experience with formal education through Further Education Colleges.

- **FECs also engage in many other types of interaction with their innovation ecosystems**, all of which can, if properly designed, enhance the effectiveness of skills delivery and match between skills demanded and those supplied through FEC programming. The number of mechanisms discussed risks overstating how prevalent these kinds of practices are. Evidence suggests that, for most FECs, interactions of this nature are rare.

- **The propensity for engagement in innovation ecosystems and the degree to which FECs are themselves engaged in organisational innovation are likely to be linked**. However, literature on innovation practices within FECs is also limited.

- **FECs are not a homogeneous group and should perhaps be differentiated in future research in terms of their actual and potential roles in innovation ecosystems**. We hypothesise that the ecosystem within which FECs are embedded can shape their perceptions of their competitive advantage – and hence their course and programme offering – as well as the opportunities for them to engage with their ecosystems.



This research suggests that more investigation is needed in four areas. (Please note that while there are initiatives along these lines underway in various departments and organisations, gaps remain):

- **Aligning policy objectives and FEC incentive structures**: A more thorough understanding of how the policy environment (sometimes described as cacophonous) impacts FEC strategies, the tradeoffs that they must consider given competing policy demands, all relative to available public and internal resources, is necessary to appropriately align incentives.

- **Inspiring innovation and empowering FECs**: We think that there is a link between the propensity for engagement in innovation ecosystems and the degree to which FECs are themselves engaged in organisational innovation. If this is the case, then concentrating only on aligning incentives may not be effective if FECs are unwilling or unable to engage. Learning more about the internal factors that enable FECs to change the ways that they operate, institute new programmes and practices, and think about their own organisational evolution is vital to effectively steer strategies to service public policy objectives.

- **Selecting the right tools for the job:** It is not clear which programmes, mechanisms, types of engagement etc. are most likely to achieve the objective of reducing skills mismatches. While each of the approaches discussed here has promise, there can be many variations in implementation and mixes of mechanisms adopted. Should all FECs be attempting all types of engagement? Are some more effective or appropriate than others?

- **Measuring inputs and outcomes:** Getting more and more appropriate data is fundamental to many of the above research agendas. On the input side, more detail about employer skills needs, spatial trends, and programmes will help to better conceptualise alignment issues. Measuring outcomes to determine impact is also crucial to refine strategies.

1. Introduction

There has been a widespread understanding that the Further Education system in the UK needs enhancement in order to improve the match between skill needs by businesses and what schools and colleges in the UK currently provide. Skills are at the heart of narratives around productivity, with economically successful regions tending to be more attractive to a wide variety of talent while less successful places often struggle to fill gaps and, consequently, attract and retain industry in their innovation ecosystems (see Box 1). While much of the focus in skills development has fallen on Higher Education institutions (HEIs), and particularly high-performing research-intensive universities, increasingly the important role of Further Education (FE) is also being recognised.

However, in this context, there has also been a widespread realisation that the Further Education system in the UK is not performing at maximum capacity, has been faced with long term spending cuts (Augar, 2019; Lewis and Bolton, 2022), and that strategies and support are necessary in order to improve its impact and economic contribution. Research reports a mismatch between the skill needs of businesses and what schools and colleges in the UK currently provide (Mason, 2021). Many members of the eight Regional Productivity Forums in The Productivity Institute report that skill mismatches are a key factor in inhibiting productivity growth in their areas. With the rising challenges of labour shortages across a wide range of occupations, the need for developing the right skills, for the right occupations and industries, and at the right time is even more critical to tackling the UK's productivity shortfall.

Whether it is initial vocational education in general or, more specifically, apprenticeship training or higher technical education, in all areas the challenges are not just a matter of quantity (how many places or programmes) but also of quality of the curricula on offer. There are concerns that there remains a misalignment between regional and local needs and existing skills provision. Also, that the focus on formal qualifications often obviates the need for clear definitions of key knowledge, skills, and behavioural requirements for particular occupations. Some research finds that FECs often lack the time, resources or capabilities to track how the regional ecosystem of business activities, innovation and potential availability of students evolve to help them respond in a more flexible and agile manner to changing needs (Vorley *et al.*, 2021). On the demand side, businesses may not always be able to articulate or communicate their skills needs, also contributing to bottlenecks.

The Productivity Institute hypothesizes that the lack of sustained interaction between FECs, business, and government on demand and supply of skills, and the failure to embed the assessment of skills needs and the solutions to meet those in a regional/local context, are important reasons why the assumed impact on innovation and productivity is often not visible. It is likely that a stronger connection between innovation at the regional level and the skills required flowing from it are key to enhancing place-based productivity. An intensive local and regional collaboration of FE colleges with business and other education institutions (including HE institutions) will contribute to resolving this. The College Business Centres (CBCs), announced in the 2021 Skills White paper, are just the most recent public initiative to connect Further Education colleges (FECs) and employers to fill this gap and accelerate place-based innovation (Department for Education, 2021) but have yet to be implemented.

Box 1: Innovation ecosystems and FECs

One framework that has been used for understanding the role of the FE sector in the UK's innovation performance is the concept of innovation ecosystems (Vorley *et al.*, 2021). An innovation ecosystem can be described as an evolving milieu of interconnected and interdependent actors that, through their activities, interactions, and outputs, directly or indirectly affect the milieu's innovativeness (Granstrand & Holgersson, 2020; Smorodinskaya *et al.*, 2017; Taxt *et al.*, 2022). Actors in the innovation ecosystem include not only the protagonists of innovation, such as innovative firms, universities, research centres, and institutions, but also the supporting actors that could be either organizations (e.g., FECs, schools, suppliers, regulatory authorities, standard-setting, bodies incubators, venture capitalists, accounting, law firms) or individuals (e.g., scientists, researchers, teachers, skilled workers, customers, managers) while their decisions and actions may cause cooperative or competitive counter-responses from other actors. (De Vasconcelos Gomes *et al.*, 2018; Rital & Almpanopoulou, 2017; Sun *et al.*, 2019; Thomas *et al.*, 2018).[1]

Local Skills Improvement Plan (LSIPs) aim to link education and training providers and stakeholders in local ecosystems. A trailblazer programme is currently underway to evaluate how these actors can work effectively together towards local skills development. In the meantime, there is much to learn about how FECs function within their innovation ecosystems and how partnerships and collaboration can enhance their contributions.

This report is the first phase in a larger project to better understand how the mismatch between supply and demand of vocational skills arises at the regional and local level, and to design and experiment with models to enhance the role of FE colleges in regional and local innovation ecosystems to improve the match. It extends initial work, funded by Innovate UK and Gatsby, on the opportunity for colleges to support business innovation - and the connection that this has for productivity in the UK. The importance of regional innovation ecosystems was also stressed in a recent report by BEIS (2021b), based on work by the National Institute of Economic and Social Research.

The first phase of research presented in this report reviews the literature on FECs and their roles in skills provision to the local and regional economy. This work is a precursor and provides a foundation for the next phase, which assesses FEC needs and their performance in those ecosystems. This subsequent research will interrogate FEC understandings of the skills needs and ecosystem performance. The current review begins at first principles. It explores what FECs are and how they have emerged as one of the focal points for innovation ecosystem development (Section 2). It then

[1] The concept of innovation ecosystems emerged from the innovation systems research stream (e.g. national, sectoral, and regional innovation systems) and in the last decades has been preferred over the innovation systems when examining innovation phenomena from a policy perspective primarily because of its conceptual flexibility (Oh *et al.*, 2016; Smorodinskaya *et al.*, 2017). Similar to natural ecosystems, innovation ecosystems do focus on particular geographical areas but these are not limited only to predefined areas such as the national and regional innovation systems. The innovation ecosystems' boundaries are flexible and could be adjusted so as to facilitate the examination of innovation phenomena among actors located within one or a group of neighbourhoods, cities, regions, countries, continents, or even in a global scale, such as the innovation ecosystems around a specific technology or platform (e.g., Google Android) (Rital & Almpanopoulou, 2017; Smorodinskaya *et al.*, 2017; Suseno & Standing, 2018; Taxt *et al.*, 2022). Another important advantage of using the concept of innovation ecosystems is that it can better describe the reality concerning innovation processes by emphasizing the dynamic, non-linear, and agile nature of the network that has been structured by the self-organizing actors of the ecosystem (Rital & Almpanopoulou, 2017; Smorodinskaya *et al.*, 2017).

turns to what they do and highlights the main pathways through which they contribute to the skills profiles of their regions (Section 3). In each of these, we present some international comparisons as a contrast to the UK experience. Section 4 presents the other roles that FECs can play in innovation ecosystems and the interplay between those roles and skills provision. It reflects on the diversity of possible experiences of FEC ecosystem engagement and proposes a conceptual framework to structure analysis of FEC strategies and opportunity sets.

In this research, we focus on FE colleges in England. This is because there has been notable divergence between systems in the devolved administrations. However, future research may investigate what lessons can be learned from the different approaches that evolved from similar institutional roots. Furthermore, we also concentrate on the totality of FE's role in local ecosystems and do not distinguish between 16-19, adult skills, or other stage of career categories. The logic here is that all of these programmes ultimately shape the skills profile of the local economy - if skills needs are not being met it is likely due to interdependencies and weaknesses across programmes and assessing them in isolation from one another may miss these dynamics. This is particularly the case as these programmes are not mutually exclusive (e.g., graduates of 16-19 programmes can feed into other qualifications). Ultimately, we want to eschew the tendency of reports and frameworks of breaking programmes into silos, which detracts from considering the institution, capacity and totality of their local role, position and offering relative to other actors in the ecosystem (particularly other FECs and HEIs), and broader impact.

The report concludes with a series of observations and a summary of the main themes that emerged from this research. Briefly, these are:

- Literature on FECs and innovation is relatively thin. Research in this area is complicated by different nomenclature, typologies, and different international policy approaches.

- FECs have experienced numerous changes in their policy environments and are now being asked to do a lot of things - it is unclear whether public support has kept pace with demand.

- Literature highlights that the links between the UK Further Education Sector and employers on skills development, especially smaller firms, can be weak although examples exist of good practice. This suggests there is potential for overall improvement. On the one hand there is potential to increase the proportion of courses with employer input and on the other, there is potential for employers of apprentices to supplement work experience with formal education through FECs.

- FECs also engage in many other types of interaction with their innovation ecosystems, all of which can, if properly designed, enhance the effectiveness of skills delivery and match between skills demanded and those supplied through FEC programming.

- We think that there is a link between the propensity for engagement in innovation ecosystems and the degree to which FECs are themselves engaged in organisational innovation. However, literature on innovation practices within FECs is also limited.

- FECs are not a homogeneous group and should perhaps be differentiated in future research in terms of their actual and potential roles in innovation ecosystems.

We conclude that there is a need for more empirical research on the FEC experience in their innovation ecosystem. In particular, there is scope to better understand why FECs adopt the strategies they do, the challenges that they face in effectively delivering on the various functions expected of them (including skills delivery), how public policy has affected their capacity to match localised skills demand, and the interplay between these factors.

2. Further Education in policy and practice

Further Education is a concept that is highly debated and contested, the definition of which varies across national contexts. The simplest definition is that Further Education focuses upon practical and vocational training. Creasy (2013) describes the distinction between Higher Education and Further Education as Higher Education is engaged in the pursuit of the unknown while Further Education seeks to master what is known. The concept of Further Education exists in most countries, but it often goes by different names. In Europe, it is usually captured under the rubric of vocational education and training (VET). In North America, these are usually analogous to associate or community colleges or vocational schools. In the UK, the Further Education sector generally includes colleges incorporated under the Further and Higher Education Act 1992 or the Education Reform Act 1988; or colleges created by either the Secretary of State for Business Innovation and Skills or by the Secretary of State for Education (Association of Colleges, 2022a). A more detailed typology is presented below.

This section explores the major classifications of FECs in the UK and maps their prevalence. It then reviews the history of FEC governance in the UK, highlighting key moments in the sector's evolution with particular attention to their emergence as agents in innovation ecosystems. Finally, we reflect on the concept of innovation and skills and literature on what skills matter in innovation ecosystems before turning to the mechanisms for skills development and delivery in the following section.

2.1 Further Education provider types

The FE sector is constituted by numerous and diverse types of Further Education providers. It incorporates all the organizations that provide post-16 education and training and receive government funding from the Education and Skills Funding Agency, except for schools and universities. The main types of the FE providers include colleges, Independent Training Providers (ITPs), Local Authority (LA) providers, employer providers, third sector providers, and Adult Community Education (ACE) providers (Figure 1) (Education and Training Foundation, 2019).

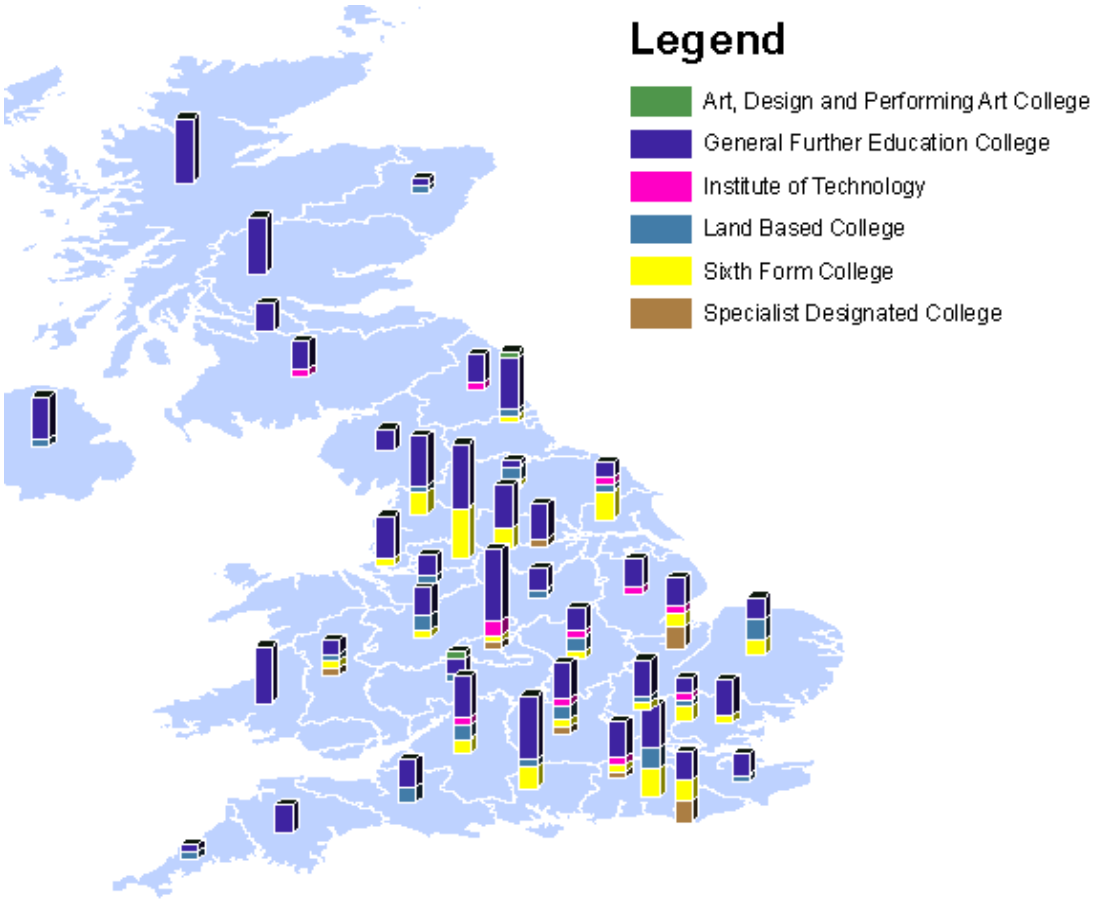


Figure 1: Map of FE Colleges in UK based on data from Association of Colleges (2022b) and categorised using additional data from National Land Based Colleges (2022[2]) and the Institutes of Technology Network (2022[3])

Table 1 presents the different categories of the FE providers together with a brief description. Unfortunately, despite the wide variety of categories, the divisions are not neat, nor are their functions unique. The descriptions show a high degree of overlap in their activities, probably because of the different origins of each type (e.g., national authorities, local authorities, employers, independent training providers), that results in confusion and a lack of coordination concerning the offering of the whole sector.

[2] https://nlbc.uk/partners/members/
[3] https://www.institutesoftechnology.org.uk/about

Table 1: Types and descriptions of the FE providers (Sources: Education and Training Foundation, 2019; Association of Colleges, 2022c)

Types of FE Providers	FE Providers	Description
Colleges	General Further Education (GFE) Colleges	Offer high-quality academic, technical, and vocational education to people of all ages.
	Institutes of Technology	Employer-led collaborations between Further Education colleges, universities, and local employers specializing in offering higher-level technical education.
	Land-based Colleges	Skills provision needed for rural economies. Specialize in education and training in agriculture, land, and animal sciences, with many land-based colleges operating on working farms.
	Sixth Form Colleges	Offer general academic, technical, and vocational education, mainly for 16-to 18-year-olds.
	Art, Design and Performing Arts Colleges	Offer specialist courses for the creative sectors.
	Specialist Designated Colleges	Independently founded charities that have a particular focus on providing high-quality education to certain disadvantaged groups (e.g., adults with few or no qualifications, learners with learning difficulties).
	National Specialist Colleges (NSCs)	Offer specialist support to young people with disabilities and/or mental health problems. They employ a much higher number of learning support staff than other provider types and usually have a smaller number of learners.
Adult Community Education (ACE) Providers	Local Authority ACE Providers	Pivotal to many local place-based initiatives, they provide education opportunities and a range of apprenticeship programs, independently or in partnership with others, including local businesses, job centres, the voluntary and community sector, and the education and training sector.
	Institutes for Adult Learning	Long-established community adult learning organizations that support adult learners (aged 19+), including people from disadvantaged communities with few or no qualifications.
	Third Sector ACE Providers	Offer a wide range of academic, specialist courses, and specialized training, filling a gap or working with specific client groups.
Independent Training Providers (ITPs) or Private Training Providers (PTPs)		Independent companies (not-for-profit and for-profit) that provide Work-based Learning (e.g., Apprenticeships, Traineeships). Working closely with employers, they offer 'off-the-job' training, including teaching theory, learning support, and practical training to apprentices on behalf of colleges and employers. 75% of all apprenticeships are delivered by ITPs either funded directly by the government or subcontracted by other FE providers (mainly FE Colleges).
Local Authority (LA) Providers		Local Authorities, such as boroughs and local councils, provide adult education opportunities and Work-based Learning.
Employer Providers		Employers' 'in-house' training. Similar to other types of FE sector, they have to comply with standards set by the Office for Standards in Education, Children's Services and Skills (Ofsted).
Third Sector Providers		Non-profit-making organizations (e.g., charities, foundations, community groups) that provide academic and specialist courses and deliver specialized training to disadvantaged learners.

Colleges are the most important category of the FE sector mainly because it includes the General Further Education (GFE) colleges which are by far the most numerous and significant FE providers in the UK (Education and Training Foundation, 2019). GFE colleges offer a wide range of choices in skills to study by providing high-quality academic, technical, and vocational education (Education and Training Foundation, 2019). Land based colleges are also quite significant in some regions and fulfill an important function of specialised skills provision for rural economies.

Institutes of Technology (IoTs) are the most significant latest development in post-16 and adult education. Established in 2019, IoTs are employer-led collaborations between Further Education colleges, universities, and local employers. IoTs specialize in offering higher-level technical education in the science, technology, engineering, and mathematics (STEM) sectors and require anchor employers to play a substantial role in the development of the IoTs' curriculum and in their general operation. By funding industry-standard facilities and equipment and bringing together colleges, universities, and employers, the government's aim is to increase the supply of the higher-level technical skills that are in demand, aligning the needs of the industry with the offered technical skills, in anticipation of synergies at the regional level and maximization of productivity (Department for Business, Energy and Industrial Strategy, 2021).

This report focuses predominantly on two types of FE providers: GFEs and Land-based Colleges. These are the types of publicly regulated FE providers most commonly associated with innovation. As described above, while IoTs have recently emerged as FE providers in the UK landscape, these are more accurately considered as consortiums. While we occasionally refer to these, we concentrate our attention primarily on the experiences and practices of FECs as individual skills providers. While the following section explores what FECs do in more detail, it is important to understand this in the context of a shifting policy environment in which the mission and public purpose of colleges has evolved (and continues to evolve) considerably.

2.2 FEC History and governance in the UK

The FE sector in the UK is perhaps aptly described as being in a constant state of evolution, as governments strive to align sector objectives with the ever-changing challenges of the economy and society (Dennis *et al.*, 2020). Criticizing the way that UK governments historically treat the FE sector, Orr (2020) noted that since the early 1980s, there have been 28 reforms that affected the sector and that each one failed to deliver what was promised, denoting ongoing debates about what the mission of the FE sector should be, particularly when compared to the better defined (and defended) mission of universities. This institutional uncertainty and confusion is combined with a strong bias in public spending towards Higher Education at the expense of Further Education and vocational education and training (Mason, 2020), suggesting that there is considerable scope for improving outcomes in the sector through more coherent policies and suitable resources. Nevertheless, in spite of the numerous reforms in the FE sector, one thing that is not debated is that its primary and core objective remains to provide the necessary and appropriate skills that are crucial for the development of the economy (Hodgson & Spours, 2019).

The term "Further Education" (or "FE") was first introduced in the Education Act of 1944 and was mainly used to refer to the technical colleges established to fill the gap caused by the lack of effective vocational education. The UK's vocational system has been described as inferior relative to other European systems, especially that of Germany, which led to a large amount of unskilled work (Hodgson & Spours, 2019; Lucas & Crowther, 2016). After the Second World War and during the 1950s, massive growth in technical education took place through the rapid expansion of technical colleges. The 1960s were characterized by a more institutionalized intervention of employers and unions in the FEC's

curriculum offered via the Industrial Training Boards. These Boards were provided for most private sector industries to operate a levy-grant system in which a levy is applied to all firms in the sector and raised by the Boards which, in turn, redistribute these funds to organize training, aiming at reducing unemployment by aligning the training with the industry needs. The objective was to deal with skills shortages and gaps while protecting training from market forces (e.g., firms unwilling to provide training if there is a risk that the skilled employee will resign), based on the assumption that if all firms in an industry are involved in training, the aggregate level of skills within the industry would increase (Department for Business, Innovation and Skills, 2015).

In the 1970s and 1980s, the FE sector started to be involved more systematically and intensively in Higher Education by offering academic courses that were not targeting specific jobs but the preparation for general work. This included the adoption of pre-vocational qualifications and low-level vocational training alongside more targeted offerings. This was instituted in services of 'social inclusion', which was meant to be advanced by increasing the national skills profile and reducing unskilled work, particularly amongst young people (Hodgson & Spours, 2019; Parry *et al.*, 2012; Savours & Keohane, 2019).

A major reform for the FE sector took place in the early 1990s. In 1992, FECs were granted independent status by removing them from the control of local government authorities (Savours & Keohane, 2019; Shattock, 2021). Polytechnics also followed a similar route and became autonomous universities (Hodgson & Spours, 2019). This was the result of a general redirection of education to serve the perceived needs of the economy, on the basis of the neoliberal policies that were established in the 1980s, resulting in a very significant burden of institutional changes (Simmons, 2010). By functioning as self-governing, centrally funded organizations responsible for the planning and execution of their own budget, curriculum, and marketing, the FE sector met the government's objective of creating a sector capable of being responsive and effective to the needs of local businesses and the national economy in general (Lucas & Crowther, 2016; Parry, 2013; Savours & Keohane, 2019). However, some note that the sector was never fully autonomous but was heavily shaped by national policy levers and by the funding councils that replaced local authorities in an oversight role (Hodgson & Spours, 2019).

This radical reform led the FE sector into a largely experimental phase during the 1990s (Gourley, 2008). A representative characteristic of this period was that quasi-market forces were encouraged for FE colleges (Hodgson & Spours, 2019; Savours & Keohane, 2019). Emphasis was put on competition among FE colleges aiming at broader participation, reduced costs, and greater efficiency (Hodgson, 2015). Another example of adopting corporate governance and business practices from the private sector was the franchising method that FE colleges followed in order to achieve growth in a competitive environment within the tertiary education system (Hodgson & Spours, 2019).

However, the autonomy and competitiveness of FE colleges eventually resulted in an over-diversified and complex sector that was focusing on financial rather than academic performance, a situation which led the government to adopt a more centralized and governmentally controlled FE education policy (Hodgson, 2015). This was mostly evidenced by the Learning and Skills Council, a quasi-non-government organization established in 2001, which was responsible for the planning and funding of Further Education (Gourley, 2008; Hodgson & Spours, 2019). Additionally, the 2000s were characterized by increased investment in FE, in terms of capital spend and growth of college budgets (Hodgson & Spours, 2019; Savours & Keohane, 2019).

Throughout this period, Higher and Further Education were increasingly seen as solutions to policy problems and keys to unlocking national (and more localised) competitiveness. They were considered economic engines that could drive productivity and growth (Skills Commission, 2016). In particular, the vocational focus and their "closeness to the world of work" (Parry *et al.*, 2012) has meant that

FECs were seen as a tool to improve the skills base of the current and future workforce, especially at the higher levels. As skills became more important to policy agendas, FECs also offered a cost-effective way of expanding access to Higher Education and widening participation, with programmes that could be delivered more flexibly and rapidly in response to demand. In this context, there has been pressure to expand offerings, provide accredited qualifications, and structure courses and modules to offer a more "HE-like" experience and culture (Baxter, 2020). Along with this have come expectations about the broader contribution FE can make to innovation ecosystems that are often more in line with more research-intensive institutions. This involved urging FECs to engage more with business and participate in innovation.

Finally, the 2010s were primarily marked by a more elaborate and intense governmental effort to re-align the FEC's skill provision with the needs of UK business by paying extra attention to the regional impact of the FECs and to their local coordination with other economic actors of the region (Savours & Keohane, 2019). To this end, in the last few years, there have been some suggestions about returning colleges back into a type of regional public ownership, almost 30 years since the colleges were removed from the control of local authorities (Orr, 2020). It is important to note that although the FE sector remained to a large extent steered by national policy levers, the work of FEC management was and still is crucial for the fulfilment of their FEC's mission, being responsible for the overall short-term operational planning and execution as well as for the medium- and long-term strategic planning (Greatbatch & Tate, 2018). Despite the reforms and changes that took place in the FE sector from its very beginning, its vocational mission has always been fundamental and of primary importance, to which have been added other policy goals, such as the right to tertiary education, aiming at individual advancement, the reduction of social inequalities, economic security, and now contributions to innovation (Bathmaker *et al.*, 2021; Hodgson & Spours, 2019).

As public policy has shown increasing interest in the potential of FECs to contribute to innovation, it has begun to explore a variety of potential types of engagements and impacts. These are discussed in more detail in Section 4. However, this "innovation turn" has also invited reflections relevant to the core FEC mission of skills provision - specifically about the various types of skills that underpin innovation.

2.3 Innovation and Skills for innovation

In practice, while FECs have a clear skill mandate, the underlying focus of Further Education policy has evolved over the past two decades to promote and strengthen relationships between FECs and business. This can be seen through the Centres of Vocational Excellence (2001), National Skills Academies (2004), Employer Ownership of Skills (2012), and National Retraining Scheme (2017); all of which required integrating employers as a condition of funding and have stimulated ongoing interaction between firms and FECs. The trajectory of FEC policy has been to encourage them to become more engaged with and closer to businesses, while still being skills-led.

The UK is not alone in trying to leverage the sector's potential not only for the effective response to present and future skills demands, but also for addressing major economic (e.g., unemployment, innovation, productivity), social (e.g., inclusive citizenship), and environmental challenges (European Commission, 2020; European Training Foundation, 2020). To this end, in the last few years, a series of countries and international organizations (e.g., UNESCO, OECD, ILO, EU, WB) have designed and implemented various notable initiatives and policies. In particular, the European Commission, in addition to promoting innovative practices and digitalisation within Further Education organizations in order to achieve a higher quality of education and training, increasingly considers FECs as important drivers of innovation capable of providing the skills to use and adopt innovations, as well as

substantially contributing to new innovations during their working life (European Commission, 2020; European Training Foundation, 2020).

In all contexts, skills are seen as the main FEC outputs that contribute to innovation (Nelson & Phelps, 1966; Tether *et al.*, 2005; Toner, 2011) and there are large differences in skill levels across nations, partly attributable to different approaches to FEC policy (Toner, 2011). However, skills for innovation remain poorly defined (Toner and Woolley, 2016). Indeed, "the notion of 'skill' is one of the most elusive and hard to define concepts" (Lafer, 2004: p. 118).

Further, there is no consensus on what factors are critical to defining skills (Grugulis *et al.*, 2004) and as a result there has been a "dramatic increase in the lexicon of skills" (Grugulis & Lloyd, 2010, p.99) and "there is enormous variation in the types of skills required for innovation" (Cobo, 2013b, p.67). Table 2 illustrates the variation of skills types identified in literature on skills and innovation.

Table 2: Summary of literature on skill types and innovation

Work	Analysis	Skill types identified	Importance for innovation
Leiponen (2005)	Panel analysis of innovation in manufacturing firms	Distinguishes between high educational attainment and low attainment	"without sufficient skills, firms benefit less from innovation, because they do not have the requisite complementary capabilities or absorptive capacity."
Tether *et al.* (2005)	A literature review on the link between skills and innovation	Pure science, engineering, problem-solving, language skills, team working and communication skills	"The report identifies management and leadership skills as being of particular importance for all types of innovation"
Dede (2010)	Compares and synthesises conceptual frameworks for 21st century skills	Perennial and contextual skills	Argues that students need these skills in order to participate in the modern economy.
Toner (2011)	Literature review of role of workforce skills in the innovation process in developed economies	Technical and generic skills	"the quantity and quality of workforce skills are a major factor in determining the observed patterns of innovation"
Cobo (2013a)	Qualitative analysis of skills required in job vacancies in large multinational organisations	Seven types of 'soft skills'	"Innovation often requires a departure from conventional approaches. The results of this study emphasize the relevance of soft skills for innovation."
Cobo (2013b)	Literature review of elements necessary for an innovative society	"Skills for innovation comprise creativity, adaptability, and entrepreneurial and trans-disciplinary competencies."	"A multiplicity of linkages among knowledge, skills, education and innovation are needed"
Cukier *et al.* (2021)	Analysis of changing future skills identified by WEF	Identifies five types of innovation and the implication s for different types of skills	Innovation is anticipated through skilled use of digital technologies and entrepreneurship

The table above highlights the importance of 'soft' skills to innovation. For example, Cobo (2013b) describes skills for innovation as creativity, adaptability, entrepreneurship and inter-disciplinary synthesis. Cobo (2013a) details seven skills, all classified as 'soft skills' in order of importance:

- collaboration
- critical thinking
- contextual learning
- searching, synthesizing and disseminating information
- communication
- self-direction
- creativity

There is substantial overlap between these 'soft skills' and Toner's (2011) generic skills:

- problem solving
- creativity
- team work
- communication skills

Toner (2011) also describes these generic skills as 'transferable' skills based on "having a broad application across a wide range of employment contexts and as transcending individual subjects" (Keep & Payne, 2004: p. 57) and are seen as increasingly important as a response to ICT which require standardised skills. However, Dede (2010) distinguishes between those soft skills that are perennial, such as collaboration which has always been a valued skill in the workplace, and those soft skills which are contextual. For example, searching, synthesizing and disseminating information may well be a contextual skillset that is disrupted by ICT, which rather creates value in the ability to discern signal from noise in an abundance of information.

Tether *et al.* (2005) juxtapose these same soft skills against technical skills, especially important in manufacturing. Technical skills are those which relate specifically to the field of the worker (Medina, 2010). These 'hard skills' are often associated with using tools and equipment and can be "acquired in a logical and systematic way" (Daniels, 2011, p. 2) through institutions of higher learning. In contrast, there are difficulties in acquiring soft skills directly through institutions of higher learning which can be achieved through experience in live business environments (Ng & Feldman, 2004; Archer & Davison, 2008; Hughes *et al.*, 2013; Billett, 2014), facilitated by traineeships, apprenticeships and internships.

More recently, innovation skills have been discussed in terms of the 'future of work', reemphasising that rapidly changing technologies, especially ICT changes, are changing the mix of innovative skills (Dede, 2010). Cukier *et al.* (2021) highlight digital skills, which echoes the importance placed on the links between digital technologies, innovation and skills (Ciarli *et al.*, 2021). The recent framing in terms of the 'future of work' also expands upon the soft skills identified above to include adaptability - sometimes discussed as a meta skill - "the ability to adapt existing skills continuously or acquire new skills" (Ciarli et al. 2021, p. 2).

Finally, the links between innovation and entrepreneurship are also highlighted. A group of 'entrepreneurial skills' such as "identifying opportunities, creating new combinations and gathering the necessary resources to implement solutions" (Cukier *et al.*, 2021, p. 25) reflect the recent research attention on the importance of innovation for SMEs , which comprise a majority of economic activity and employment in the UK (Lu, 2018), to compete internationally (Saridakis *et al.*, 2019).

As we turn to a discussion of the core mechanisms of skills provision in FECs it is worth reflecting on how these contribute to the development of different types of skillsets and how appropriate these are to supporting innovation ecosystems and innovation policy goals. That said, it is worth reiterating the lack of consensus about definitions of different skill types. In this context, it is perhaps not surprising that there is very little work that explicitly links FECs with the development of specific skill categories.

3. Further Education skills provision

This section explores the main pathways through which FECs provide skills to their ecosystems (and beyond). We have deliberately limited our investigation to three large themes: Courses and curricula; Apprenticeships; and Enterprise and entrepreneurship education. Each of these categories includes several subcategories where the literature was not developed enough to address them alone.

This is an observation that we can make of the literature on FECs and innovation more generally. In terms of academic literature, there are certain themes and contexts in which small clusters of scholars have developed research agendas. However, these tend to be fragmentary and descriptive. Robust empirical studies are rare and much of the empirical work on the subject focuses on small numbers of case studies, possibly due to the coverage and quality of the data (Parry & Thompson, 2002). Many of these have limited value as current examples as many are now out of date, having been produced in the 1990s and 2000s. While FECs appear to be a perennial topic of interest for researchers focused on regional development, clusters, innovation systems and economies, etc., our review of the material suggests that this interest is rarely sustained over the long term and so there are very few contexts (e.g., nations or regions) with sufficient depth of publications over time to use as robust examples of best practice. Policy and grey literature fills this gap to a certain extent, but is of variable quality and vintage and suffers from many of the same limitations as academic scholarship.

Part of the problem may be that many studies conclude that while FECs can make a valuable contribution to innovation ecosystems (or processes, or clusters, or regional development, etc., depending on the focus of research) they also often skirt around the issue of whether these programmes generate sufficient return on investment to justify more serious investigation or intervention. This is in part due to the difficulty in obtaining data from businesses and other methodological complications. Consequently, research has been limited to description and, as such, deeper (longitudinal) analysis and theory building is more rare. As the following section will note, in the UK many achievements are not in areas *typically* associated with the innovation economy (see Figure 2, below) such as engineering, ICT, or business administration.[4] As our discussion on types of skills suggests, there is more to supporting innovation than just technical skills, but this observation does raise some questions worth answering about what the potential capacity of FECs actually is to skill and upskill individuals for the innovation economy at sufficient scale. All of this suggests that there is a significant opportunity to fill gaps in the literature and our understanding of the role and impact of FECs on innovation and innovation ecosystems; also, that readers should proceed through this section outlining the various vectors of skills development with the caveat that it is based on evidence that is fragmentary and not as rich as we had hoped.

[4] One exception is the high level of achievements overall in "health, public service, and care", which does include some science-based occupations. However, a large proportion of the skills in those programmes will be in caring and service roles. These should not be dismissed as having no innovation potential, but they may be less likely to than some other types of skills and occupations.

Turning to the review of mechanisms through which FECs deliver skills, the FE sector provides skills in a number of ways in their communities. The mix is determined by the history of each college in a region, demand from both learners and employers, and competition and collaboration with universities and private education providers (Orr, 2020). Governments - from national governments to local authorities - have a role to play in fostering this collaboration and ensuring coordination where potential for competition exists. In the overview that follows, we focus mainly on describing the mechanisms of skills delivery at a general level with specific attention to what practices, if any, exist to align these with labour demand, cognizant that significant variations in experience and practice will exist at the institutional level (and that not all FECs will be engaged in all of these types of activities).

3.1 Courses and curricula

Academic literature on Further Education student courses is sparse (Robson, 1998), which is especially challenging given the frequent and recent changes to the sector. Historically, Further Education has provided for students in the gap between compulsory schooling and degree level studies although in practice the provision overlaps with both ends by providing a "range from basic skills to degree level work" (Avis, 2009, p. 653). Therefore, the line between Further Education and Higher Education has become blurred, with Further Education lecturers often expected to deliver Higher Education courses (Harwood & Harwood, 2004). Since Further Education Colleges do not always award their own qualifications (Parry, 2009) with the recent exception of Foundation Degrees (Parry, 2012), individual FECs have differing links to awarding bodies, such as universities and national awarding bodies, depending on the range of their provision. This results in a wide variation across FE Colleges in their course provision and their links to actors within their ecosystems. There is an ongoing debate about whether diversity across institutions is a strength or weakness (Stanton *et al.*, 2015).

The diversity of course provision in FECs is moderated by their differing size. There is a small group of large FE Colleges "*commonly described as 'mixed economy' colleges*" (Parry & Thompson, 2002, p. 13) who provide a significant share of Higher Education. Overall, Further Education peaked with provision to over 3 million students (Foster, 2005) although this has trended down to 2.2 million possibly due to the rapid rise in apprenticeship uptake (Orr, 2020). It may also relate to overall spending shrinking by 37% in real terms in the last decade (Bosetti & Gariban, 2020).

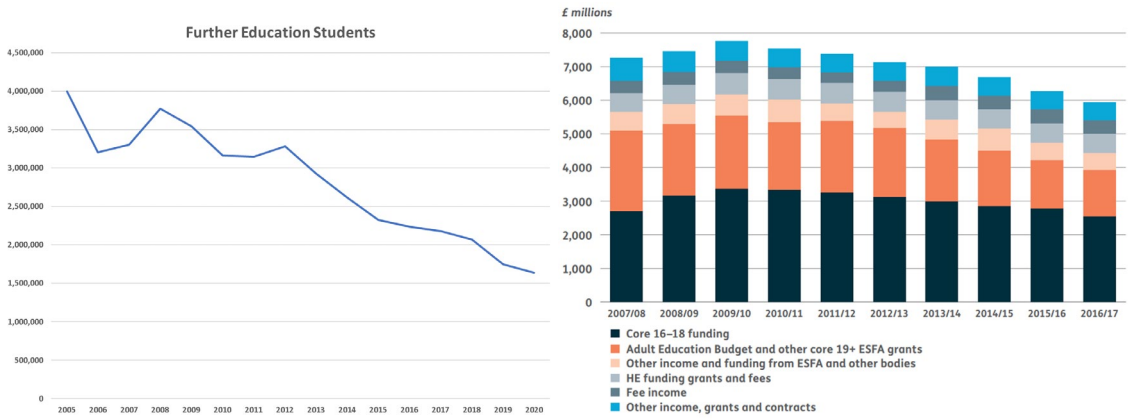


Figure 2: Side by side trends of Further Education student numbers (Gov.uk, 2022) and Further Education funding (Augar, 2019)

The largest proportion of Further Education students are studying at General Further Education colleges which offer mainly vocational programmes (Orr, 2020), and primarily focus on compulsory education for students aged 16–18 (Snelson & Deyes, 2016; Allison, 2022). Courses range from 'community learning' such as Yoga or language classes, which are typically funded by fee paying students, to more technical classes in areas such as hospitality and information technology ranging from basic through to degree level (Bailey & Unwin, 2014).

Often the highest level within the Further Education sector was Level 3, which aims to provide the "ability to gain or apply a range of knowledge, skills and understanding at a detailed level" (NIDirect, 2022, Table 1), although this has expanded (Creasy, 2011). FECs now also provide education at Level 4, which aims to provide "specialist learning, involving detailed analysis of a high level of information and knowledge in an area of work or study" (NIDirect, 2022, Table 1) and at Level 5 "ability to increase the depth of knowledge and understanding of an area of work or study, so you can respond to complex problems and situations" (NIDirect, 2022, Table 1). Indeed, there are approximately twice the number of Further Education Colleges providing Level 4 and 5 Higher Education courses than do Higher Education Institutions (Foster, 2019, p. 6). Table 3 provides an overview of the wide range of qualifications provided in Further Education Colleges.

Qualifications within Further Education cannot be simply understood in terms of their levels (Creasy, 2011). For example, within Computing, level 3 qualifications include A-Levels, BTECs, Cambridge Technicals, Access Courses and T-Levels (Allison, 2022). The latter includes a 45 day work placement and has been described as the 'gold standard' of technical education (Straw & Sims, 2019, p. 31). In contrast, BTECs do not typically include any formal work experience. The qualifications and corresponding curricula are better understood in terms of their objectives. For example, while T-levels were designed to "provide a direct route into skilled employment" (Allison, 2022, p. 4), Access Courses aim to prepare students for progression to Higher Education.

Table 3: Description of qualifications provided by Further Education Colleges

Qualification (Common abbreviation)	Level	Aim	Introduced	Sources
Community classes	Entry	Recreational skills ranging from sport to foreign languages	1912*	Bailey & Unwin (2014)
National Vocational Qualification (NVQ)	Entry - 4	Based on practical skills and completed in the workplace, they reward practical achievement with a view toward employability	1986	Davenport (2007); Bidgood *et al.* (2006)
General Certificate of Secondary Education (GCSE)	2	Secondary Education qualification to standardise and unify the previous O-Levels and Certificate of Secondary Education (CSE)	1986	Uniguide (2022); De Bellaigue *et al.* (2022)
Advanced-Level (A-level)	3	Typically worked towards over two years, they aim for student progression to Higher Education	1951	Allison (2022); Davenport (2007)
Technical-Level (T-Level)	3	Two years courses with the aim for progression to skilled employment. Equivalent status to A-levels	2020	Allison (2022); Straw *et al.* (2019)
Access to Higher Education Diploma	3	An alternative to A-levels with the aim to progress to Higher Education	1970s	Allison (2022); Hayes *et al.* (1997); Stanton *et al.* (2015)
Cambridge Technicals	3	Designed for secondary school students to develop the knowledge and skills required for the workplace. Level 3 is equivalent to A-levels	1920	Allison (2022); Foden (1951)
Higher National Diploma (HND)	5	Intended for full time students only, designed to give skills to put knowledge to effective use in a particular job	1920	Uniguide (2022); Foden (1951); DirectGov (2012)
Diploma / Certificate of Higher Education (CertHE)	4	A one year course, CertHE aims to be academic rather than vocational and roughly equivalent to the HNC. Typically achieved as the first year of a degree course	Unknown	Parry *et al.* (2012); DirectGov (2012)
Professional Qualifications	4	Whilst longstanding, it is typically relegated to “non-prescribed Higher Education” and therefore under-specified	n/a	Parry *et al.* (2012)
Foundation Degree	4-5	A combined academic and vocational degree focussed on specific professions that provides progression to Bachelors degree	2001	Uniguide (2022); Bathmaker & Orr (2022)
Bachelors Degree	4-6	Taking 3 or sometimes 4 years, it is intended to provide a full understanding of a subject	**	Parry *et al.* (2012)
International Baccalaureate (IB)	3	Provides a qualification for entry to university	1960s**	Huddleston & Unwin (2013); Uniguide (2022); Tarc (2009)

* Possibly earlier

** These qualification introductions precede their offering by Further Education Colleges

Beyond the diversity in qualifications and their levels, Figure 3 presents some selected regional variations in the range of subjects for recent Further Education achievements across England. Health, Public Services and Care is the largest proportion of FEC achievements across most regions. However, there is diversity in other subject areas. Regions in the North East have consistently higher proportions of Engineering and Manufacturing Technologies FE achievements than other regions while regions in the South East have a consistently higher proportion of retail FE achievements than other regions. Regions in the North West have higher proportions of Construction FE achievements than other regions. In the West Midlands, ICT appears to consistently be overrepresented. The consistency of these higher proportions across multiple regions within the North East, South East, and North West suggest that student achievements may be responsive to economic specialisation within their regions.

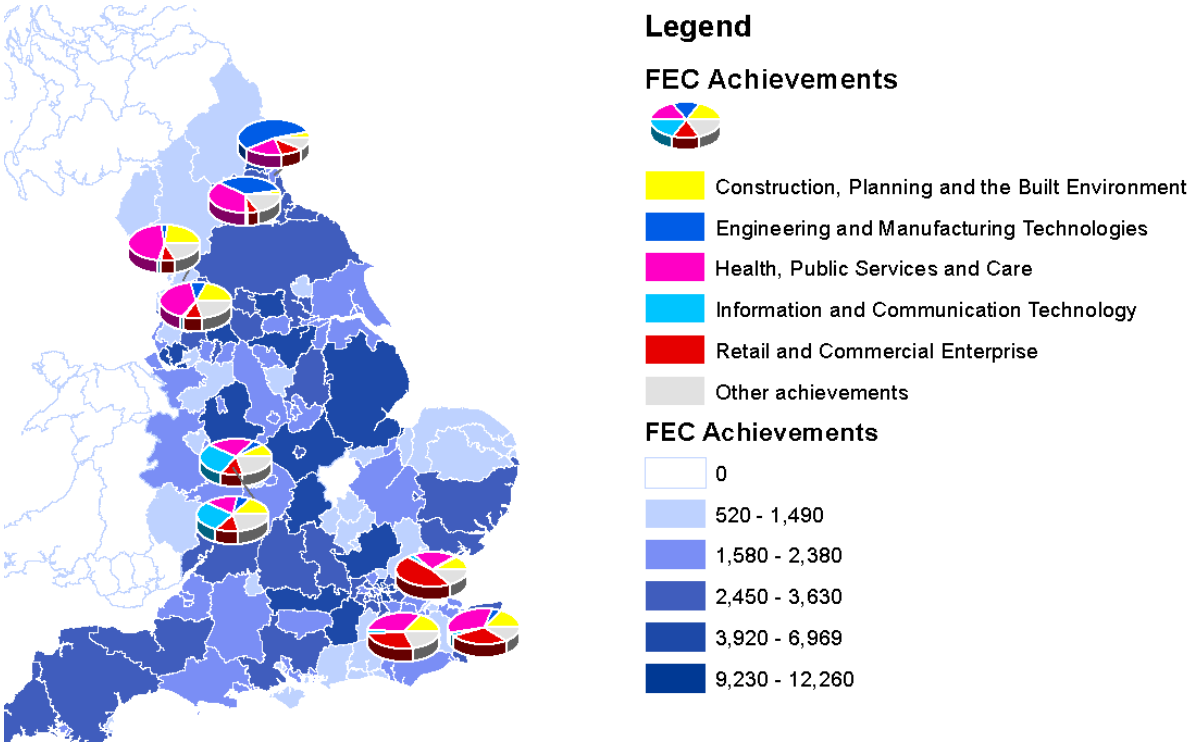


Figure 3: Further education achievements across selected NUTS3 areas in England based on Further Education and Skills Data (Gov.uk, 2022)

While the literature suggests that course provision is driven by student rather than employer demand (Bailey & Unwin, 2014; Orr, 2020), students make choices based on employment prospects (Parry *et al.*, 2012; Perry & Davies, 2015; Snelson & Deyes, 2016) and are likely to choose courses that offer good employment prospects. Thus, even if there are no links to employers for course development, employer engagement through recruitment and placement may provide the necessary links. These links are evident across FE College promotion materials. For example, Fareham College near Portsmouth offers full time student courses in Health that include Nursing, Midwifery, Mental Health care and Laboratory Sciences, with corresponding "links with local employers for industry placement opportunities in care homes, day care centres, hospitals, and laboratories" (Fareham College, 2022).

Further, there is significant diversity within each subject area of the provisions by FE Colleges. For example, in Fareham College there are 20 courses in Engineering ranging from Car repair to Maritime Defence, while Richmond and Hillcroft Adult Community College offer none.

The Foundation Degree is designed as a standalone programme as well as a programme that provides progression into the final stage of a Bachelor's Degree. Further Education Colleges partner with universities to enable transfer from Further Education to undergraduate education in universities, while stimulating demand for the college course through reputational affiliation with a university (Parry *et al.*, 2012). For this reason, FEC courses are generally complementary to the provision by neighbouring universities.

FEC course portfolios appear to be less stable than university offerings due to FEC links to specific employers; however, "despite repeated calls for colleges to serve the needs of their particular local economies, the courses that colleges offer align most consistently with student demand not employer demand" (Bailey & Unwin 2014, p. 57). Engaging with employers is difficult (Brockmann *et al.*, 2008; Greer, 2016), particularly in the UK where employers have little interest in investing in the effort required to improve skills as large, low-wage firms (Grugulis 2007; Keep, 2012). Employers also appear to prefer work experience to qualifications due to the wide variation and uncertainty of Further Education qualifications (Shury *et al.*, 2007). The literature on Further Education colleges and employer engagement focuses on how colleges should support employers rather than how employers can support colleges to develop programmes, with recent calls for development of two-way relationships through external partners such as Local Enterprise Partnerships (Hodgson *et al.*, 2019b). However, McGurk and Meredith (2020) argue that the structure of Local Enterprise Partnerships (LEPs) is poorly aligned for enabling engagement of local employers because they lack representation from precisely those sectors which are in most need of upskilling. This represents an opportunity for LEPS to view regional development through skills provision not from a position of what high-skill employers require at present, but to what low-skill employers require to innovate and become the high-skill employers of the future.

Internationally, there are various examples of strategies that encourage business-FEC interaction for course design and skills alignment. Some noteworthy international initiatives concern a broader collaboration of private companies with FE providers, especially for the provision of current and future skills profiles as a response to the rapidly changing labour markets. For example, the German Public Employment Services has established the Berufenet, an online career advice portal that contains information about all the occupations with their corresponding skills profiles and about the new occupational profiles in demand (European Commission, 2020). Another notable example is the Katapult community in the Netherlands, a public-private venture that involves stakeholders from all interested parties (i.e., FE providers, universities, companies, governments, and research centres), collaborating for producing future-proof professionals and education (European Training Foundation, 2020). In the Estonian system, the occupational examinations are designed by specific employer groups, which have been authorized by sector skills councils to deliver occupational qualification standards and examinations (Field, 2018). The China Nonferrous Metals Industry operates an industry-wide recruitment and human resources service website that publishes information on the distribution of industry skills by level and region and on the future skills profiles and the appropriate training planning (Asian Development Bank, 2022). Another examples is Tknika, a centre of research and applied innovation in vocational education and training in the Basque Country, charged with the task of enhancing innovation within the FE Colleges of the region, by delivering new methodologies to support teachers and learners in line with regional strategic priorities and making sure that the latest educational and training developments are effectively embraced (International Centre for Technical and Vocational Education and Training, 2020). Finally, Skillman is an EU-funded transnational network with over 600 members that strives to connect industry and training providers by offering a solid

knowledge of skills needs and training practices through a well-organised systemic and sector-related information system (European Training Foundation, 2020).

Links between Further Education Colleges and employers appear stronger for short courses to full time employees. Since their inception, FECs have arranged training courses for employers on a 'full-cost' basis. Examples include management training and health and safety courses. (Bailey & Unwin, 2014), although these provide a very small proportion of FEC revenue. Similarly, a minority of employers used FE colleges as an external training provider (Berry *et al.*, 2014) in part due to the bureaucracy involved (Office for Standards in Education, Children's Services and Skills (Ofsted, 2015). This represents an opportunity for the UK Further Education sector.

With regard to innovation, employers in some sectors have expressed a desire to see more generic and flexible skills in their staff and would embrace integration with colleges through work placements (Jack *et al.,* 2014). However, evidence on the evolution of work placement requirements in courses, the quality and impact of those experiences, and their adoption by FECs in different parts of the country remains sparse. More commonly, work experience can be gained through apprenticeships.

3.2 Apprenticeships

Apprenticeships in the UK were first documented in the mid-1500s (Lee, 2012), developing from the learning of traditional trades to now include a wide range of modern skills such as IT, retail and customer service (Doel, 2011). Apprenticeships have been linked to the Further Education sector since the 19th century (Huddleston, 1998). In the post war period, students in FE colleges were typically locally employed and sent to the college on a day-release basis (Huddleston & Unwin, 1997). Good apprenticeships "offered a sheltered and extended period in which the young person was able to grow up and become job-ready" (Vickerstaff, 2007 p. 331). Apprenticeships differ from internships and work placements in that they are offered to full-time employees, while internships are often limited term and without formal training attached to them. In contrast, work placements are very short term (HopInto, 2022). The stated purpose of apprenticeships is to improve productivity by driving up skills levels and maximising national competitiveness (QAA, 2019). The advantage of apprenticeships over student courses is that they are expected to deepen collaboration between the Further Education sector and industry, which is better placed to determine skill requirements (Gospel, 1998). However, apprenticeships do not always lead to improved collaboration between the education sector and industry, and when this happens, apprentices can be sidelined from activities that would enhance innovation within their employers (Hernández-Lara *et al.*, 2019).

Perhaps as a result of the potential benefits of apprenticeships as well as the potential pitfalls, the last three decades have seen frequent reforms to apprenticeships in the UK (Hughes & Saieva, 2020). In 1994 the Government introduced the 'Modern apprenticeship' scheme as a "crucial method to deliver intermediate skills" (Leitch, 2006, p. 21). Key skills envisaged for this scheme included "IT, communication, numeracy, working with others, improving own learning and performance and problem solving" (Payne, 2002, p. 263) although these were poorly integrated into programmes (Kodz *et al.*, 2000; Winterbotham *et al.*, 2000; TSC, 2000) and shrank to include just communication and numeracy (Payne, 2002). Modern apprenticeships were also plagued with low completion rates (Payne, 2002). In 2004 'Modern apprenticeships' were rebranded as 'Advanced apprenticeships' (Mirza-Davies, 2015), and in 2010 the 'Higher Apprenticeship' was introduced. Further Education Colleges saw 'higher apprenticeships' as progression routes for apprentices at lower levels (Saraswat, 2016). The vast majority of apprenticeships are at the Advanced, rather than the Higher level (Hodgson & Spours, 2019).

In contrast to traditional education, apprenticeships are driven by employer demand (Grugulis, 2003; Hughes & Saiva, 2020) although there is variation in engagement across types of employers. Large employers are able to negotiate with FECs to develop programmes specific to their needs while smaller employers typically adapt to existing FEC programmes (Huddleston, 1998). Smaller firms often do not know how an apprenticeship might fit into their business, creating a role an FEC as 'honest broker' - "someone who can help SMEs look at their existing 'skill- and knowledge-set and help them look ahead to the future to plan how expansion and succession might work for them using apprenticeships" (Smith & Cui, 2021, p. 32). The role of both large and small employers has been further shaped by the introduction of the 'Apprenticeship levy' in 2017. Under this scheme, large organisations pay a levy which subsidises non-levy paying (smaller) organisations (Hughes & Saiva, 2020).

The emphasis on employer led training is reflected in the substantial institutional differences between UK apprenticeships and their EU counterparts in terms of educational requirements (Ryan, 2000). In the UK there were historically no requirements for education and the apprenticeship qualifications rather emphasised outcomes in terms of skills proficiency required by employers. In contrast, EU apprenticeships require part-time vocational education under day release or block release (Ryan, 2000).

As a result, the majority of apprentices receive no 'off-the-job' training (Hogarth *et al.,* 2012), although the UK has sought to make apprenticeships increasingly standards-based (Hodgson & Spours, 2019) while maintaining an employer-led approach through the Institute for Apprenticeships and Technical Education. This follows the experience of Ireland which until the 1990s closely resembled the UK apprenticeship system but moved toward standards-based training with the 1993 Apprenticeship Act (Ryan, 2000). This was done to overcome employer resistance to interference with their apprentices such as block release that may not fit employer schedules (Ryan, 2000).

Experience in the UK shows the influential role that local government can play by encouraging public commitment from local employers to the apprenticeship programmes. In London, local authorities and political figures such as the Mayor have played a strong role in raising apprenticeship numbers by increasing public sector commitment to employing 2000 apprentices (Evans & Bosch, 2012).

Figure 4 shows that the proportion of apprenticeships across sectors differs by region, reflecting the local nature of apprenticeships and their influence from the presence of local employers. The regional patterns of apprenticeships follow some of the regional patterns identified for FEC achievements. Apprenticeships are consistently most common in Health, Public Services and Care and several regions in the North East have high proportions of engineering apprenticeships. Several regions in the North West have a high proportion of Construction, Planning and the Built Environment and regions in the South East have a high proportion of Retail and Commercial Enterprise.

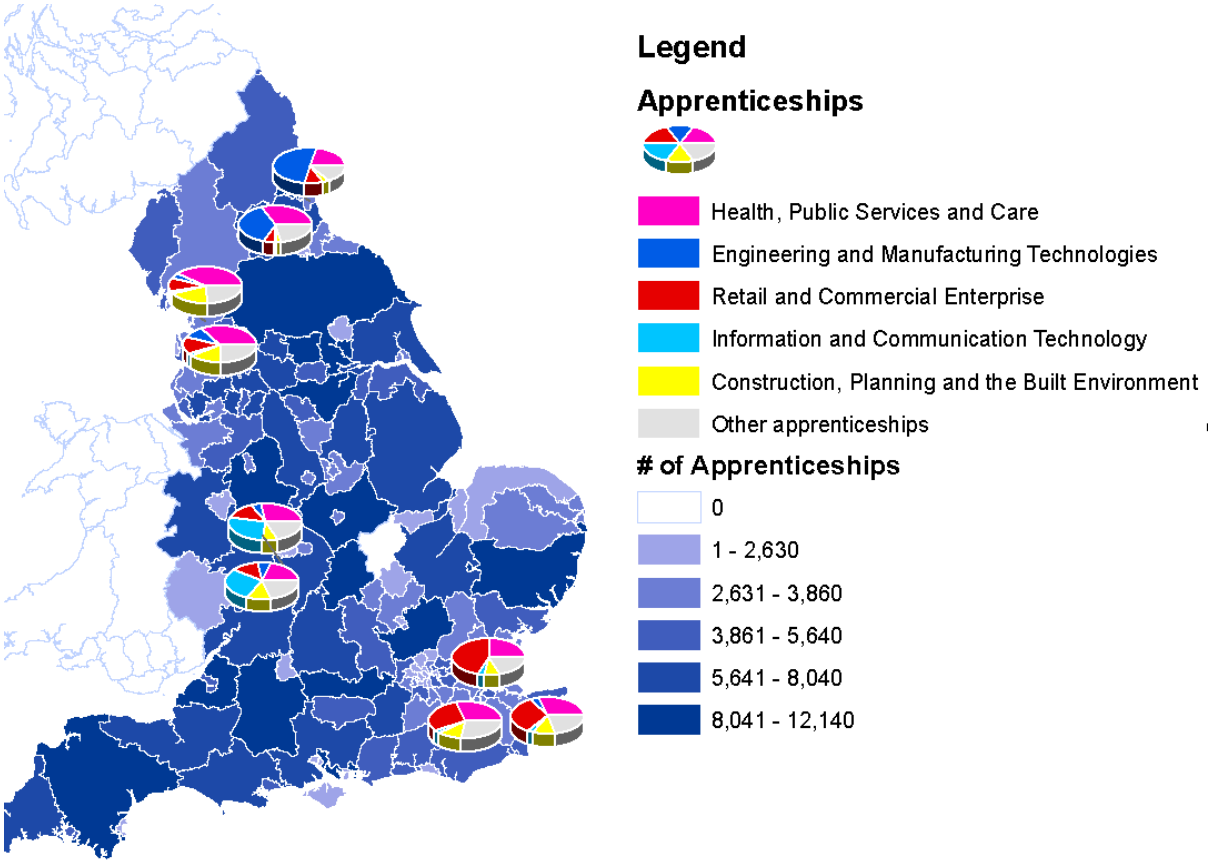


Figure 4: Selected NUTS3 breakdown of apprenticeships in England based on Further Education and Skills Data (Gov.uk, 2022)

In terms of impact, the current apprenticeship system appears to have a positive influence on social mobility and there are increasing numbers of women entering STEM occupations (Anderson, 2018). There is evidence to suggest that apprenticeships improve productivity by enhancing the skills base (Centre for Economics and Business Research, 2013). However, these benefits are only realised on completion of apprenticeships (Arad Research, 2015) and there is a very low rate of apprenticeship completion (Ryan & Unwin, 2001; Gambin & Hogarth, 2016) which represents an opportunity for regional productivity improvements. Further, there is some evidence to question the impact on skills development since many apprenticeships appear to require the very skills from recruits upfront that they claim to deliver through the apprenticeship programme (Fabian & Taylor-Smith, 2021).

Looking internationally, there is a great extent of diversification across different countries regarding the degree to which vocational education takes place in classrooms or workplaces (mostly through apprenticeships). Brunetti and Corsini (2019) categorized VET (i.e., analogous to FE in Europe) into three distinct systems based on this criterion: the school-based vocational education and training; the formal apprenticeships; and the dual vocational training systems. The first system adopts the school-based vocational education and training that offers a formal curriculum combining occupational knowledge (e.g., France, Italy and Spain). In the second system, VET is provided through formal apprenticeships complementing workplace training, with the apprenticeship to function without close links to the formal education system (e.g., UK, Australia, USA). The third one, the dual vocational training system, provides a balanced workplace learning under work contracts and classroom teaching (e.g., Austria, Denmark, Germany, Hungary, Switzerland) and is often regarded by scholars as the most successful model in providing a qualification bridge for learners in order to transition to the labour market (Brunetti & Corsini, 2019; Renold *et al.*, 2018; Rözer & van de Werfhorst, 2020).

Germany is one of the most cited examples of apprenticeship systems (well-known for its dual vocational programme) which has initiated the Perfect Match programme. This programme aims to prevent matching problems in workplace training by supporting SMEs in filling their training places with suitable learners relying on the guidance of expert advisors (Cedefop, 2020). Moreover, the dual VET programme has been promoted by international German firms in countries outside Germany. In particular, the association of Germany's SMEs in Taicang, China has encouraged the Taicang Vocational Secondary School to create dual apprentice training programmes in collaboration with the German firms (Asian Development Bank, 2022). Another interesting example from China comes from the Suzhou Industrial Park Institute of Vocational Technology, where the Suzhou Industrial Park established an intermediary agency to align the institute's training with the local industry's demands by sponsoring the institute and by participating in its curriculum development (Asian Development Bank, 2022). There is some evidence to suggest that the dual programme can be introduced to new environments through multinational companies (Tasli-Karabulut and Keizer, 2020). In Turkey, where the state requirements are minimal, a multinational company was able to use its reputation of providing German apprenticeships to develop skills for a suitable Turkish workforce through apprentices that were selected for by the local chamber of commerce and course content delivered by the MNC but regulated by Turkish law. The MNC draws in apprentices to the selection and courses by prioritising their employment on graduation, and their qualification is nationally recognised with certification through the Ministry of National Education which "not only increases their employability but also allows them to start their own business" (Tasli-Karabulut and Keizer, 2020 p.160).

3.3 Enterprise and Entrepreneurship Education

Promoting enterprise and entrepreneurial culture as a stimulus to economic growth and prosperity has been high on the agenda of many governments in the UK (Jones & Iredale, 2006; McGowan *et al.*, 2014). A key issue towards this aim is the extent of skills and capabilities related to entrepreneurship and enterprise among the people entering the workforce. Consequently, the role of the FE sector in promoting an enterprise and entrepreneurial culture is clearly important (Ofsted, 2012).

In educational terms, Enterprise and Entrepreneurship Education takes place not only in the FE sector, but also the HE sector and the schools (All Party Parliamentary Group for Micro Businesses, 2014; Gibb, 2008). Enterprise education has been defined as "the process of equipping students (or graduates) with an enhanced capacity to generate ideas and the skills to make them happen while entrepreneurship education can be seen as equipping students with, the additional knowledge, attributes and capabilities required to apply these abilities in the context of setting up a new venture or business" (McGowan *et al.*, 2014, p.2).

Enterprise and Entrepreneurship Education aims to produce individuals with developed enterprising capability (e.g., cope with uncertainty, respond to change, identify opportunities, undertake risk/ reward assessments, set up a new venture, develop and grow an existing business), financial literacy (e.g., knowledge of money, credit and investment, skills relating to budgeting, financial planning and personal risk management and attitude development focused upon taking responsibility for financial decisions), and economics and business understanding (e.g., knowledge of economic concepts of markets, company efficiencies, prices and growth, skills related to decision making and economic judgment, scarcity of resources) (Gibb, 2008; Williamson *et al.*, 2013).

A 2013 report from BEIS on the impact of enterprise and entrepreneurship education in the FE sector showed that 74% of FE colleges offered formal courses that were a constituent part of a qualification

(e.g., formal full qualifications, credit-bearing units), 31% offered non-formal provision (e.g., student enterprise clubs and societies, business competitions, and enterprise, advice, and mentoring events), and 13% did not offer any enterprise and entrepreneurship education provision (Williamson *et al.*, 2013).

Concerning the regional distribution of FECs offering enterprise and entrepreneurship education, in the South West, South East, and North East, FECs provide the more official courses while the highest proportions of those providing non-formal enterprise education are in the North East, South West, and London (Williamson *et al.*, 2013). As expected for this particular knowledge field, the engagement of the business community appears to be very important (All Party Parliamentary Group for Micro Businesses, 2014). This involvement can be manifested either through the formal courses (e.g., visits to employers, guest speakers) or through the non-formal education (sponsorship and participation in business competitions, enterprise events, workshops, and enterprise societies) (Williamson *et al.*, 2013).

Moreover, some important cooperative initiatives have taken place in the FE sector aiming at further promoting enterprise and entrepreneurship education. One of the most characteristic examples was the Gazelle Colleges Group, a federation of 20 FECs formed in 2012 aiming at promoting the entrepreneurship agenda in FECs by developing innovative new learning models and new partnerships with businesses. Another noteworthy major systematic initiative concerns the Enterprise Education in FE Initiative, a cooperation between the Association of Colleges and the Manchester Metropolitan University, funded by three Regional Development Agencies, targeted at introducing enterprise education in 32 colleges in the North East, Yorkshire and the Humber, and the North West (All Party Parliamentary Group for Micro Businesses, 2014). Other examples include the National Association of College and University Entrepreneurs (NACUE), which was funded by the BIS to promote the establishment of enterprise societies within the FE and HE sectors and the Thinc, an initiative developed within Yale College, Wrexham to support and promote entrepreneurship within the creative industries (Welsh Government, 2012). Finally, a report by Ofsted (2012) presented a land-based college's approach to enterprise education, according to which commercially-run college departments provided facilities and services for external clients and the wider community, including private enterprises. It is worth mentioning that the managers of these facilities were not teaching staff but commercial managers.

The non-formal provision of enterprise and entrepreneurship education within the FE sector happens in different ways and at different scales internationally. For example, the National Centre for TVET Development in Romania has used simulation techniques in order to help learners to acquire entrepreneurship skills by asking them to create and run a virtual company with all the necessary staff and activities (European Commission, 2020). In the same vein but stemming from and organized by the college itself, the Malta College of Arts, Science and Technology has established an Entrepreneurship and Entrepreneurial Learning programme in which the learners are taught how to start and operate successful innovative businesses while the teachers are encouraged to conduct research in the entrepreneurial learning pedagogy (International Centre for Technical and Vocational Education and Training, 2020). The business incubator at Riga State Technical School in Latvia brings together students, educators, alumni, employers, researchers, and professionals from other educational institutions and universities, and aims to promote an innovative, entrepreneurial and creative business environment. Another interesting initiative comes from the VIA University College in Denmark, which has integrated entrepreneurship in all its educational programmes, offering in

parallel extra training in entrepreneurship for the teaching staff while establishing student entrepreneurship centres on its campuses (European Commission, 2020). Finally, Innoventer is an Interreg-funded project which aims to promote vocationally oriented social entrepreneurship training for SMEs so that they can be more innovative while, at the same time, employing disadvantaged people.

4. The intersection of skills and FEC roles in the innovation ecosystem

The previous section reviewed the various pathways through which FECs provide skills to the innovation ecosystem. The crux here is that in order to be effective, all of those pathways must be supported by observation of, interaction with, and participation in the broader ecosystem. Even core functions such as determining which courses to offer and designing their curriculums, the foundations of FECs' competitiveness, must be done with an understanding of the labour markets that their graduates hope to enter. More activist programmes, such as apprenticeship and training offerings definitionally require private sector partners. Consequently, cultivating networks that provide market insights and feedback and recruiting and retaining private sector hosts and partners is a vital element of FEC success in skill delivery.

Innovation ecosystems are a conceptual framework which identifies opportunities for additional ways in which FECs can interact with their environment to support innovation: through pooled infrastructure, business support programming, R&D and technology transfer, and local leadership.[5] While these functions are sometimes considered as separate from the "core" mission of skills provision, they are often very closely intertwined and synergistic. Properly executed, each of these "additional" innovation ecosystem functions can support and help refine teaching and training offerings by providing greater access to employers, feedback about emerging skills requirements and opportunities, and more extensive training grounds and testbeds for learners. Local firms and governance organisations also typically benefit from this kind of engagement. This section summarises each of these roles and details the synergistic relationship between skills missions and ecosystem engagement.

It is important to note that there is considerable variation in which mechanisms FECs have engaged with; the degree to which they have embraced these functions and their success in those experiences; as well as their capacities to initiate, sustain, or grow these forms of engagement. Some have noted that the sector as a whole lacks a common culture and that, as a result, despite some examples of interesting engagement, appetite for innovation overall is relatively low (Hadawi & Crabb, 2018). The second phase of this research concentrates on establishing when and how FECs have taken on these more explicit innovation roles, the calculus involved in designing those engagements, and barriers and challenges that may be constraining their effectiveness. For the purposes of this report, we treat these functions as an opportunity set that may be available to FECs more broadly. The following section raises the question of how these are linked to organisational innovation within FECs. We conclude with a proposed framework to distinguish between FECs in different contexts that may help shape hypotheses about what kinds of strategies may be most prevalent in different ecosystems and about opportunities for ecosystem engagement.

[5] This list is adapted from Baxter (2020) and Vorley *et al.* (2021)

4.1.1 Pooled equipment/infrastructure provision

In innovation ecosystems, FECs can host specialised equipment and facilities that enable innovation and development (Department for Education, 2021). This may be as simple as land or building space but can also extend to facilities like labs, production facilities, air gapped computing centres, servers, or specialised product testing facilities. FECs with specialised programmes often require, and acquire, equipment or facilities to support instructional activities. When not in use, these assets can be leveraged to enhance the innovative capabilities of local firms. These infrastructural assets can be useful in attracting business partners, who may then be willing to extend their relationships with the FEC to setting up apprenticeships, providing workstudy experience, or encouraging them to invest in shared equipment and develop training programmes.

Specialised infrastructure has obvious advantages for teaching and learning in addition to being assets for local firms in their innovation processes. Students get access to the technologies or facilities that local firms are also using, giving them an immediate experiential advantage in the local job market. For example, the Dudley Advanced II Centre for Advanced Building Technologies at Dudley College provides a modern method of construction training. The college allowed a local construction firm to use its hangar space to develop and test a new type of flooring. Students were involved in some of the testing, gaining experience in the experimental phases of R&D as well as broader exposure with working in the industry. Sometimes firms are the catalysts, leasing or gifting specialised equipment to FECs to enhance their skills pipelines. ABB, a technology firm, partnered with South Devon College, providing equipment and investment for their Hi Tech & Digital Centre (South Devon College, 2019). A dedicated digital classroom equipped with ABB motor and drive, programmable logic controller (PLC) and human-machine interface (HMI) gives students hands-on experience of some of the latest automation and control technologies and an insight into how they are helping enterprises realise the power and efficiencies of today's digital transformation. While this arrangement benefits ABB and its innovation processes, it also trains students to use these technologies in other firms, enhances the attractiveness of the college's offering, and enables the college to run training programmes.

Interestingly, some sources have noted that the infrastructure sharing relationship can go in both directions: colleges borrowing access to machinery and equipment located in firms for training purposes have also been documented (Eneka *et al.,* 2019). In this case, knowledge diffusion and process innovation may occur in parallel as FECs gain applied insights from interacting with the equipment and the principals in the firm charged with running and maintaining it and transmit those through course work and other partnerships.

4.1.2 Business support and incubation/accelerator services

FECs can provide all sorts of supportive services and facilities (Department for Education, 2021) and through these offers can have direct and significant impacts on innovation ecosystems as well as benefits for skills development and transfer. These include physical hubs such as business innovation centres, accelerators, enterprise zones, and business parks (Luke, 2013; Baxter, 2020). Other services they can provide are assistance with product and process development, market and feasibility assessments, mapping and strategy around education and technology needs, loan of equipment, data sharing, mentoring and reverse mentoring, and technological expertise (Madgett *et al.*, 2005). Providing business support was an increasing priority for FECs even before the Department for Education announced funding for the creation of College Business Centres (CBCs) to enhance links with employers and facilitate collaboration to meet local business needs. An AOC survey found that 83% of colleges felt that supporting SMEs was a high priority for economic impact and 42% felt they

should play a role in supporting business innovation more generally (Association of Colleges, 2020, p. 18).

Some business support structures can be highly attuned to a specialised to the local economy: Myerscough College hosts the Rural Business Centre (RBC) designed to provide incubator and start-up support to small rural-focussed businesses. The facility provides low-cost office rent and space for businesses to develop (Baxter, 2020). It also allows access to other support networks through a range of business networking opportunities. Other support services are much more generic and bare bones. A business incubator located in a college in Wales was described as a hotdesking service, which provides businesses with a place to work, loans of equipment, and covers some of their utility costs (Voisey et al., 2005).

Again, other than revenue generation, one of the principal benefits of this kind of business engagement is the potential to expand the range of partners available to contribute to other FEC activities. A business that is successfully incubated in an FEC facility might ultimately turn into a benefactor, a client (for training services or specialised facilities), or a partner willing to provide internships, work placements, or apprenticeships. Business consulting opportunities can provide students in management or administration with experience in advising, research, and organisational analysis. Instructors can use those firms as case studies, enabling students access to production processes or management in ways that might not otherwise be possible. In short, adopting a business service function can influence skills development within FECs in a myriad of ways, with potentially broad effects on the innovation ecosystem.

While the support that FECs can offer to their business communities are quite varied and many FECs have these capabilities, not all of them advertise or bundle them in accessible ways or are able to fully leverage benefits. Aside from established and resourced programmes such as innovation centres, ad hoc arrangements tend to dominate. In some cases, FECs have dedicated business offices to serve as portals and brokers for interested businesses. Only 52% of FECs in an AOC survey reported having dedicated account managers to work with businesses on knowledge transfer and information dissemination, half had an office focused on delivering technical support to an industry, and only 28% offered specific services related to business planning (Association of Colleges, 2020, p. 7). Even with dedicated staff, FECs build these relationships through involvement in forums like employment boards where specific solutions can be discussed rather than firms coming to them independently for services. Things like technical expertise might be accessed on a one-to-one basis, through specific relationships, rather than being widely known among the local business community or even available at sufficient scale to impact innovation in the ecosystem.

4.1.3 R&D, knowledge, and technology transfer

Universities are often privileged as centres of knowledge creation, overlooking the wider range of organisations engaged in research and knowledge creation, including FECs (Elliott, 1996). However, colleges can be well suited to solving technical, process and social problems in a community or industry (The New Engineering Foundation, 2008), as well as adding value through their knowledge reproduction and diffusion roles.

FECs are engaged in knowledge generation, formal exchange through partnerships, and established partnerships to different degrees (Harwood & Harwood, 2004). Similarly, this practice varies across departments and can be more developed where places have particular technological or industrial specialisations. One report observed that much of the knowledge and technology transfer that does occur is ad hoc and opportunistic (Kitson & Hughes, 2009). Partly this is because FECs do not often have deep rosters of research active faculty, access to public funding for projects and research centres,

or research specialties that help to raise their profile with potential partners in joint ventures and commercialisation. Some of the most successful examples come from highly specialised programmes. Bishop Burton College in Yorkshire, for example, has worked extensively with an agronomy firm on a variety of applied projects. Notably, these partnerships emerged in part because of the college's unique facilities - including land for crop experimentation and a digital farm - as well as its links with the satellite applications industry.

In some cases this will also take the form of supporting non-technical innovations related to business management and operations. A college based in the North West of England has developed an approach to working with businesses centred around defining and solving problems. In this instance, college staff engaged in the co-creation of programmes, rather than research projects or technical solutions, to meet employers' needs in terms of skills planning, networking and coaching. This includes working with businesses to overcome supply chain challenges and supporting businesses with flexible working during COVID. The need to enhance project management skills in the sector is an important prerequisite to realising wider innovation opportunities.

For most FECs, however, it is less easy to identify research strengths (for knowledge transfer and commercialisation) or attract potential partners for contract or collaborative research. There are several ways in which colleges could address the challenges of engagement, including having a formal process in engaging partner businesses, having employer boards from which they receive regular, relevant information and feedback or running employer days where businesses are invited to contribute to discussions on what is relevant and important to them. Ultimately, FECs looking to position themselves as knowledge transfer partners often struggle making their research and innovation capabilities broadly known and many relationships that develop do so because of previous connections, specific public initiatives, and/or luck.

In either case, FECs have much to gain through research partnerships and commercialisation opportunities, not least of which is, if properly leveraged, the exposure that students have to applied research and knock on effects for local skills.

In light of these, and other, challenges, some argue that FECs should "eschew research" and focus on stimulating "the timely take up, modification, and marketing of knowledge solutions that already exist but need to be adapted to local environments" (Gibbons, 2004, p. 97). In other words, FECs should concentrate on their capacity to affect absorptive capacity. Here is another place where skills and innovation intersect. The knowledge embodied in learners is also crucial to adoption and diffusion. Toner and Woolley (2016, p. 322) note that "the capacity of firms, government agencies and other organizations to absorb, adapt and use these innovations will always depend to some extent on the technical competences of the internal workforce", which is partly dependent on the FEC sector. Some of the literature refers to technical workers as "change agents'' in organizational innovation. Change agents are "key individuals who proactively create, experiment with, validate, and influence the development and implementation of new organizational practices, processes, and structures" (Rupietta *et al.,* 2021, p. 2). These agents combine external knowledge, acquired in FECs with tacit knowledge from job experience to drive innovation.

However knowledge transfer happens - whether directly through R&D, joint ventures, or other forms of business engagement, or indirectly through embodied knowledge - the process has benefits not only to the broader innovation ecosystem but creates positive feedback for the institutions themselves by multiplying networks, access, and opportunities for student exposure to industry. The boundary between knowledge transfer, skills development and application, and business support is

blurry, which speaks to the importance of thinking of mechanisms of ecosystem engagement as part and parcel of the core mission rather than as separate from it.

4.1.4 Local anchor, leadership, and networking

HEIs and FECs are often described as anchor institutions (Smallbone & Kitching, 2018; McCauley-Smith *et al.,* 2022) - organisations that make some strategic contribution to a local or regional economy that is likely to be a secondary aim rather than the main focus. As owners of real estate and (sometimes) land and (usually) large employers, FECs have a strong interest in local economic policy and development strategies and can both identify and contribute to development opportunities (UCL Institute of Education, 2017; Porter, 2007; Kitson & Hughes, 2009; Kitson *et al.,* 2009). Others note that colleges can function as leaders and make a strategic impact by taking a broader view and working with localities to understand labour pool and industrial projections and skill demand trends (as these are both central to their business model and relevant to regional development trajectories). The UCL Institute of Education report also notes that they can proactively engage with business to learn about needs and gaps as well as encourage them to invest in the skills of their workforce (UCL Institute of Education, 2017). This is consistent with Keep's (2014) view that there is a 'bottom up' role for colleges in supporting workplace innovation through college/industry links (in contrast to HEIs' more top-down approach through knowledge exchange).

In this description, leadership is conceptualised along two axes. First, leadership in identifying and developing businesses can be a proactive mission. In this instance, the FEC has a vision of the innovation ecosystem and its potential and uses its resources to engage with and educate firms about how its offerings can be transformative to mutual benefit. In this view, FECs function as civic anchors in their locality through the creation of 'sticky capital'. However, Culkin notes that for this role to be effective requires firms to recognise, and make use of, the expertise present in colleges (Culkin, 2016). Engagement with regional development happens through a variety of mechanisms internationally. For example, the Regional Coordination Authority of the Västra Götaland region of Sweden offers information on current and future skills demand in the region in collaboration with the region's FE providers, employers, and government agencies, as a complement to vocational education. Secondly, in the same region, the Gothenburg Technical College runs the Smart Factories project, through which regional smart specialization ideas and strategies are communicated among the companies, academia, organizations, and schools of this region (European Training Foundation, 2020).

In a second instance, the FEC may be less targeted. Instead, thinking about how the ecosystem as a whole might grow and either assembling or joining coalitions that are involved in that collective visioning processes. As highlighted elsewhere, FECs exhibit very different levels of maturity in business development units and their capacities, their engagement with and interpretation of market intelligence, and in professional cultures within relevant offices that align with and understand business constraints and needs. In other cases, FECs might make a contribution not directly as leaders but as participants in governance networks focused on the collective growth of businesses and local profile. Either way, collaboration and networking are thought to be vital for FEC impact and skills delivery. The UK FE and Skills seminars noted the importance of "colleges collaborating more actively with a range of other local and regional partners, such as local authorities, universities, schools, independent training providers, voluntary and community organisations, to improve opportunities for learning, working and living" (Hodgson *et al.,* 2019a, p. 285). These can contribute to building 'high progression and skills networks', which benefit from greater collaboration and a reduction in unhelpful competition between providers that broader civic engagement and leadership can bring (Hodgson & Spours, 2019).

There are a number of FECs that are engaged with the LEPs to identify needs in the areas of skills and business development, which feed into LEP strategies. This has been particularly effective where FECs are able to use these insights to develop courses and shape curriculum as part of a collective vision. This demonstrates how FECs both have and can contribute to supporting businesses more directly, and benefit from co-creating an offer that aligns with the priorities of the broader ecosystem. The example in Box 2 is another way that FECs can demonstrate leadership that supports both the ecosystem and internal agendas. By convening business in an area experiencing skills shortages within the centre, Fareham College helped to solve a pressing problem affecting the ecosystem and created the conditions for deeper knowledge exchange and networking in a competitive industry. Where effective this convening role can support in the diffusion and adoption of innovation to firms, as well as developing the absorptive capacity to innovate.

Box 2: Building an Innovation Ecosystem around an FEC

Fareham Innovation Centre, owned by the Fareham Borough Council, provides "bespoke workspace and business support for growing companies in the marine, aerospace and engineering sectors" (Fareham Innovation Centre, 2022a). It is co-located with Fareham College's Centre of Excellence in Manufacturing and Advanced Skills Training (CEMAST), with all their apprentices working at the centre. CEMAST houses a range of facilities from classrooms to a full-size Westland Wasp Helicopter (CEMAST, 2022), providing the pooled infrastructure required for both training and companies.

In addition to CEMAST partnerships with large employers such as General Electric and BAE Systems who co-design courses (Baxter, 2020), and other large employers who provide students with a pathway to employment (e.g., the Royal Navy careers partnership (FE News, 2018)), the Innovation Centre hosts companies who link to Fareham College students by providing project briefs as part of their qualifications (Baxter, 2020). These companies include a diverse range of support service companies such as web design, digital marketing, business consultancy, accountancy and recruitment (Fareham Innovation Centre, 2022b). It has further links to angel investment coaching, which is in turn linked to Oxford University's technology transfer arm (Oxford Innovation Finance, 2022) and the associated fund has invested in 9 companies in 2021.

Further, the centre hosts networking events to coordinate the supply and demand of skills in the area (Yahoo News, 2022), which is facilitated by the Solent Local Enterprise Partnership, and includes a College apprentice presentation on an opportunity to describe their motivations and experiences. Links beyond the local area are achieved through the manager of the centre, Oxford Innovation, which manages more than 25 centres throughout the UK and supports over 1,000 companies at these spaces.

This section described the major mechanisms through which FECs can impact innovation ecosystems. The overarching message here is that while we tend to think of these functions as extracurricular they are, ideally, not. Rather, each type of ecosystem interaction serves to build connections and networks that can, in turn, benefit skills development within FECs, as well as the attractiveness of their offerings, revenue, and broader impact. While focusing on slightly different observations, Hodgson *et al.* (2019a) reinforce this view in their reflections on the UK Further Education and Skills Inquiry where they posited the value of seeing various FE functions as linked. In contrast to the highly marketised system in place in England and the more highly regulated Germanic example, it might be appropriate to conceptualise FE as a more socialised and co-ordinated space. This space might have the potential for greater collaboration between social partners; a comprehensive spatial focus on an area; and the

contribution of a diversity of actors to constructing what has been referred to elsewhere as a social ecosystem or innovation ecosystem that provides a ladder for learners and includes partnership with employers to co-design technical and vocational programmes and to encourage innovative working practices in the pursuit of inclusive economic development (Hodgson & Spours, 2018). As such, even though pursuing innovation impact entails some tradeoffs, these are not necessarily to quality of education and training offering or their core skills provision mission.

It is worth reiterating that not all FECs have embraced these functions. If they do, they have not engaged with all of them equally, nor are they necessarily successful when they do. This raises some important questions relative to the policy goal of increasing the innovation impact of FECs in their local economies. First, what impacts do we want FECs to have and which mechanisms are most effective at optimising those? It is not a given that all FECs should do all types of engagement - either because of the ecosystems within which they operate or their own strengths and capacities. Secondly, why are some FECs more successful than others at engaging with their innovation ecosystems? Understanding this can help design interventions to support and empower FECs to increase their local and regional impacts. An empirical exploration of these questions is the focus of Phase 2 of this research. However, in this phase we propose two potential explanations for differential FEC success and engagement patterns: the propensity of FECs themselves to be innovative and the contexts within which they are embedded.

4.2 Innovation in FECs

It stands to reason that the likelihood that FECs will adopt strategies and practices that will contribute to the development of the innovation ecosystem will hinge, at least in part, on its capacity as an organisation to be innovative. This involves developing internal cultures of innovation with the aim of fostering an environment and set of practices that continually introduces new ideas or ways of thinking, then translates them into action to solve specific problems or seize new opportunities (The New Engineering Foundation, 2008).

Literature on innovation in colleges, however, is relatively thin. While there is notable work on innovation in pedagogical practices (Armstrong, 2019; Ryan *et al.,* 2020; Zhuravlova *et al.,* 2021) - e.g., adopting digital technologies, etc. - less research has been produced on organisational change, risk taking, and entrepreneurship.

What does exist is somewhat critical about the FE sector's track record for innovation despite noting that it has the potential to do more. One article argues that the sector is, in fact, "highly innovative and entrepreneurial" (Keep, 2016, p. 42), particularly in its capacity to adapt to student preferences. However, they are less adept at crafting their own innovative visions and priorities as organisations and in implementing these. FECs are described in the literature as "reactive" rather than proactive in their own evolution (Hodgson *et al.,* 2015; Hodgson *et al.,* 2019a). Partly this is because FEC Principals, their senior management teams, and governors feel that innovation and, particularly external engagement, is beyond their core learning and skills role (Gibney *et al.,* 2009) and so have been resistant to organisational entrepreneurialism. Sector leaders and stakeholders have also complained of a lack of continuity, clear expectations, and appropriate support structures in the policy landscape for FECs and skills. The Skills Report notes that leaders within the sector have few opportunities to engage in thought leadership, innovation, and to share lessons with peers (Skills Commission, 2016). Interestingly, these (and other) narratives tend to prioritise external barriers to broader innovation engagement (e.g., confusing government policies, lack of business interest, lack of support, too many mandates, etc.) as potential areas for policy intervention on the assumption that doing so would

liberate FECs to deploy their scarce resources differently to the mutual benefit of their institution and region. However, the problem of internal capacity - willingness to change, devote attention and resources to increasing engagement, to take risks, and develop their own organisational skills as brokers, anchors, and leaders, is also highly linked to the organisations' entrepreneurial institutions, cultures, and leadership.

Again, while a literature is emerging around how FECs can contribute to innovation and regional development (and barriers to impact), the question of FEC openness to the types of organisational innovations that might support such activities remains underexplored. A recent report identified seven factors (and subfactors) that influence organisational innovation in FECs (Sester & Morris, 2015):

- Leadership (vision, purpose, permission, routine, urgency, trade-offs, humility)
- Communication (clarity, framing, champion, engagement, transparency, frequency)
- Resource allocation (team, time, funding)
- Structure and process (light structures, reinforcing process, habit)
- Capacity (mindset, knowledge and skills, ability to execute, support)
- Policy environment (orientation, leverage enablers and remove barriers, aligned incentives)
- Learning agenda (testable hypotheses, rapid prototyping, measuring progress, managing change)

However, this framework was created as a self-assessment tool and does not test the explanatory power of these factors or provide a pathway for how they could be improved.

In short, there is currently a gap in our understanding of the role of internal approaches to innovation that, once explored, may partially help explain observed patterns of engagement, approaches to skills provision, and contribute to policy development around FEC roles in innovation systems.

4.3 Rethinking FECs and innovation: A conceptual framework

Literature on FEC skills delivery and participation in innovation ecosystems tends to treat them as a homogenous group. While each country typically has some way to differentiate FECs internally, these are usually on the basis of historical categorisations, often tied to previous policy waves and funding streams. While these categories can be indicative, they are sometimes used inconsistently (in policy and academic literature) and they often don't accurately capture variation in what those colleges actually do. For instance, in the UK, land based colleges tend to specialise in agricultural and extractive industries, but also provide a variety of other types of courses. General and Further Education Colleges can offer highly specialised courses alongside base course offerings, or might not have any specialisation at all. Furthermore, none of these categories provides insight as to whether an FEC is likely to be research active, what types of skills provision it might offer, or about the degree and nature of engagement with its innovation ecosystem. In sum, FECs, as a group, are not homogenous and should not be treated as such in innovation research or policy. Nor are existing categorisations adequate to distinguish FEC roles or develop hypotheses.

In view of this project's goal to understand alignment between local and regional demand and FECs' roles in skills pipelines, it might be useful to consider what broad factors might feed differentiation and how these might also suggest different opportunities and engagement strategies. Our model (Figure 4) proposes a loose classification of FECs based on the characteristics of their innovation ecosystem. The argument here is that if FECs do (or should) respond to demand cues from the economies within which they are embedded then understanding these contexts can give us clues as to how they might behave and which strategies may be most viable. We describe this classification as

"loose" as, at this point, it is largely conceptual and not yet rigorously operationalised. We conceptualise innovation ecosystem context across two dimensions: HEI/FEC density and ecosystem specialisation.

Given that FECs tend to draw their students from a relatively small area[6] the degree to which they face competition will shape their strategies around skills provision and local engagement. Note that we consider the density of *both* HEIs and FECs. While FECs are not direct competitors with HEIs on skills development, the presence or absence of HEIs (and their characteristics) may affect FEC strategies with respect to engaging employers as well as roles within innovation networks.

In places with low HEI/FEC density, it is likely that they will have more flexibility in the courses that they offer, curriculum design, and the roles that they see themselves playing in the innovation ecosystem. Where they are the "only game in town" from a skills provision perspective they are, for example, possibly more likely to be leaders (and be seen as leaders) in innovation governance networks and to have close partnerships with the private sector (Toner & Woolley, 2016). Where there are numerous other HE and/or FE providers in the area, roles and opportunities might be more limited. In such cases, FECs may choose to pursue strategies to differentiate themselves from other local competitors, which may affect the courses that they offer and how they market themselves to learners. In this environment, some FECs may specialise in different niches on the spectrum of FE skills provision - focusing on specific themes/industries, or types of skills/qualifications. Some may opt to remain relatively general and compete on the basis of cost, location, reputation, or other factors. In a denser context, FECs are less likely to function as leaders - a role that is more likely to fall to larger research-active universities - although they may be viewed as valuable participants in and contributors to governance networks.

A second dimension reflects the degree to which the innovation ecosystem has defined specialisms. Here the logic is that where a local economy is more highly specialised - where a few core industries dominate, or where there are industries present that are not found in other areas of the country - FECs may be more likely to also have specialised departments, courses, and training offerings related to those specialisations. When there are dominant industries, particularly if they are significant employers, FECs may be more entrepreneurial in seeking out partnerships and synergies. Our findings about spatial variation in patterns of achievements and apprenticeships suggests that some sort of local cues may be influencing student choices and FEC offerings.

As Figure 5 shows, we argue that the interplay between these two factors can help theorise the skills profile and nature of engagement with the innovation ecosystem. Again, at this point, this should be considered a loose classification as the boundaries between low and high density, and low and high specialisation are not clearly defined. But the framework does serve to illustrate how different contexts can affect strategies.

For instance, where HEI/FEC density is low and specialisation is low, we might expect FECs to function as a Regional Anchor. In this conceptualisation, they may fulfill many of the core functions of an anchor institution in terms of leadership and engagement with local economic development. However, given low levels of specialisation, their skills profiles are likely to be relatively general to serve the broad needs of the economy. Where HEI/FEC density is low but specialisation is high the FECs are more likely to forge alliances with the leading industries and work closely with them to develop workforce

[6] The average distance from student home postcodes to learning location for undergraduates was 15 miles for FECs compared with 54 miles for universities (Association of Colleges, 2021)

strategies and specialised course offerings. In both of these cases we anticipate that FECs will be more likely to take the lead and be active in their ecosystems.

When FEC/HEI density is high, FECs are likely to face both competition from peer FECs and to be in an ecosystem in which other educational organisations, such as research active HEIs, play a leadership role. In these contexts, FECs can still play engaged and important roles in innovation ecosystems and governance networks as participants and partners. But they may be more likely than in other contexts to only have minimal participation, particularly where HEIs are dominant or exclusionary or where a large number of FECs create a highly competitive environment. Economic specialisation will also likely affect their engagement strategies. In high specialisation contexts, FECs may again be more likely to pitch their course offerings to feed those industries. Where there are multiple FECs, there may be a division of labour where some adopt a more specialised strategy whilst others function as more generalised skills providers. Where economic specialisation is low, FECs are more likely to compete on other factors and opt to provide a more general menu of technical skills.

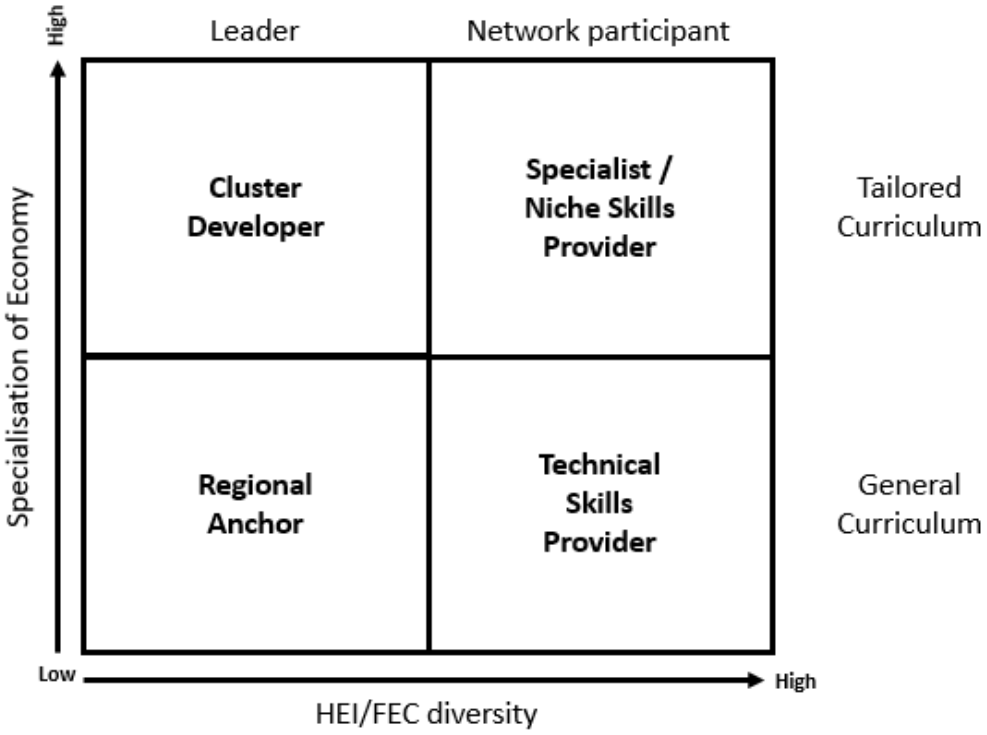


Figure 5: Model of FEC roles within the innovation ecosystem

These categories are indicative of the kinds of strategies that are likely to be successful and should be encouraged in each context. Where FECs might be potential Cluster Developers or Regional Anchors, policies might seek to support that leadership potential to coordinate cluster strategies (in the former) or local development coalitions (in the latter). Where FECs might have the potential to function as Specialised/Niche Skills Providers, they should be encouraged to seek partnerships with local HEIs and other FECs to coordinate their roles to refine their skills contribution to fill important gaps and to participate in cluster governance networks where appropriate. Technical Skills Providers should also be encouraged to participate in local networks and coordinate with their peers to either develop individual specialisms or to create shared infrastructure to manage partnerships with the private sector, administer work placements and infrastructure, and to advocate for FEC interests in broader

networks. Box 3 provides some examples of FECs that may play each kind of role in their respective ecosystems.

The overarching point, however, is that FECs are not all alike, and the environments within which they operate in part condition their strategies and opportunities for development. Consequently, there may be limited utility in research, policy, and practice treating them as a homogenous bloc - especially in relation to innovation ecosystem engagement and potential.

Box 3: Examples of FEC roles in the ecosystem

Located in the South West of England, Falmouth Marine School, as part of the Cornwall College Group, is specialised to support the Cornwall Marine Cluster. The link between ***Cluster Development*** and the school is epitomised by the dual employment of the head of Campus who is also the Marine Cluster Innovation Manager.	Capel Manor Lodge is a Land based College situated on a 30 acre campus. It functions as a ***Specialised Skills Provider*** in environmental learning in the diverse South London region. By specialising, it engages with the local community to provide unique services such as visitor gardens.
Herefordshire & Ludlow College based in Hereford provides a diverse range of courses from A levels to Foundation Degrees in a variety of subject areas through a network of smaller colleges. This area has few other FECs and no major universities, and so Herefordshire & Ludlow College may function as a ***Regional Anchor*** for the north of Herefordshire and the south of Shropshire.	Richmond and Hillcroft Adult Community College began as a ***Technical*** institute because there was limited secondary education in the region. Today it is situated in a highly diverse West London, equidistant from three universities (St. Mary's, Roehampton, West London) and several other colleges. Shortlisted for an award as the adult community learning provider of the year in 2021, it has achieved excellence by adapting to offer a more ***General Skills Provider*** curriculum.

5. Conclusion

This report reviewed the literature on FECs and their contribution to skills in innovation ecosystems. We focused particularly on the FEC experience in the UK, bringing in international examples where possible to provide contrast and insights into best practices. What we discovered was that the literature on this topic is far from consolidated and that evidence, even when searching globally, was relatively fragmented. The study of Further Education in general is complicated by different nomenclature and national policy frameworks that make international comparison difficult. And while there is a fair amount of empirical work out there, it is often based on small numbers of cases or out of date. In sum, the evidence base was thinner than we hoped to find. This has both advantages and disadvantages. While the thinness of the academic literature complicates the compilation of a solid evidence base, it also affirms the need for more empirical research on FECs and innovation, in the UK and internationally. However, as the research agenda progresses it is perhaps useful to ask some hard critical questions in addition to gathering evidence on the FEC experience and impact on innovation. For instance, what kind of return on investment is reasonable to expect from FECs in innovation ecosystems? And, to what extent is asking FECs to adapt their strategies to serve a regional innovation goal appropriate to their existing mission(s) and capacity?

These questions are meant as provocations - to critically consider the potential of FEC contributions to the innovation economy relative to other mechanisms for aligning skills with localised demand - as well as justifications for building the evidence base not only of experiences but impact. Our view in this report is that the ask of FECs to contribute to innovation can be appropriate, but must be sensitive to a range of factors that can limit their ability to optimise impact - not least of which is the complex policy environment. This is particularly important in the UK, given the long history of policy changes in the FE sector and the increasing pressure that government agendas have placed on FEC missions. From providing vocational education and basic qualifications that contribute to full employment, social equity, and widening participation, to providing foundational degrees and ladders into Higher Education, and contributing to upskilling, FECs have been asked to fulfill a wide range of social and economic goals. The advent since the 1990s of industrially and regionally focused contributions, encouraging involvement in governance, and interactions with employers to serve regional skills demand, cluster development, and now levelling up, has further complicated the FEC mission. This policy environment has been described as confusing and riddled with unfunded (or underfunded) mandates. And so just as important as understanding the perspective of FECs in their engagement with their ecosystems is to understand where support structures are lacking or where innovation on the policy side might facilitate the kinds of programme development and external linkages that are thought to optimise skills alignment with innovation ecosystems.

This report focuses particularly on mechanisms for skills development and delivery. We survey three main categories of skills development: courses and curricula, apprenticeships, and enterprise and entrepreneurship education. Interestingly, even though a variety of work experience routes to skills development exist, completions are overwhelmingly still through traditional coursework within FECs. Existing research suggests that direct employer engagement in course and curriculum development is still relatively weak although examples of good practice exist. However, it is possible that feedback occurs in less measurable ways and through other forms of engagement. That said, it appears that even though we (and the literature) spend much time and space in reports elaborating cases of and potential benefits of business engagement, it is not as widespread or as influential as anticipated.

With that in mind, it is worth noting that FECs also engage in many other types of interaction with their innovation ecosystems, even if the prevalence of this kind of engagement remains in doubt. We argue that all of these can, if properly designed, enhance the effectiveness of skills delivery and match between skills demanded and those supplied through FEC programming. While these mechanisms are open and available to FECs, and are thought to contribute both to innovation ecosystem development and the competitiveness of FEC offerings, which of these mechanisms have the most impact and most favourable return on investment (both to the FEC and the ecosystem) remains an open question. It is likely that for some FECs and ecosystem contexts, a mix of engagement strategies is appropriate where for others only one (or none) might work best. Again, while broad benefits are assumed, their distribution and magnitude is unclear and will likely vary by context and programme design. Similarly, the burden and distribution of costs - financial and otherwise - of ecosystem engagement has not been rigorously considered.

From our perspective, this suggests that more research is needed in four areas. (Please note that while there are initiatives along these lines underway in various departments and organisations, gaps remain):

- **Aligning policy objectives and FEC incentive structures**: A more thorough understanding of how the policy environment (sometimes described as cacophonous) impacts FEC strategies, the tradeoffs that they must consider given competing policy demands, all relative to available public and internal resources, is necessary to appropriately align incentives. This may involve exploring solutions that reduce the burden on FECs to single handedly manage the skills matching mission. For instance, public portals that pair business skill needs with programmes that can provide suitable skills may help learners identify options and FECs to better respond to broader trends (such as the Berufnet example). At the local scale, regularly refreshed, and more detailed local skills strategies could potentially be vehicles to provide feedback to colleges on specific skill needs. Other approaches already in progress, such as the CBC programme, and others, can also help provide both incentives and resources for strategic alignment of FEC skills offerings. However, more information is necessary about how policy and practice interact in order to properly design, socialise, and implement new approaches.
- **Inspiring innovation and empowering FECs**: We think that there is a link between the propensity for engagement in innovation ecosystems and the degree to which FECs are themselves engaged in organisational innovation. If this is the case, then concentrating only on aligning incentives may not be effective if FECs are unwilling or unable to engage. Learning more about the internal factors that enable FECs to change the ways that they operate, institute new programmes and practices, and think about their own organisational evolution is vital to effectively steer strategies to service public policy objectives.
- **Selecting the right tools for the job:** It is not clear which programmes, mechanisms, types of engagement, etc., are most likely to achieve the objective of reducing skills mismatches. While each of the approaches discussed here has promise, there can be many variations in implementation and mixes of mechanisms adopted. Should all FECs be attempting all types of engagement? Are some more effective or appropriate than others? Is there a natural phasing that makes sense or does it not matter as long as some interaction is occurring? Furthermore, what should the ultimate goal(s) of these mechanisms be and how should outcomes be prioritised?
- **Measuring inputs and outcomes:** Getting more and more appropriate data is fundamental to many of the above research agendas. On the input side, more detail about employer skills needs, spatial trends, and programmes will help to better conceptualise alignment issues.

Understanding existing links with businesses and learning from cases of successful co-design of programmes for student placements (etc.) would add a lot to the knowledge base and help design strategies to collect appropriate data to measure outcomes. These efforts may also be useful for recognising where employers are failing to invest, or underinvesting, in training and upskilling. Measuring outcomes to determine impact is also crucial to refine strategies. The latter will be much more complicated, as outcomes are not always localised, evident, or easily quantifiable. However, sustained data collection of well-conceived indicators can help to answer some fundamental questions that face the sector.

In all of the above, it should be emphasised that FECs are not a homogeneous group and should perhaps be differentiated in future research on their actual and potential roles in innovation ecosystems. Other more important differences may emerge from the framework that we propose based on HEI/FEC density and local economic specialism, but this seems a fruitful place to start formulating hypotheses about the strategies that we observe, opportunities for FEC development, and to shape policy expectations.

In sum, this review of the literature has demonstrated the importance of continuing investigations into FECs and their interactions with and potential impacts on innovation ecosystems. It has also highlighted some challenges and opportunities. Phase 1b and Phase 2 will continue this vital work of plugging empirical gaps as they assess college needs and business interactions and consider policy interventions and evaluation.

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Innovation Caucus

Contact

info@innovationcaucus.co.uk
Oxford Brookes Business School
Headington Campus
Oxford OX3 0BP

www.innovationcaucus.co.uk

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