# Adopting Open Source IT Certification in Higher Education: Lessons from the Field

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**Abstract**. This paper suggests areas of good practice and considerations based upon the experience of embedding an open source information technology (IT) certification into a UK higher education program. Academically, open source is used as a vehicle for teaching general academic skills and values, but also as a collection of marketable skills. IT certification is used to further develop and signpost these skills to employers. This paper critically reviews literature in the fields of open source software in education and IT certification. A case study then discusses the methods used to embed such certification at Birmingham City University in the UK. Key barriers are reviewed along with a summary of lessons learned for the benefit of those considering similar actions.

**Keywords:** open source software · IT certification · higher education

## 1 Introduction

Open source software (OSS) as defined by the Open Source Initiative [1] offers advantages over proprietary counterparts in areas such as acquisition cost [2], independence from vendors [3] and in some cases, improved reliability and performance [4, 5]. Such attributes are driving the increased popularity of OSS [6–8] into a 'second wave' of adoption beyond its traditional user base of computer enthusiasts [9]. OSS technologies now underpin many Internet delivery platforms [10] and are paving the way for the rapid expansion [11] of public and private cloud provision via technologies such as OpenStack [12]. However, this growth is not without problems. There is evidence to suggest demand for skilled practitioners is outstripping supply [11, 13]; applying extra pressure on the educational system to produce suitably qualified graduates to address this need.

With this backdrop in mind, this paper critically reviews literature regarding Information Technology (IT) certification and the use of OSS in education, highlighting a gap where these intersect. It then delivers a case study discussing the main issues surrounding the adoption of the Linux Professional Institute (LPI) Linux Essentials (LE) [14] certification as a valued-added extension to an academic

curriculum at Birmingham City University (BCU) in the UK. It will then go on to identify lessons learned from this experience and areas where work is still needed.

## 2 Literature Review

### 2.1 The Role of Certification in Higher Education

Higher Education (HE) worldwide is coming under greater scrutiny than ever before [15–19]. Taking the UK as an example, there have been concerns [17] over the effectiveness of degrees generally [20] and the employment prospects for computing graduates in particular [21]. This has led to a focus on general employability and industry-relevant practical skills [22]. One method to signpost programs containing such skills is professional body accreditation through institutions such as the British Computer Society or the Institution of Engineering and Technology. However, such bodies may have limited international currency and while they are a broad assurance of overall 'quality' [23], they do not signpost any specific skill to an employer. Additionally, it has also been argued that such accreditation schemes can stifle innovative program design and have limited currency with students [24].

While accreditation can signpost employable skills, it cannot foster them. Industry placements are an effective approach to developing such skills [25], but the number of computing students taking up such opportunities has declined [26]. Suggested reasons include students not appreciating the benefits and practical issues relating to obtaining and attending placement employment [27]. As this decline limits the utility of placements, parallel methods need to be sought [28], one such being IT certification (henceforth certification) [29].

Certification comes in two broad forms, vendor-specific and vendor-neutral [30]. Vendor-specific certifications are developed and managed by the provider of that technology (e.g. Microsoft and Cisco). Vendor-neutral certifications are commonly offered by independent third parties, with content that is generic to many providers' technologies (e.g. CompTIA, Linux Professional Institute). Both types of certification are valued when hiring IT practitioners [13, 31, 32], so much so that they may be a prerequisite for a position [22]. When not mandated, they may be used to differentiate [33] or quickly short-list suitable candidates [22]. Anecdotal evidence from BCU and elsewhere [32] suggests that even where certification is not officially sought by an employer, it can act a point of positive discussion during the selection process.

### 2.2 Challenges to Embedding Certification

While there appear to be employability benefits to the inclusion of certification within academic programs [34], few institutions have done this. Some do not consider it the job of HE [35], or consider it beneath the academic rigor of university-level study [34]. This poor perception of certification amongst academics

in particular may partly be explained by their own lack of understanding, with few holding these qualifications [36]. This negative view contrasts with disciplines such as law and accountancy where external certification is widely accepted [37]. In fact, there is evidence to suggest that HE is the correct place to embed certification. HE provides the theoretical underpinnings to scaffold the practical skills fostered by certification [38], leading to a greater depth of understanding [39] than either type of study alone.

Benefits notwithstanding, the content of some certifications has come under scrutiny. Some vendor-specific exams are narrow and product focused [38], and in some cases have been likened to propaganda [32]; a poor match for academic environments that promote critical thinking. Other exams may rely heavily on the reproduction of facts [40], leading to concerns that candidates may not know how to apply these skills in practice (so called 'paper certifications' [41]). This narrowness and focus on minutiae may contribute to the limited ‘shelf life’ of the skills taught [20].

As with the adoption of any innovation [42], the process of integrating certification can be challenging [32]. Academics may need to gain the certification themselves, a time-consuming and costly exercise [43]. This is commonly followed by a cycle of re-certification in the following years [39] to maintain qualified status. Changes may be required to the schedule of academic delivery, content, teaching style [29] and possibly even teaching staff. Where substantial commitment is not present, adoption may be reversed [29], leading to dissatisfaction amongst staff and students.

Given the rapid pace of technological change, educational programs delivering certification can date rapidly. The differing pace of change for academic and certification curricula can lead to conflicts [29], and may place additional pressures on those delivering synergized programs to be pro-active in adopting new technologies. Vendor-neutral alternatives have some advantages in this area [30], especially where the certified technologies are relatively stable. Linux may be one such example. Commands familiar to a UNIX administrator of 30 years ago can still be used on the latest distributions of Linux, bringing an element of continuity. When changes do occur, they are usually evolutionary, not revolutionary. This promotes stability in certification content, making them easier to integrate with academic programs.

### 2.3 Open Source in Education

OSS is increasingly used for teaching and learning [44]; both for pedagogic and infrastructure purposes. Often, as in industry, OSS is a pragmatic choice. The absence of a license fee permits easy trial [45], experimentation and deployment without a lengthy administrative overhead. This ease of ‘trialability’ is positively associated with the adoption of many technologies [42]. Pedagogically, OSS is commonly associated with software engineering [46], where such tools are frequently used in industry. There is also preliminary evidence to suggest that

participation in OSS development communities can foster employable skills such as communication and team working in a way that complements a formal education [47]. Participation in OSS projects has also been cited as a method to give students realistic challenges within their studies [48] or even as a 'virtual placement' in lieu of formal work experience [49].

There are numerous degree programs now teaching OSS principles and practices [50], and some have implemented 'self-certification' of OSS skills on an institutional basis [46]. However, unlike third party certification, this could suffer from limited currency in the job marketplace [32]. The author can find no work where OSS-specific skills have been verified via third-party certification, perhaps partially explaining the apparent lack of skilled practitioners in the eyes of some employers. To partly fill this gap, the following case study outlines how OSS vendor-neutral certification was integrated into a UK degree program and the lessons learned from that process.

## 3 Case Study

Two academic modules (discrete study elements) are the basis for this case study at BCU in the UK. Both modules supply similar outcomes on different computing degree programs, aiming to teach theoretical and practical skills relating to systems administration, computer networking, OSS concepts and transferable problem solving skills. The modules reference other subjects of study to allow synthesis of concepts and deep learning [51].


**Fig 1.** Module delivery pattern

Figure 1 shows the pattern of delivery utilized in the 2014/15 academic year. The academic portion of the modules are delivered via a one-hour slot in a traditional lecture theater and two hours in a computer lab, every week, for 12 weeks. The lecture session makes use of audience participation and flipped learning principles [52]. Students investigate OSS culture and projects outside of class and feed-back to the group during the lecture slot. The lab sessions develop practical skills by utilizing Linux virtual machines on an OSS virtualization platform, allowing students to easily re-create the lab environment on their own computers. Students are encouraged to work in small groups and peer-teach. Model solutions are provided in written and video format to allow self [53] and peer-assessment.

For practical administrative reasons, as well as the academic reasons previously discussed, the certification exam is not used for academic assessment. Summative assessment for the modules utilizes a combined theory and problem solving practical exam, delivered using the University's virtual learning environment (VLE). An

evaluative coursework exercise has also been used in the past in one of the modules to enhance the critical analysis skills of students.

The module content aligns to the LPI LE [14] certification program. This is a vendor-neutral, entry-level certification covering Linux system administration and general OSS skills. The certified material forms a subset of the material taught on the academic modules, with certification used as external verification of OSS skills. To facilitate the process of certification, students optionally attend a certification 'bootcamp' that follows on from the academic element of the module. The bootcamp program revises key exam topics and focuses on the further developing the skills needed to pass the certification exam. A variety of methods are used to prepare students for certification [54], but emphasis is placed on practical exercises and formative feedback via the use of practice questions. This means the face-to-face session are used as troubleshooting surgeries, rather than opportunities to 'deliver' content. In the penultimate week, students attempt a mock exam with the final week being the certification exam itself, facilitated by the University's own LPI test center.

### 3.1 Discussion of Key Adoption Challenges

**Choosing a Certification – Philosophy and Practicality**

Choosing the right certification to adopt is a critical decision. Factors such as currency in the employment market need to be considered, but one of the most important is the match between the philosophy of the certification and the academic program. It is rare that curricula are designed from scratch, so there needs to be some synergy between the existing academic approach and the certification; or a willingness to make this the case. Unsuitable certification cannot be successfully 'bolted on' to an academic program.

At BCU, a number of 'big-name' Linux certifications were investigated, but all were found to be too expensive to run or prescriptive in their approach at that time. They also offered a 'vendor's eye view' of the world, which was at odds with the focus of the academic curricula. At the time, the only vendor-neutral solution offering progression beyond one certification was the LPI program, and this is the scheme that was adopted. Two important aspects of the LPI offering are that their certifications are developed using open source principles and that a new certification was being designed with the academic environment in mind (Linux Essentials). The latter point was important, as this led to lower exam costs and aided the University's facilitation of the certification process. The LPI also had a pragmatic approach to what preparation resources could be used and had clear certification life cycles [55], ensuring flexibility of academic delivery could be maintained.

**Content Alignment and Difficult Choices**

Students are busier than ever, with the pressure on their finances leading many to work long hours to support themselves through their studies [56]. With this in mind, additional work, over and above their compulsory academic studies may be viewed

with skepticism and will need to be visibly advantageous. This makes aligning the academic and certification content one of the main objectives to foster participation and success.

For the example presented here, the content of the modules is well-aligned to that of the LE certification, but there are differences. Academic degrees should provide high-level cognitive skills and it is felt that they should be distinct from training courses for specific technologies [39]. One of the major issues with offering certification in academic programs is also one of its major benefits, namely the detailed knowledge required to pass a certification exam. Much of this knowledge may be at an academically low level on Bloom's taxonomy [57], making it hard to justify the use of such exams as part of a HE academic assessment process. Because of this, the decision was taken to separate the certification process from the academic assessment completely. While this may be detrimental to promoting participation in certification, it does resolve some concerns regarding both the rigor [58] and security [59] of certification exams.

**The Right Support at the Right Time**

When BCU initially trialed the LE exam in 2011/12, no structured support was offered for certification. Students who sat the exam found it challenging, something identified by others who have embedded certification [54]. This may be due to the disparity between the format and expectations of such exams and academic assessments. Whatever the reason, it was clear that additional support would be needed.

In industry, certification training is traditionally delivered via short, highly focused courses [43], sometimes called bootcamps. While the students already had much of the required skills and knowledge needed, the idea of using a bootcamp was compelling. However, deciding the timing and duration of this bootcamp proved challenging, and various formats were considered. One model that was quickly rejected due to resourcing and educational veracity concerns was the high intensity one week 'burst'. Between the initial bootcamp in 2012/13 and the latest in 2014/15, both the time within the academic calendar and duration have been adjusted.

Duration proved the easiest problem to solve. During the first iteration in 2012/13, a three-session bootcamp was offered, but students indicated that they would like additional support. A further two weeks were added, and this format has been used since then. The positioning within the academic calendar proved more problematic. Term-time offerings were initially popular, but led to large drop-outs due to conflicts with academic assessment schedules. The availability of both staff and labs was also limited due to academic commitments. Bootcamps in the summer period seemed ideal, but some students reported issues with the availability of accommodation and conflicts with family and work commitments. After much debate, the summer option was retained, as participation in the certification exam seemed to be higher at this time of year.

**Participation**

While the idea of certification appeals to students, participation in the final exam is an area where improvement is needed. Those that engage with the post-course certification are generally successful, with 95% of those who attempted the exam achieving certification in 2015. However, the numbers attempting the exam are limited. In 2015, around 190 students were eligible to attend the bootcamp, but only around 11% sat the certification exam. While this may seem low, this compares favorably with published participation rates [54], suggesting this is a generic rather than local issue.

One major barrier to participation is the cost of sitting a certification exam [60]. Certification is not currently considered a core part of the students' learning at the university, so is not covered in their tuition fees. One of the factors leading to the selection of the LE certification was its low cost, but any cost to the student is still a barrier to participation. This has been partially ameliorated by students competing for funded exam vouchers, but these are limited in number. New funding models and incentives are being investigated with a view to increasing the numbers of potential participants.

### 3.2 Summary of Lessons Learned

The literature shows that some attempts to embed certification have been unsuccessful [29] due to practical issues and philosophical objections. Some of these have been discussed in detail above, but others are also worthy of consideration and are summarized below:

1. Certification is challenging, so commitment is needed from the institution and staff to maximize the chance of student success. Half-hearted commitment will lead to dissatisfied staff and students. Those teaching and advising students need to have a good understanding of the benefits and practices of certification and ideally need to hold the qualification themselves. This will require a program of staff and resource development prior to offering certification to students.
2. Ensure that the academic and certification syllabuses are well-aligned. The greater this disparity, the harder it will be for students to succeed.
3. ‘Sell’ the benefits of participation to students. Able students may see the benefits for themselves, but others may need convincing. Consider using alumni to assist in this activity.
4. Check that the chosen certification provider does not mandate or restrict what resources must be used during preparation. Many vendor and third-party materials utilize a didactic approach to content delivery, which students familiar with a more participatory approach, may find unappealing. The ability to customize delivery and select appropriate resources is therefore essential.
5. Preparation for certification is not just a class based activity, personal study

is a necessity. Books, software, labs and practice questions need to be accessible as and when needed by students.

6. Offer coaching in certification exam techniques, as well as content. This may form part of the academic program itself, or be add-on support, such as a bootcamp. Many students will not be familiar with the customs and practices of certification and will need help to perform at their best.
7. Time delivery of support such that the students can focus their attention on it sufficiently. While there is no perfect time, some times are better than others and this will need to be identified on a local basis.
8. Look at factors surrounding the academic environment such as availability of student accommodation outside term time, student workloads and resource availability. These are issues that can impinge upon participation.
9. If certification is optional, offer incentives to participate (free exam vouchers, prizes, etc.). While the benefits of participation should be enough by themselves, pressures on modern students mean they may not be sufficiently tempting on their own.

## 4 Conclusions and Future Work

Despite being an imperfect solution, certification can form part of a valuable employability package for HE students. It offers the dual benefit of fostering and signposting the skills needed by employers, making it a useful method of embedding employable skills into an academic program. This paper has outlined some of the methods by which BCU has successfully embedded and aligned the LE certification as part of its students' learning journey.

In this institution (as elsewhere [29]), the separation of certification from the academic element via means of a bootcamp has been found to aid in the certification process. This has helped to clarify student priorities and ensure that academic rigor and high-level skills are maintained. However, the alignment between academic and certification syllabuses is essential to ensure students can achieve certification success with a modest outlay of additional effort. As elsewhere [61], factors such as the timing of support, staff commitment and qualifications as well as the academic and social environment have been found to be significant in ensuring successful outcomes. However, challenges remain surrounding certification costs and participation rates, underlining that they should form part of a suite of employability measures, and not be the only solution.

To tackle some of these issues, we encourage further work to understand and mitigate barriers to student participation in certification. It would also prove instructive to have a better picture of whether it is the content of the certification itself that appeals to employers or the fact that the student has extended their studies beyond the required minimum, and whether there are generic factors that differentiate certifications in the eyes of an employer.

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