

# Employable Knowledge: Benchmarking Education about Standardization in the UK

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## Management Summary

### Lessons learned from (best) practice teaching of standards

For academics and students in the United Kingdom the main source of standards is via British Standards Institution (BSI). The research demonstrates that British, European and International Standards play a key role in many areas of education. In some disciplines their inclusion in the course is mandatory, e.g. in building construction and performing risk assessments of equipment. Where not a requirement, other courses successfully encourage students to understand and apply specific standards and principles from them, to their design and project work, in topic areas such as quality management and user-computer interface design. Assessment practice is a key part of learning and academics have indicated how this fitted into the learning activity, e.g. by expecting students to develop an understanding of standards and reference them in all assessed work.

Likewise, students taking part in the survey also suggest that they were actively engaged with one or more standards and that their understanding was measured through an assessed activity. However, students also emphasised the importance of additional support, e.g. introduction to standards in the workplace or as part of work placements, by library staff as an information resource, and by presentations from BSI experts.

Employers have also indicated the importance of students' knowledge, understanding and appreciation of relevant standards in the right context, emphasising their desire for standards to be included more widely in the curriculum.

The draft recommendations from this study were subject to International review and comment, the results from this review served to strengthen the recommendations of this work.

The study has highlighted a number of limitations or barriers to the effective use of standards in teaching and has generated the following recommendations to address them:

### Recommendations

#### 1. Access to standards

- a. **Access to Individual Standards** – Some Universities have full text access to standards via British Standards Online (BSOL), some have partial access and some buy standards individually. The type of access is not known by all academics and difficulties are presented by the method of selling individual standards, the cost of individual standards, the inability to provide deep level linking to specific standards and the scope of the BSOL search facility. It is recommended that BSI compare access to standards to that offered to other academic published resources and ensure a comparable level of access.
- b. **Access to Standards on a Topic** – Students and academics described the difficulty of identifying standards relevant to an area of work particularly to assignment and dissertation topics. It is recommended that BSI improve the search facility to enable searching of the content of standards using keywords or phrases.
- c. **Access to Draft Standards** – The system for accessing the text of draft standards was not widely known and not thought of as easy to use. Draft standards can be of

particularly benefit to academics carrying out research and PhD students. Teaching academics also need to know when changes to the standards they teach will occur. It is recommended that information on draft standards is more widely distributed in the research community.

- d. **Access to Committees** – Only those academics who also worked as standardisers reported any linkage to or communications with standard committees, since this linking could be of mutual benefit to the committees as well as to the academics, researchers and PhD students. It is recommended that BSI works to encourage this linking.
- e. **Knowledge of Access** – It is recommended that Universities and Colleges identify and publicise their access to standards and ensure that both staff and students are aware of current arrangements. If this access is insufficient alternative access methods should be investigated by the relevant librarians.

## 2. Information about Standards

- f. **Publicity and Communication about standards** – Many academics and students have gaps in their knowledge about standards. A lack of knowledge also exists within the professional bodies that are responsible for curriculum development. It is recommended that BSI produces more information targeting academics and professional bodies telling them that standards exist and can be useful. This should cover both STEM (science, technology, engineering, and mathematics.) and the non-technical areas e.g. customer services. The design of this information needs to take into account the different academic teaching levels so that it can be utilised in Further and Higher Education appropriately, e.g. for Masters, Bachelors, HND and BTEC etc.
- g. **Presentation of standards** – Representatives of employers, students and academics all reported the difficulty of using standards. It is therefore recommended that for the future standards could be made more accessible in terms of language, complexity, wordiness. The addition of more images and images in colour might also be helpful.
- h. **Information about changes** – It was reported that some academics had come across colleagues who were using out of date standards. It is recommended that information is targeted to academics about changes to standards within curriculum areas.
- i. **Production of support materials** – Many of those who replied to the questionnaire asked for support materials including guides to individual standards, explanations of why certain standards exist, guides to groups of standards, guides to how standards and standardisation works, brief descriptions of standards and list of standards linked to particular industry or curriculum areas (reading lists). It is recommended that BSI produce this material in academic areas where they wish to see more teaching and use of standards.

## 3. Positioning of Standards

- j. **Mapping to curriculum and teaching** – The difficulty of accessing relevant standards for specific courses and areas of research was reported. It is therefore recommended that BSI identify mapping to curriculum and teaching practice and

prioritise areas from the identified map to work with curriculum designers and planners (including professional bodies and exam boards) to actively include the use of standards.

- k. **Valuing standards within academia** – The respondents to the questionnaire were those academics and students who do use standards, but it must be acknowledged that many do not. It is recommended that BSI consider why academics don't use standards and consider the position of standards with respect to other academic source material. The value of standards is that they are global and provide an international perspective and that they demonstrate consensus. It is recommended that BSI works to promote standards as a valued resource within the academic community for instance by producing journal or conference papers or by the Head of BSI offering to give a keynote at HEA Annual Conference, 2015. Ideally standards should be seen as equivalent to other academic primary texts.
- l. **Valuing standards for employability** – Representatives of all groups referred to the benefits of learning about standards for the students' future employability. It is recommended that BSI promote standards to students, academics and stakeholders involved in curriculum development based on their use in employment. Universities and Colleges should ensure that relevant teaching on standards is provided to support their students' future employability.

## Introduction

The teaching of technical standards to students in higher and further education in the United Kingdom is carried out as a necessary part of many practical and technical programmes. This report describes the results of research into the teaching of standards in higher and further education and provides recommendations, based on research with academics, students and industry, which will enable BSI to offer more support in future. The research has also identified a number of case studies which describe good practice and lessons learned by professionals who use and teach standards.

This research was commissioned by British Standards Institution (BSI) and was produced in association with the Department for Business, Innovation and Skills as part of its ongoing programme of support for standardization in order to provide BSI with information to enable it to improve the depth and breadth of the support it gives to academics, librarians and students.

The research was carried out in late 2013 and early 2014 using online questionnaires, interviews and workshop discussions. Information was obtained from current and previous academics, educators, students, librarians, and employers of new graduates, across a range of academic disciplines and employer occupations. In order to identify where, when, how and why students were being taught about standardization and standards, the surveys gathered information on:

- the field of work and the type of standards being studied
- the ease with which the educators and students could access the standards
- if there was a requirement for supplementary support information on standards and standardization directed towards students and educators
- what other publications or communication streams could be utilised or created to assist the students' appreciation of standards and their utility.
- examples of good practice in the teaching of standards so that information about them could be shared
- the extent to which employers require new employees to be knowledgeable about individual standards and the standardization process.

The need for students to be engaged with the standardization field is important for a range of stakeholders: for students' future employment; for employers to maintain the quality of their workforce; and for society in general, which depends on the quality provision provided by standards. This need has been identified by a number of standards bodies including DIN, the German Institute for Standardization, who describe in the German Standardization Strategy (2009) the need to integrate standardization in higher education: This document, available online at [http://www.din.de/sixcms\\_upload/media/2896/DNS\\_2010e\\_akt.pdf](http://www.din.de/sixcms_upload/media/2896/DNS_2010e_akt.pdf), goes on to say:

“The strategic importance of standardization and the benefits of active involvement in standards work need to be incorporated into curricula to a greater extent in order to introduce prospective specialists and decision-makers in industry, politics and society as a whole to standardization at an early stage. Professional and vocational training courses and academic programmes alike should incorporate standardization in their curricula, particularly in the natural sciences, engineering and management fields. One prerequisite for this is the development of strategies and action plans for an increased integration of standardization in higher education.”

The aim of this report is to identify how BSI can work with educators and librarians to increase their impact and the impact of the standards to which they provide access. The main result from this research has been a series of recommendations which provide information to BSI on the promotion and presentation of standards, the need for additional information to support the teaching of standards and the way in which standards can be linked to the curricula in Higher and Further education.

The draft report and recommendations were made available to International Standardisation Experts to review and comment with respect to their experience.



## Background to British Standards

British Standards Institution is the National Standards Body of the United Kingdom. British Standards provides UK education, industry and other stakeholders with access to and influence on standardization, both in the European arena (with CEN – the European Committee for Standardization, CENELEC – European Committee for Electrotechnical Standardization, and ETSI – European Telecommunications Standards Institute) and internationally (with ISO – International Organization for Standardization, and IEC – International Electrotechnical Commission).

BSI provides a wide range of information on standards including introductory information such as ‘Pocket Guide to Standards Development’.

Students, academics and librarians from Higher and Further Education can interact with different parts of BSI via different online and offline links. The main areas that they will access are as follows:

### British Standards Online (BSOL)

BSOL is BSI’s online standards database that provides access to over 60,000 British, European and adopted international standards via the BSOL webpage. Around 70 universities and 20 FE colleges in the UK have membership of BSOL. Access is available to students and academics that are at institutions that have one of the following BSOL subscriptions:

- Subscription to the full collection – this gives access to over 60,000 standards and to draft standards.
- Subscription to subject based modules– the BSOL database is broken down into 53 standards based modules and 3 book modules. Subscription can be provided to the institution’s choice of modules.
- Subscription to a customised collection of standards – subscription can be tailored for an institution by providing list to a specific number or list of standards.

In addition to BSOL, online access can be purchased to Eurocodes PLUS (an online database that gives access to the complete set of Eurocodes and related standards), Perinorm(bibliographic database of national, European and international standards) and Self-Assessment Tools, SATs (The measurement of compliance with the requirements of a standard).

### British Standards Shop

Unbound print copies or electronic copies (Pdf) of individual standards can be purchased from the BSI online shop. The shop provides access to British, European and adopted international standards and information (including books and publications) and also to training courses on standards.

### BSI Education

The BSI Education website contains a specific section for students in Higher Education. This section describes the history and role of BSI, what Standards are and how they're created, and the benefits of their use. It also describes how to find and use relevant Standards and other documents. The section on how to find a standard directs the student to the BSI shop.

## **BSI Speakers Network**

The field of standards and standardization is introduced to many students by talks given at their institution by BSI staff members or volunteers.

## **BSI Standards Development website**

The BSI Standards Development website enables students, academics and others to find and identify draft standards which are out for public review. The site enables people to “search through standards currently in development and monitor their progress, discover and comment on proposals for new standards, read and comment on draft standards available for public comment”.

Additionally it links to the BSI Proposals for New Standards Website, the BSI Draft Review Website, the BSI New Proposals Website and the BSI Shop.

## Background in education

Universities are able to award qualifications autonomously and there is no nationally agreed curriculum. The development and delivery of qualifications and programmes are subject to quality agreements such as ‘The framework for higher education qualifications in England, Wales and Northern Ireland’ (FHEQ), and ‘The framework for qualifications of higher education institutions in Scotland’ (FQHEIS), and internationally ‘The framework for qualifications of the European Higher Education Area (QF-EHEA). Amongst other things these set out processes by which different qualifications can be compared and transferred.

**Table 1 Descriptors defining levels in the European Qualifications Framework (EQF)**

<b>The EQF Levels</b>	<b>England and Northern Ireland Education Qualifications Equivalent</b>	<b>Knowledge</b>	<b>Skills</b>
Level 4	Higher National Certificate (HNC)	Factual and theoretical knowledge in broad contexts within a field of work or study	A range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study
Level 5	Higher National Diplomas (HND)	Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems
Level 6	Bachelors degrees with honours, graduate certificates and graduate diplomas	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study
Level 7	Masters degrees, postgraduate certificates and postgraduate diplomas.	Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research Critical awareness of knowledge issues in a field and at the interface between different fields	Specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields

The educational focus is on student learning rather than on the teaching with the definition of learning outcomes having a central role in defining the course, the teaching and assessment practice and the level of the teaching. At this higher education level, student learning is characterised at Bachelor level by the demonstration of critical thinking and the current boundaries of knowledge and at Master’s level on the advancement of knowledge.

Bachelors students “. . . will have developed an understanding of a complex body of knowledge, some of it at the current boundaries of an academic discipline. Through this, the holder will have developed analytical techniques and problem-solving skills that can be applied in many types of employment. The holder of such a qualification will be able to evaluate evidence, arguments and assumptions, to reach sound judgements and to communicate them effectively.”

Masters students “. . . will have shown originality in the application of knowledge, and they will understand how the boundaries of knowledge are advanced through research. They will be able to deal with complex issues both systematically and creatively, and they will show originality in tackling and solving problems. . . .”

*[ref to ]The framework for higher education qualifications (FHEQ) in England, Wales and Northern Ireland. The Quality Assurance Agency for Higher Education 2008*

The survey of academics set out to examine the depth of teaching about standards through a series of questions that reflect the simple hierarchy as it progresses from remembering, understanding, applying, analysing, evaluating and creating.

New course programmes within a university follow a carefully structured process which may include reference to professional bodies, and industry and external academics who have to approve the course according to a strict timetable. Although the procedure will vary from one university to another, a newly proposed course, or even a new module within a course, may require a revised programme or module specification covering its “main features and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if full advantage is taken of the learning opportunities that are provided”(from MA, MSc Industrial Design Programmes Specification at Loughborough University). These specifications would be submitted to the learning and teaching committee or other academic panel, to be discussed and approved if acceptable. It is critical that students do take full advantage of the learning opportunities that are provided, and academics will want to design each lecture and assessment to enable their students to attain those intended learning outcomes.

In some subjects the professional bodies have a strong influence on the curriculum that will lead to professional recognition of the students and may take responsibility for validating courses and the institution that provides them. Additional measures need to be taken to resource the course and to ensure that there is sufficient interest from the students to be economically viable.

Course development at Further Education level is much more subject to national agreement; however there are differences within the UK between England, Wales, Northern Ireland and Scotland. Most FE students are aged between 16-19 years old and some may well go on to higher education. Many of the students at FE are following traditional programmes in GCSE and A-level courses. Many others, including adults, follow vocational courses on a full-time or part-time basis.

Quality in education and transferability is achieved through The Qualifications and Credit Framework (QCF) which is the national credit transfer system for education qualification in England, Northern Ireland and Wales. The QCF replaced the National Qualifications Framework (NQF) which closed at the end of 2010.

The content of vocational courses generally looks to industry and to the National Occupational Standards (NOS) that are developed and agreed with the support of appropriate trade, skills and professional bodies and industry.

For example, the NOS for IT and telecommunications professionals are the responsibility of eSkills UK. Partners in eSkills UK include the professional bodies British Computer Society (BCS) and The Institution of Engineering and Technology (IET), business representatives from the Confederation of British Industry (CBI) and Confederation of Small Businesses, IT Jobswatch who monitor the IT job market, and others.

The level of teaching at FE focuses much more on the practicalities and competencies. The main national examination bodies for FE teaching include Edexcel (Pearson Education Ltd) and City and Guilds. Qualifications include BTEC and NVQ (and SNVQ in Scotland). However there is also an extensive range of qualifications that are supported directly through many trade and professional bodies.

## Method

The first stage adopted by the project to collecting data on the use of standardisation in education was to conduct three surveys of representatives from academia (further and higher education), employers who recruit students and students themselves. The main criteria for inclusion was that the academics should currently include standards within their teaching, that employers should require students with knowledge of standards for their work, and that the students should have experience of standards within their courses. For more details see Appendix 1 Method and Sampling.

Preceding the survey, a mapping exercise was carried out to identify potential contacts for each of the surveys and to try and ensure coverage of the main activity sectors recognised by BSI. Recruitment took place via email introductions inviting participants to complete one of the three surveys hosted online via Survey Monkey.

In order to gather further details about the use of standards in education and of people's views a number of telephone and face to face interviews were conducted. These were written up as short case studies to show areas of good practice often by people with a clear interest in standards development as well as their use in teaching. It also highlighted some of the barriers they faced in incorporating standards effectively within teaching.

As a further activity, two workshops were held, one organised at Loughborough University and the other by Middlesex in conjunction with BSI. Again the aims of the workshop were to explore in detail: experiences of using Standards within teaching, accessibility to the academic community, whether students know enough related to standards when they start work, ideas for enabling Standards to be taught more easily. Workshop 1 was held in Loughborough on the 24 February 2014 and was attended by 10 people including the organisers. These included members of staff from the Design School (including design and ergonomics staff), from the Department of Materials and from the Business Schools. An ergonomics master's student was also present. Workshop 2 was held at BSI headquarters and was attended by 15 people including 4 university librarians, one academic, 4 design and engineering students and the project team. The workshop included the presentation of a case study where standards are central to the teaching activity, discussion of creating engagement with students, and information seeking and access to standards.

## Study Findings

The results of the three surveys were captured electronically with the results summarised on spreadsheets as well as individual responses.

The total number of respondents from each group was as follows:

Table 2 Completed surveys

Survey group	Fully completed	Partially completed	Total
Academic	45	18	63
Industrial	19	6	25
Student	95	13	108

For full details of the questionnaire study and responses from academics, students and industrialists are included in Appendix 3. The quantitative data analysis as well the qualitative result including the open questions, interviews and workshop discussions were analysed thematically to support the discussion of experiences.

### Experience of academics

The academic survey was completed by 45 academics and partially completed by a further 18 academics giving a total of 63. The academics originated from 24 UK universities, and two FE colleges.

#### Access to Standards

There was an apparent lack of knowledge about whether standards were available within the educational institution and the means by which students could access them without breaking copyright rules.

“I am not sure about availability of standards in my own University, or HE more generally - this applies to hard copies and e-access. My impression is that these are expensive and generally not easy for students / Staff to access and use.”

“I am fortunate in working for a university that supports those of us who teach Standards and has provided access to BS Online since it started. There was a time when there was a single reader in the university, and my students were competing for access with postgraduate researchers. It seems many more people are using the BSI for teaching now that access is so much easier.”

“It would be helpful to have more content easily available for student, and a simpler interface, so they can interact with the content and understand why it is so important at a general level.”

“It is extremely useful that [our] University provided very good access to Standards. However, the cost of Standards makes it very difficult for students to continue to have access once they leave University..... Perhaps BSI could make available a list of Universities and Local Government libraries that have a wide BSI-OL subscription.”

“I would like to see the statement about copyright and the rules about destroying hard and soft copies of Standards made much more prominent. I know some colleagues, who only dip into Standards, don't know about this. It's scary when you are offered a copy of a Standard and see it's the version before the version before last.”

Most of the academics (81%) indicated that they specified which standards the students should be aware of.

When asked about their teaching practices, the scope, specificity and assessment processes varied.

Some academics reported providing a general introduction to standards in class, for example:

“Explain purpose, methodology and examples of analysis”

“General reference to appropriate standards. Refer to standards in various lectures and practical classes.

“Lectures on content. Workshops on the understanding of content, case studies of implementation and critique of benefits and barriers”

Academics did not describe directing students to the work of specific standardisation committees, although one academic stated that he would not teach standards if he was not on a committee as it was his way of acquiring knowledge.

“If I was not so involved with Standards, it is doubtful whether the knowledge about the usefulness and relevance of a wide range of Standards would be brought to students' attention.”

Gaining access to standards is also an important issue dealt with both by lecturers and librarians, for instance one librarian reported that they run postgraduate skills training sessions for research postgraduates, any students from across the facilities can sign up, as described:

“The Library largely teaches in simple terms what Standards are, what they are for and why you might want to use them. This is for project/final year undergraduates, taught and research postgraduates. We cover basic literature/database searching skills, then demo and provide hands-on training times with British Standards Online (BSOL) and IEEE Standards (IEEE Xplore Platform).”

Independent searching for standards can be very important for student project work, especially in design projects:

“It is very much on an individual student basis for my teaching as each student is allowed to choose their own major design project.”

Time may however be very limited:

“I teach this area as part of a one hour lecture on quality (TQM vs Standardisation, performance quality, conformance quality, perception of quality)”



In some instances there is a very specific requirement to identify a particular standard, especially in relation to risk and safety, and engineering drawing:

“All trainee teachers are taught how to produce risk assessments for their lessons. This is a statutory requirement for every lesson. BS4163 is one of several documents to which trainees must refer in producing risk assessments.”

“I teach medical electrical safety which covers the development of standards to support the field, their importance for ensuring patient safety and how and why they are developed and amended over the years.”

“We teach Engineering Drawing as a technical skill to support design and designing. Students must adhere to the relevant communication standards and as such they must be aware of the relevant standards and be able to adhere to their contents. Students are asked to obtain their own copies of the relevant standards and we also teach and practice drawing to the standards.”

#### CASE STUDY 1: Teacher training in health and safety

In their teacher training, students are required to use the standard BS4163 ‘Health and safety for design and technology in schools and similar establishments’. This standard applies to all educational organisations which have practical environments and is the single standard that produces risk assessment for all tools, materials and processes in workshops so we have to teach them how to use it. Students are on teaching practice so every time they plan a lesson in school on teaching placement they have to follow this standard to produce a risk assessment of safe procedures. The lecturer has a licence agreement from BSI which he can put on any copy that he distributes for training purposes. Alternatively every student has to log on separately and download it for themselves via Athens while they are training. Since the standard is 129 pages, the policy is to encourage students not to print the standard but to view it in Adobe Acrobat. This restriction on use is in contrast to the government educational curriculum documents which are freely downloadable under CLA agreements and government websites and the HSE website where materials are also freely available.

The BSI standard is a working document and has to be used because the range of tools, materials and processes that trainee teachers could use in a school is so wide. For example every hand tool or band saw is covered. So when teachers are making a risk assessment for their own classroom practice, they have to know what the risks are and how to produce the procedures for safe working practice. BS 4163 is the enabling document. The other enabling documents are the CLEAPSS documents on materials which are freely accessible.

However there is also a phase lag in the standards materials. The BS 4163 standard is on version 2007 but the tools and machines in workshops now are RP machines, laser cutters etc. Many are built overseas so have to be modified for safe use. This has led onto a research project about the use of laser cutters in education.

**Requirement:** A mechanism for students to obtain access to relevant BSI standards at low cost for training purposes. Consideration of how to keep health and safety standards up to date with the latest technological developments.

### **Information about Standards**

Some comments indicated that not all academics knew which standards were most suitable for their subject and curriculum. One idea was for BSI to create a list of relevant standards for the different parts of the curriculum in conjunction with the professional bodies for each main discipline.

“Help to navigate different standards and find relevant ones.”

“Is hard to keep up to date about what standards available except in a rather narrow field; not sure how resolve.”

“Better information (directed and discipline specific) about changes.”

“Keeping them up to date and user friendly.”

“It is appreciated that there will be a time lag between standards and the latest developments with technology and methods within a sector. If there was a means to inform academics about changes and recognise the areas where standards needed to be updated this would be useful.”

While standards were seen as important or central to many curricula, it was felt that the overall presentation of standards in terms of language, complexity, wordiness and sometimes a lack of clear and colourful images could be improved, make them more appealing and widen their use in education.

“More multimedia and social networking tools to support them.”

“Enlivening learning about Standards through for example, case study examples of good practice in using Standards, topical events/stories, industry involvement.”

“It would be good to offer summaries or condensed versions of standards free to universities.”

“They are fine. While the language may be at times difficult for some students, they are not expected to use them without academic support.”

“A student version with access to the developmental cycle would be very useful so that the rationale for the standards requirements was patent.”

“Suggested exercises that can be employed within teaching.”

“More problem based relation - solving issues or making suggestions would help.”

Understanding of the background and context was important to connect to education:

“The material within many standards is important and relevant to teaching. However some background or contextual material about how they were developed, how they might be applied and how they link together could be invaluable for their use within education. It would be helpful if there could be a pool of teaching materials such as case studies, teacher’s notes, exercises and discussion of how they are used in industry. Teachers could

then draw on these materials and apply them within their teaching which would assist their inclusion within teaching sessions and save time in lecture and exercise preparation.”

“Because we critique and contrast approaches (and get students to do so) we can work with the existing standards quite well. The fact that the standards have limitations, therefore, is not a teaching limitation in itself at MSc level.”

““I believe it will be useful for teaching standards to have a global vision of standards-setters on how groups of standards are linked together (in particular for cross sectorial standards).”

“Knowing how to apply them.”

“A short guide to the relevance and need for standards that can be used as a hand-out for students.”

“Provide support material for lecturers and students, including background to standards content.”

### Positioning of Standards

The survey of academics set out to examine the depth of teaching about standards through a series of questions that reflect the simple hierarchy as it progresses from remembering, understanding, applying, analysing, evaluating and creating.

**Table 3 Academic Teaching levels**  
(highest percentage for each question is underlined)

Teaching level classification	Yes	No	Other (please specify)	Total Number
Do your students have to show that they can remember the content of individual published Standards? e.g. BSI, EN and ISO	30%	<u>51%</u>	19%	47
Do your students have to show that they understand and can apply individual published Standards, for example, by solving a work related problem or conducting an evaluation?	<u>58%</u>	29%	13%	48
Do you require your students to find and critically evaluate published standards as part of their studies?	38%	<u>53%</u>	9%	47
Do you enable your students to be involved in the creation of standards as part of the standardization process?	6%	<u>81%</u>	13%	48
Do you specify the individual Standards which the students should be aware of?	<u>81%</u>	9%	11%	47

As shown in the table [1], half the students were not required to show that they could remember the content of standards. For some this could mean that it is not included in assessments. Nearly 20% commented on this question, for example:

“To some extent. They have to show they have understood key points, such as the difference between shall and should”

“They have to demonstrate awareness of the content, without necessarily specifically quoting the standard”

Being able to show understanding and apply a standard is more consistent with HE academic practice. More than half the academics indicated that students needed to show understanding and could apply the standard and more than a third required the students to find and critically evaluate published standards. However, only 3 people involved the students in standards creation, as the highest level of critical thinking.

Sometimes there appears to be integration into the wider context and theory:

“ISO9000 is used for comparison between other quality management theories and students are required to analyse the pros and cons of the standard and how it is applied in practice.”

“Risk standards are compared to other frameworks for strategic risk management (especially IRGC Risk Governance Framework) and similarities/differences are very useful for gaining insight into many aspects of the subject.”

Assessment practice is a key part of learning and some indicated how this fitted into the learning activity:

“Students are encouraged to reference standards in all assessed work and to develop their understanding of the standards.”

“... Self-assessment questions are set to test understanding, and exam question may be set.”

“Students have to perform calculations using standard methods as part of their exams.”

### **Content of standards**

There was only limited indication of a general introduction to the standardisation process:

“I put an emphasis on the importance of standards. I show why it is important to have international agreement on standards. I also discuss the testing methods given in standards, to show the importance of quality control in industry.”

When asked to describe one or more standards that were important, almost all the academics (46) described at least one standard and 30% described 3 or more standards. There was little consistency among the academics as to which standards they regarded as most important. There were six instances of the usability standard ISO 9241 in its various parts. ISO 9000/9001 (quality) and ISO 14000 (environment) were each mentioned five times, and BS8888 (technical drawing) was mentioned four times. ISO 18001 (quality health and safety), ISO 31000 (risk management) and ISO 60601 (medical equipment safety) were mentioned twice. Over 50 other standards were only mentioned once including BS0 (standard of standards), suggesting that the academics have a very wide range of academic interests in standards to support their teaching.

Some standards are unequivocally central to the student learning such as technical drawing for design and engineering student. The popularity of ISO 9241 may in part be attributable to sampling bias within product and interaction design at Loughborough and Brunel universities. The popularity of ISO 9000/9001 is of note since it crosses disciplinary boundaries and has relevance for engineers, construction and others because of the processes of project management. Only one of the six references to ISO 9000 was to a Business course (MSc Marketing).

#### **CASE STUDY 2: Professional development in construction**

Various short courses are offered in timber construction. These courses support professional development. The use of standards such as EN 1995, EN 14801, 338, 4978 and 408 among others are integral to the course. The students have to be able to show that they understand and can apply the relevant standards.

The lecturer actively participates in the development of relevant standards and makes use of the new BSI drafts website enabling the students to read standards that are in development and understand the process by which they are created.

A problem arises with enabling library access to published standards. The students are generally working full time and may be fortunate to have access to the standards through their workplace, however they are not eligible to use the library resources because they are on a short-course and are therefore not recognised as 'students'.

**Requirement:** There is a requirement for part time, short course and distance learning students to have equal access to standards.

#### **CASE STUDY 3: Use of standards for teaching civil and construction and building engineering**

Within the teaching of civil engineering and construction and building engineering, standards form an important part of the student curricula. One such group of standards are the Structural Eurocodes BS EN 1990-1999. These are very specific design standards which provide a common approach to structural design and structural checks across the EU ensuring that buildings comply to a rigorous set of criteria. There are variations within particular countries in the EU which are specified within a series of appendices. Another standard that is taught is BS 11000, Collaborative Business Relationships, which describes principles for working and communicating in an appropriate way across multiple companies, sites and teams within building projects. Although students do not have to show that they remember the details of a particular standard, their knowledge is tested through the application of a particular standard in coursework or description of the general procedure for applying a standard as part of an examination question. This teaching is designed to follow professional association requirements e.g. IMETI and the IEEE in a way equivalent to how industry would undertake the task. Various bodies in the industry provide examples of the application of Civil Engineering Eurocodes which make good teaching case studies. For example, the Mineral Products Association produces a handbook which shows how relevant standards are applied. Students are expected to download copies of the relevant standards from BSOL although one or two pages containing extracts from the standard might be provided for in class teaching.

**Requirement:** BSI could make it clearer to lecturers what standards are relevant to each of the main subject syllabuses. This could be done in collaboration with the relevant professional institutions or associations.

### **Special Requirements in Further Education**

Five librarians from Further Education (FE) colleges responded to a supplementary questionnaire, all worked at Institutions which had BSOL subscriptions. The list of BSOL subscriptions only includes twenty of the over four hundred FE colleges in the United Kingdom. All the five colleges had limited access to BSOL for example one discrete vocational area or ten BSI modules. The students at the five colleges were studying a range of technical subjects for example Building and Construction, Plumbing, Engineering, Health and Safety, Offshore Technology and Ophthalmology. The qualifications that used standards ranged from Level 1 to Level 5 with standards being used more at the higher levels. Two of the five colleges had received assistance from BSI in the use of BSOL.

### **Issues raised by academics**

Overall, the depth of teaching notably depends on the role of the standard and its status within the academic context. Simply raising awareness without inclusion in assessment will result in the standard having little impact on student learning. Teaching about standardisation rather than, or in addition to, context is given some mention.

Many of the examples of teaching practice indicate that engagement with one or more standards is encouraged through practical assignments, and analysis of the content in relation to theoretical models and other academic literature. Most often the academics report that students are directed to a specific standard; however there are also instances, for example in design, where the student may be expected to search out relevant content.

The teaching of standards in FE and HE depend on the interest of the academic in standards and in their availability, if academics do not request standards there is no reason for libraries to provide them. If standards are not available at an Institute academics are less likely to teach them for example a short vocational course focused on a standard cannot be created if access to that standard is not available.

### **Experience of students**

In contemporary teaching practice, emphasis is given to student centred learning and the successful achievement of defined learning objectives. Teaching delivery at least in technical subjects still largely consists of a mixture of lectures and practical work, with progress determined through assessed assignments and exams.

The survey was attempted by 108 students and 95 were recorded as completed. The students originated from 15 universities.

Overall most students taking part in the survey appear to indicate that they were actively engaged with one or more standards and that their understanding was measured through an assessed activity.

#### **CASE STUDY 4: Searching for relevant standards for student group work**

Ergonomics students are assembled into teams and each team has to design a monorail service for Loughborough University staff, students and visitors. There are standards that relate to monorail design including the carriage seating and handrails, station stairs and doorways, control room layouts as well as monorail health and safety. The students are told that standards ought to be incorporated into design but not for which particular standards or standards topics. Thus the exercise puts the onus on the students to search

for, locate and apply standards. Those who do so will gain extra marks. This is one less structured way of introducing standards into teaching. Often students locate standards from other countries such as America and Germany and are allowed to employ them in their designs.

**Requirement:** A means for students to search for British standards relating to a particular topic such as the design of a transport system.

### Access to Standards

More than two thirds of the students had full text electronic access to standards through either or both the online teaching resources, and through the online library resources. While a further 14% accessed an electronic summary via the teaching resources, 14% reported having been given a printed summary in class, but only 3% received a printed full text copy in class.

More than a quarter agreed with the statement that the standards were difficult to find in the library resources.

"They are horrible to find in the library."

"A Full version should be available on line with link to the specific standards"

First introductions to Standards are important and in many cases this introduction is carefully controlled. The students report that those early introductions were included:

- as a number and title on a lecture slide 88%
- as a reference in online teaching materials 50%
- within a text book or other print materials 40%

This appears to have been followed up with a summary of the main details (64%), an in depth description (20%), or less commonly a discussion of the details (11%).

One student reported more specifically:

"Summary and practical application of standard through laboratory experiments"

The introduction in many cases included independent search activities. This high percentage may in part be due to the high proportion of design students taking part in the survey, where project work may include a wide variety of product types:

- Searching for a standard that was relevant to a topic area in project or assignment 71%

In many cases the students reported that standards formed part of their marked assignments:

- Apply a Standard as part of a class room activity, assignment or project 85%
- Be tested on your knowledge of a Standard as part of a marked coursework or an exam 38%

Exceptionally students reported that they only had "to be aware" or "it was an option and not a requirement". While another reported that he used a standard "To design the experiment for dissertation."

Most students reported being taught about standards; however the results also indicated that non-academic support was also important:

- Introduced in the workplace or as part of work placements 20%
- Introduced by library staff as an information resource 16%
- Two students reported that the introductions had been made by a BSI expert:
  - “In form of a lecture given by an expert, a Secretary to BSI, CEN/CENELEC and IEC Technical Committees”

In describing the experiences of using standards there was a distinction between students who made use of a specific named standard and those who needed to discover standards appropriate to their assignment:

For example:

“We were tasked to find set standards relevant to our own chosen products; in my case, a shower radio. We would then look in detail at how the product has been designed to meet the criteria of each standard.”

### **Information about Standards**

The students identified the need for information about standards in conjunction with the text of the standards being used.

“ I also feel that at least one tutorial or some form of video presentation would help in the learning process as this can often clarify a point that may not be very clear from just reading the course modules. “

“By providing students with a longer list of standards than that provided will give them more to write about in their coursework. A brief guide explaining what each standard is about would encourage more students to read about them. Students are lazy. They do not like doing research outside the scope of their coursework/report.”

“sometimes there are no good practice guides to accompany a standard that could be helpful to breakdown new terminology or methods of work.”

“The wording of the standards can be a little vague at times and important details can get lost amongst over labouring of certain other aspects.”

"It would be great to be provided with a copy of the standards that are applicable to the courses that we study. This was what was done in my previous university, and it really helped understand how the whole standard works rather than an extract in the lecture slides.”

“Lectures could have been more based around detailed business based examples - rather than just telling us about the standard.”

### **Positioning of Standards**

In considering how standards were integrated into their learning activities, some students reported using a standard in a very specific context for measuring or applying a test method such as this student studying civil engineering who reported:



“Used standards thoroughly for third year dissertation. Specifically to do with timber testing and grading.”

Or this student studying a work related Diploma in Acoustics and Noise Control

“A study of the application of BS4142 and BS8233 to noise complaints surrounding supermarket delivery noise.”

Or this student studying for a degree in yacht and powercraft design:

“Group Project, Final Year Project design of marine vessels”

Around two-thirds of the students (68) were able to describe the context of the standards studied. Most of the design students referred to searches for standards in relation to their wide ranging design projects which included children’s toys, kitchen and a shower radio. Only fifteen students named specific standards. For example these two design students:

“Working on a brief for the early learning center the BS 3443:1968 was used to ensure adequate safety standards were achieved in the design.”

Currently designing cargo nets for aircraft - ISO 4115:1997

Fourteen students reported using process standards in relation to risk (ISO 31000), security (ISO 27000/27001) and quality management (ISO 9000/9001) such as this Masters student in security systems who reported:

“We studied ISO 31000 (Risk management) and were examined on the subject of risk management.”

Eleven students from engineering and design mentioned or described BS8888 for technical drawing such as this mechanical engineering student:

“Computer Aided Engineering and Design assignments (BS8888 standard)”

Nine students described using standards related to building and construction in projects or exams although generally without naming the standard:

“To analyze the methods of construction on a building site, the standards that were relevant were investigated and shown in detail as part of the assessment criteria”

“Construction management project designing a car park to British standards.”

“We study Eurocode 2 as an entire module (Including calculations, design projects and examination)”

Other domains mentioned included specific measurements in acoustics (BS 4142) or machine tools such as this one:

“BS ISO 230-1:2012, Test code for machine tools, Part 1: Geometric accuracy of machines operating under no-load or quasi-static conditions”

The remaining descriptions were usually specific to the subject area – such as food manufacturing, electronics, timber or marine vessel design or developing a test method for a dissertation; however no specific standards were named. Two students were required to investigate standards that might be relevant to their future employability.

The comments also captured an international element which included the use of the quality standard ISO 9001. A UK mechanical engineering student whose work placement was in Switzerland reported:

“Business module ISO9001 and ISO 14001. Placement year, loads of Swiss standards (working in Switzerland)”

While a contribution from a student studying for a Masters Degree in Quality Management in Greece reported using ISO 9001:

“Developing Quality Management Systems with ISO 9001. Customising ISO 9001 in Innovation Management Systems through CEN : TS 16555-1”

#### **What did the students know about standardisation**

The survey included a multiple choice test of common knowledge of standardisation. Around three quarters of the students managed to recognise that the main topic of the first ever standard was engineering, that standards are not laws, that the kitemark indicates a product has been independently tested and identified the correct acronym for ANSI. The question that caused most difficulty was that the CE mark indicates compliance with the European Directive rather than European quality standards.

#### **Importance of learning about standards**

More than half the students commented about what was important about learning about standards. For example, developing knowledge and understanding, and the benefits in relation to industry, work and the real world:

“Knowledge of compliance to standards helps to anchor creativity in the real world”

“Standardisation is the key for effective global business, standards are essential for effective communication”

“Learning about standards is important as it gives you a template of how you should tackle appropriate activities within an organisation”

“A background knowledge of working with and navigating standards was essential when transitioning to the workplace for an internship”

Practical applications were valued – both in learning how to access standards and applying them within a project.

“Give practical examples on how to apply them and when you should use them”

## Issues raised by students

The students raised the following issues:

- The students showed reasonable levels of understanding the importance of standards to industry, and personally to improving employability.
- The students acknowledged the requirement to find standards in relation to project work.
- The students identified the need to understanding content of standards, but needed more help with structure and content.
- The students preferred to be able to apply standards in a practical context.
- The students appreciated the international context of standards.

## Experience of employers

The survey of the employers aimed to discover the level of knowledge of Standards that employers would ideally like graduates and college leavers to have and to what extent this was achieved. This survey was attempted by 25 employers, of which 19 completed the survey. The employers were primarily engaged in various aspects of engineering, construction and manufacturing but also included interests in customer service, information management, health and safety and security. Nearly three-quarters rated standards as very or extremely important to their business sector and half of them participated in the development of national or international standards.

Two-thirds of the respondents (12) also had some responsibilities for recruitment and employing students and graduates. The sample size here is small, however the results indicated that nine of the employers offered full-time employment and seven additionally offered work placement or internships. Only two offered apprenticeships. All of the respondents recruited bachelor level students and a third recruited masters' level students, and two recruited people with professional qualifications.

When asked about requirements for prior knowledge of standards ten people indicated that good or very good knowledge of standards was required but seven of these indicated that students had much less or no prior knowledge. All of the employers involved in recruitment or employment indicated that on the job guidance was given to enable new employees to gain sufficient knowledge of standards and half provided in-house training courses. Three quarters offered company policy handbooks that included information about relevant standards and half provided a physical copy. Only two had access via BSOL

## Contents of standards

Employers were asked what standards are important to their employees. Only ten of the employers answered this question and half cited the quality standards ISO 9000 or 9001. Three named the environmental standard ISO 14001 and three named or described the health and safety standards BS OHSAS 18001.

All named two or more standards, and some of the groupings had obvious close thematic relationships such as:

- Fire Safety: BS 9991 and BS 9999 with BS 8300 accessibility to buildings for disabled people
- Quality and management: ISO 9001, with environment ISO 14001, OHSAS Health and Safety, BS 27001 Information security and BS 31100 Business Continuity

- Safety of machinery: BS 1005, BS 547, BS 614 as well as materials BS 11228 and the usability standard 9241.
- Electrical wiring standards (IEEE) with specifications for security systems BS 5013
- Customer service, health and safety and equality and diversity

This clustering of work related standards was much more pronounced than those described by the academics or students.

### **Access to Standards**

Employers seemed to rely more on physical copies of relevant standards than on online access via BSOL. None of the employers who replied to the survey appeared to have any knowledge of students' access to standards, or the possibility that students might have free access via BSOL. The access issue was further described by employers who asked for "better communication from Standards organisation on how to find relevant (standards)", "Making them less expensive, free to students." "Better availability and awareness". Employers also supplemented student knowledge through formal and informal training. It was felt to be a failing on the part of the educator and the standards bodies to fully prepare the student, as described by one respondent: "This should be made available as part of the course and not an additional cost to the employer once the student has graduated."

### CASE STUDY 5: Employer in Construction

An experienced consultant in the building and construction industry confirmed that standards are very important in that industry sector. He stated that standards should be seen as representing the minimum level that needs to be achieved. It needs to be recognised that they are often a compromise agreement, having international consensus.

The international element is very important in the construction industry on large-scale projects. He works in different countries - Europe and worldwide as well as UK. Projects are so big that materials may well come from several different countries but all need to work together. Materials such as steel may be sourced from USA, Japan and UK and can have different properties – so you need to specify what you need. Benefit of using ISO standards to cover a large chunk of the planet.

Standards tend to be too expensive. The Building Information Model (BIM) - is a PAS (publicly available specification, published by BSI), and has replaced previous BS 1192. Government decision to make it available for free to encourage take up with building publicly procured projects. BIM is a process standard - a good initiative and innovative and one where the UK is leading the way.

The Construction Contractor has a key role between the architect and builders, takes responsibility for procurement, building regulations and performance of the other contractors. Standards and building regulations are critical and BIM gives a process to manage communication between all parties and the client.

All sorts of regulations are important: thermal fire, sustainability. Building regulations sound fixed but are in fact interpretive - and one inspector can have different views to the next inspector.

**Requirement:** Graduates need practical experience to fully understand the construction industry and how to build buildings; this will include access to standards actively used in the construction industry.

### Information about Standards

Employers expressed concern over the students' apparent lack of understanding of the importance of standards. This was stated most clearly by one employer who wrote that there was a need for a 'clear explanation of why standards are important: legal, safety, commercial aspects' and another who stated that what was required was 'teaching them why standards are important as part of the studies.' BSI has an important role to play in providing this information to students, teachers and academics.

The need for support materials to enable students to access and use standards was identified by employers who asked for 'Crisper structure of standards including sharper relevance of titles', 'Overview compendium of subject areas' and material to assist the students to 'understand the terminology'.

### **Positioning of Standards**

Employers generally seemed to find that students were willing to learn about standards, but felt that this should have been addressed by educators. This would require curriculum designers and planners to work with industry to map and prioritise standards within the curriculum and teaching practice.

This issue was the one of highest importance to the employers. Students need to appreciate the importance of standards in general, especially in science, engineering and technology, although one person contested this view ('who cares, it's so cumbersome') and only one thought that there should be a course specifically on standards. For most others the context is more important than standardisation as a whole, and the requirement is to understand and apply standards in the relevant context. All the following comments indicate the desire from employers for standards to be included in the curriculum.

"They need to know the Basic Standards; they need to have the experience to implement standards in their work force."

"Understanding of the standards applicable to the industry"

"but give examples of use of standards"

"Greater opportunity to recognise and apply knowledge in practice, so that they understand the relevance in context."

"The three basic standards I have mentioned should in my opinion form part of the study for anyone wishing an industrial role within manufacturing."

"A good basic understanding of the importance of standards during design and manufacture to build a more specific more detailed knowledge from."

The employers who filled in the survey were self-selected, and many had active involvement in standards and standardisation. The three following comments give a flavour of their thoughts with respect to the teaching of standards.

"If standards are important to industry - students need to be made aware during their education - finding the appropriate time to fit this into the curriculum is critical. Many of the students I see have a very basic knowledge of industry at all let alone the standards we work to."

"I provide induction training for new starters in our department (mainly graduates), and none of them seem to have had any training or induction into standards at all. This seems to be a serious failing in universities."

"There needs to be a fundamental and significant change to executive thinking in the approach to managing risk and the way that demonstrating conformity with published standards can provide evidence of due diligence with ever increasing regulation."

### **Issues raised by employers**

The main issues raised by employers were the cost to themselves in providing training to supplement the knowledge of new graduates, the need for students who were working on

international projects to know about relevant standards and the value put on knowledge about standards in various fields of employment.

## Examples of Teaching about Standards

The following example demonstrates how a Master Level module is structured around a specific process standard. This example was presented to the workshop at BSI on February 28<sup>th</sup> 2014 and was used to focus discussion on how to engage students with standards.

### Example: Distance learning risk management and information security

A distance learning module in risk management and information security attracts around 100 students studying for a masters in information security. ISO 27001 and 27002 in risk management are a critical part of the teaching and learning and students have full access to the standard through the online library facilities.

The teaching follows the process set out in the standard and students take a practice based approach within their own organisation to apply the risk management process. Critical thinking about the issues and a theoretical framework linked to the development of the standard ensures that the quality of the assessments meets the requirements of a masters level programme. Critical thinking forms part of the course assessment as the students consider how to apply the various stages of the process carrying out a real risk assessment and they must also analyse and evaluate the results of their independent research for an end of module assessment.

Quoting from one of his own students

“It provoked different perspectives for me to consider within security and it challenged me to think about things differently.”

The lecturer raised the following issues about using standards within masters level teaching:

- theoretical positions are an important part of critical thinking and the conceptual basis of some standards is unclear,
- the standard is not self-contained in relation to the topic and other standards and resources are needed,
- this practice based learning strategy is highly dependent on the employer providing institutional access,
- there is concern by academics and others that standards may fall ‘behind the curve’ of technology practice and leading edge solutions,
- the update cycle is not education-friendly – changes in the middle of a teaching phase can be very difficult to accommodate in the learning outcomes and assessment. Course content and materials have to be agreed, approved and delivered in advance and especially so with distance learning.

A supplementary issue was raised by the librarian for this institution of the difficulties of ensuring the same level of access to standards as to other academic publications. There is no deep-linking, meaning it is not possible to provide an embedded link within the elearning materials or library resources direct to the relevant standard or section within the standard.

**Requirement:** BSI need to consider the academic need for theoretical underpinnings and the wider context of Higher Education Courses and the requirements of contemporary elearning teaching.



## Gap analysis

The study identified many examples where teaching about standards is integrated into Bachelor and Masters level courses and programmes.

The first part of this section summarises the main points from the case studies included in the previous sections

The analysis of the results of the survey and comments generated during the two workshops reveal issues where there is scope for sharing good practice, and identifies opportunities for providing better support for the educational environment.

## Case study reflections

The case studies in general show that British, European and International Standards do play a key role in many areas of education. For example their use is mandatory in for performing risk assessment of the practical equipment and machinery in a lab and for performing construction checks during a building programme. At the same time some courses draw more generally upon a wide range of standards to assist in completing project such as the design of a monorail system or timber construction where students need to show they understand and can apply the relevant standards. Other courses rely in general principles from standards such as quality management, communication between different contractors on a building site and principles for user-computer interface design.

There was a suggestion that in consultation with the professional bodies, BSI could issue a table of which standards should be used for different parts of the teaching. This would ensure that the most relevant standards are used and that students are made aware of others.

Making Standards available to students' remains an issue although for educational institutions that subscribe to BSOL this is mainly a matter of communicating to the students how they can download the Standards themselves. For those institutions who do not subscribe then special arrangements need to be made either by teaching staff or by library staff.

Not all teaching for Standards requires direct access to the original documents and some staff can use summaries of key points to support a classroom exercise. It was widely felt that the provision of teaching and materials and exercises would be helpful for teaching staff and would certainly help promote an appreciation of and the use of Standards in educational courses.

The phase lag that occurs in standards keeping up with the latest practices in industry and technologies is an inevitable part of the standardisation process, and indeed while some courses do require the latest versions others can manage with older versions in order to practice applying the principles embodied within them. However it was felt that Standards users do need to be made aware if a standard is not the latest and also to be informed of what the committees are working on and the timescales for release so they can plan future courses effectively.

## Access to standards

Both academics and students commented on the complexity and difficulty of finding standards. At one University different academics had different beliefs in the availability of standards. Access to

BSOL varies between institutions - from full text access launched through the library software, to limited number of standards and no access. Knowledge of the access is confused amongst individual academics and students. Students trying to access BSI standards through Google reported problems identifying the appropriate part of the BSI website to access and finding the shop rather than BSOL. For those searching independently, the search engine on BSOL was criticised for not searching within the text of the standards.

The lack of deep level linking within BSOL compounded the problem, especially in relation to e-learning environments and when working remotely from their home campus because academics could not provide a direct link to the required standards. Students (and academics) did not always know what to search for once they had followed a link to the home page of BSOL. A number of the librarians felt that access to BSOL compared negatively to the access to other resource databases that the students' use.

It is important for librarians, academics and students that access to BSOL is compatible with the online library services, including systems such as Talis Aspire and Summon which run searches across all publications held by the library. The method of sales of individual standards was felt to be inappropriate for academic use for organisations without BSOL membership by one librarian who expected to buy a bound copy or an activated link and was not able to store or manage an electronic file or unbound text.

One academic reported that 'If I was not so involved with Standards, it is doubtful whether the knowledge about the usefulness and relevance of a wide range of Standards would be brought to students' attention.' Many of the academic respondents were already involved in the standardisation process. It is not easy for the many academics who are not expert in standards to locate the standards to support their teaching.

## **Finding and selecting relevant standards**

The academic staff mentioned over fifty standards but there was little consensus and most were only mentioned once, the students mentioned some standards by name but more often described the context. Employers' interests in standards appeared to be clustered in relation to specific domains.

Table 5 shows where there was some evidence of commonality between the three groups surveyed and there was at least some shared interest in 9001, 14000 and 8888. It would be interesting to pursue where teaching might be ahead of industry such as ISO 31000. The data set is insufficient to draw any firm conclusions, but given the large number of standards mentioned for which there is no overlap suggests that there is room for improvement in consensus and in identifying industry critical standards.

Both the academics and students need support in identifying appropriate standards, identifying related groups of standards and keeping up to date with new developments. It is likely that some consensus is achievable as to the most important standards on specific topics.

Table 4 Overlapping standards between academics, students and employers

Standard	Academic	Student	Employer
ISO 9000/1 quality	x	x	x
ISO 14000 environment	x	x	x
BS 8888 technical drawing	x	x	x
ISO 27000 information security	x	x	x
ISO 31000 risk	x	x	
ISO 18001 occupational health and safety	x		x
ISO 9241 usability	x		x
ISO 8300 design of buildings	x		x
ISO 19011 auditing management systems	x		x

x = used

## Teaching support materials

Some support material is available within BSI and BSI education, although it is of concern that references include standards listed as withdrawn.

A number of the academics identified the need for BSI to engage with Higher and Further Education more proactively. Suggestions from the research included the suggestion that BSI provide:

“support material for lecturers and students, including background to standards content”.

“case study examples of good practice in using standards”

There were requests for case study material to match with the teaching method used and the field of work which demonstrated the benefit of applying a standard within a specified activity. For integration with practices in higher education such case studies need to support analysis and critical thinking as demonstrated by some of the examples of teaching practice described by academics and students.

Academics who are not actively engaged with standards and standardisation will need much more help to find individual standards and sets of standards in their area, to enable them to be made aware of changes and updates to standards, and to show how they can be embedded into the teaching syllabus at an appropriate level.

In addition BSI needs to promote the availability and usefulness of standards as an academic resource. Opportunities for communicating with academics include linking with STEM initiatives, presenting papers and running workshops at teaching and learning conferences, working with JISC to promote training in the standardisation area and identifying communication opportunities with the

Higher Education Academy (including the opportunity to run workshops). Lecturers are also continuously under pressure to maintain their research activity, and to disseminate the results of their research to a wider audience. There is a potential for mutual benefit to BSI and the academic to share leading edge issues and results that impact on standards development.

## Creation of new knowledge

At the higher education level it is expected that students will show higher level critical thinking – such as analysing and evaluation. By Masters Level students are expected to participate in the creation of new knowledge. As predicted, at HE levels the results indicate that students were not expected to simply remember or recall information but were required to demonstrate higher levels of cognitive engagement through understanding, applying and analysing. The students particularly reported on assessments that involved applying the standard to a design or measurement. The students also reported having to find appropriate standards. There were however only limited examples of student involvement in standards creation and this gap has the potential for engagement of top research students and future academics.

Table 5 Analysis of teaching levels

Category	Draft Suggesting Mapping to Standardisation HE and FE Teaching	Gap Analysis
<b>Remembering:</b> Recall previous learned information.	<b>Level 1</b> – Teaching of Individual Standards	Students were introduced to specific named standards but not required to remember their text. This approach is appropriate at this level of education.
<b>Understanding:</b> Comprehending the meaning, translation, interpolation, and interpretation of instructions and problems. State a problem in one's own words.	<b>Level 2</b> - Introduction to concept of Standardization	Students were expected to demonstrate understanding standards through assessed work. There was almost no teaching on the process of standardization.
<b>Applying:</b> Use a concept in a new situation or unprompted use of an abstraction. Applies what was learned in the classroom into novel situations in the work place.	<b>Level 3</b> – Student enabled to apply standard in new situations.	Many students were expected to apply standards to take measurements, utilise methods, or processes or within a design project.
<b>Analysing:</b> Separates material or concepts into component parts so that its organizational	<b>Level 4</b> – Student enabled to select between standards.	Students were expected to analyse standards and compare with other conceptual and theoretical frameworks.

structure may be understood. Distinguishes between facts and inferences.		
<b>Evaluating:</b> Make judgments about the value of ideas or materials.	<b>Level 5</b> - Student enabled to select between standards and utilise elements as required (particularly relevant for new areas of work).	Students were expected to independently find and critically evaluate standards.
<b>Creating:</b> Builds a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.	<b>Level 6</b> - Encouragement to take part in real Standardization activities.	Only 6% of academics reported teaching the students to create standards. Both interest and negativity were demonstrated with respect to the idea of students working on the creation of standards.

## Student employability

There was overwhelming belief from over two thirds of the students and academics that learning about standards increased the employability of the students. In some domains such as construction and engineering there is a strong requirement for knowledge about standards. The employers in these domains referred to a lack of knowledge of standards by new employees as a cost to themselves, and offered support through formal and informal training:

“this should be made available as part of the course and not an additional cost to the employer once the student has graduated.”

One academic on describing the need for additional easy to use information for students to access before they entered employment echoed this feeling and said:

“It is not information they generally find interesting, and until in the work place, they seem to find it really hard to truly understand why they are relevant to them”

The benefit to students’ employability of learning about standards is an obvious area for BSI to exploit.

## Analysis of international comments

The international survey was completed by 17 international representatives and partially completed by a further 8 people. The respondents were based in 14 countries, mostly Europe but including Canada and Russia. Four respondents from UK reported in relation to their international roles and activities:

- |                   |                |            |
|-------------------|----------------|------------|
| 1. Austria        | 6. Greece      | 11. Russia |
| 2. Belgium        | 7. Ireland     | 12. Sweden |
| 3. Canada         | 8. Macedonia   | 13. Turkey |
| 4. Czech Republic | 9. Netherlands | 14. UK     |
| 5. Denmark        | 10. Portugal   |            |

They covered a range of disciplinary backgrounds:

- |  |  |
|--|--|
| 1. Accessibility; Universal Design; Design for all (3)     | 10. Human factors and ergonomics                 |
| 2. Computer Science  | 11. MD, ergonomics, health and work policy       |
| 3. Consultancy and training on market access and standards | 12. Mechanical engineer                          |
| 4. Engineer  | 13. Product Safety                               |
| 5. Family and Consumer Science                             | 14. Public Health, Child Safety, Risk Assessment |
| 6. Fire & Safety   | 15. Public policy and legislation                |
| 7. Food  | 16. Standards professional                       |
| 8. HCI, Design for All, Information Design                 |  |
| 9. History, European studies, regional integration         |  |

Their professional roles include professor/academic/trainer (5), consultant (4), manager (4) and other (4).

Further comments were received about the continuing support provided by W3C (World Wide Web Consortium) and the Web Accessibility Initiative (WAI) for ISO/IEC 40500:2012 [Web Content Accessibility Guidelines (WCAG) 2.0]

The respondents acknowledged the importance of standards in the International context;

“When considering standards it’s important to recognise that this is not just BSI or a few national bodies. There are a huge number of organisations who are responsible for standards including companies who produce their own. To understand standards importance it is necessary to understand this full range and how they interlink with society and commerce.”

“To my mind the ideas of this Questionnaire are very important for the development cooperation in this field between Russia, European Union, APEC, UNECE and ITU.”

“If future generations are to continue to value consensus-based standardisation over proprietary technical solutions, academic understanding has to be improved.”

There was a very positive response for the need for students to be able to find, understand or apply standards of the respondents 14 rated this need at 4/5 or 5/5. The respondents explained the importance both in relation to the content and the standardisation process;

“Standards define the acceptable state of the practice. They are the result of broad consensus (as opposed to the personal opinions of an individual or small group of individuals that is found in a text book). As such, they identify the issues that are truly most important in general within their field.”

“Depends on the academic discipline, but in technical areas, knowledge of standards is essential, in areas such as business education highly desirable, etc. NB the issue is not just about understanding standards, but particularly at postgraduate level, it is understanding how standards are developed and amended.”

Respondents were generally agreed about the need for standards bodies to do more to promote standards, and that knowledge of standards was important to the discipline. While there was little concern about standards being too difficult, there was little support for the statement that students are generally knowledgeable about standards or that teaching of standards seems generally good. The following additional comments were made:

“It is important to organise more awareness and involvement in standardisation. Exchange of knowledge and practice in standardisation group members gives input for new research questions and improvements in business processes.”

“More pressure on academic institutions is needed to ensure standardisation is included in higher education curricula and indeed referred to appropriately in high school.”

“Colleagues also have difficulties with standards, they were not taught deeply about them.”

## Access to standards

### Finding Standards

The following methods were suggested as ways for students to improve their ability to search for standards or draft standards:

“Better information design including visualisations, especially overviews of topics and related standards could be useful...”

“Partnership between universities and standards bodies widely disseminated”

“BSI should also promote the use of standards in academic research, so that teachers, lecturers etc have knowledge of standards to alert their pupils to.”

“It isn't just students who need better access to finding applicable standards. It is a difficulty even for standards developers.”

“Engage best practice, eg some European countries foster cheap on-line access to standards for students.”

The following statement provided some practical advice on improving finding relevant material:

“Everyone, not only students, should be "able to find, understand or apply standards".

Some techniques used by W3C include:

...draft standards are permanently archived using "date-space" URLs to ensure that any reader can find the latest version of the standard or its draft.....We also look at search engine optimization and other mechanisms to direct readers to the most suitable resources first.”

These points can be summarised as the need to provide additional descriptive content on standards, to work with academics and students and to investigate the effectiveness and usability of the search tools.

### **Connecting Academics, Researchers and Standardizers**

The following suggestions were made as to how the linkage or communications between standard committees, academics, researchers and PhD students could be encouraged.

“Hold standards meetings in Universities.”

“Internships for the students and the university staff.”

“Joined up training for academics, representatives of industry, standard committees, trade authorities... “

“Student section on standard body website.”

“Standards development often lack the support of good and updated research, technical committees could approach universities for research purposes.”

“Universities could promote seminars on a topic.”

“Standards bodies should better promote the existence of new and existing committees to academics, to reach researchers and PhD students.”

“Internal advocacy: Having academics being standardisers, having them communicate with their researchers and PhD students and colleagues.”

“W3C/WAI provides a broad collection of materials that are suitable for training and for course settings, and are in the process of developing more..... We welcome participation and contribution to the development of these materials.”

“Some recognition from academic community for standards work.”



These points can be summarised as the need to connect both at the research level and at the teaching level, and to reward and promote such connectivity.

## Information about Standards

The respondents reported the following thoughts with respect to the use of more images and images in colour or other ways of making future standards more accessible and usable:

“They do need to be better illustrated to make them easier to understand.”

“For an Introduction course it could be very useful.”

“Standards themselves need to evolve (and maybe will do so) into an interactive on-line resource.”

“My many years of working in standardisation convinces me that the style and wordiness of standards cannot be changed!”

“Remember that standards are created by volunteers. Standards development organizations already place too many burdens on volunteers.”

In conclusion the respondents believed in the importance of presentation of standards but acknowledged the practical difficulties of changing the way in which standard committees work and in asking the committees for additional material. Standards must also be accessible to those with visual impairments.

The respondents suggested a number of ways of improving the provision to academics and students information about changes or updates to standards including mailing lists, notifications and social media. It was also suggested that the standard bodies should provide specific people to work with academics and students.

The respondents were asked if they could point to any examples of support materials (e.g. guides to individual standards or groups of standards, why certain standards exist, or brief descriptions or summaries of standards).

“Accessibility is a more complex topic that requires an understanding of the context and technical solutions to implement properly. Thus we spend a lot of resources on explaining the concepts and the standards, and provide a lot of support materials around them. We encourage other technical standards bodies to do the same for other areas of ICT.

An overview of introductory materials is available at:  
<http://www.w3.org/WAI/gettingstarted/Overview.html>”

“The IEC web page on electrical outlets and plugs: <http://www.iec.ch/worldplugs/map.htm>.”

“The CEN/CENELEC Joint Working Group on Education about standardization (JWG-EaS)  
<http://www.cencenelec.eu/standards/Education/JointWorkingGroup/Pages/default.aspx>”

“ISO Technical reports for example; ISO/TR 12295:2014, Ergonomics -- Application document for International Standards on manual handling.”

“System Concepts publicises standards on its website <http://www.system-concepts.com/articles/usability-and-ergonomics-standards.html> “

“ANEC [www.anec.eu](http://www.anec.eu) “

“Child product safety guide of the European child safety alliance :  
<http://www.childsafetyeurope.org/publications/info/product-safety-guide.pdf> “

“ISO/IEC Guides for example ISO/IEC Guide 71”

## Positioning of Standards

The respondents suggested the following ways to map standards to curricula and teaching practice, or ways to encourage the active inclusion of standards in the curriculum.

“Promote, promote, promote. No substitute for individual contact in countries like the UK where education is fragmented, easier for France where it is centralised!”

“In the Design for All curricula taxonomy developed by IDCnet, there was a large subject area labelled ‘recommendations’: This was a catch-all for principles, standards and guidelines, relating to Design for All.”

“Students are taught that they must not reinvent the wheel, they must be guided by what recommendations already exist, and also that these should not be seen as constraining, (a common view among students and practitioner designers) but as inspirational.”

“At WAI we spend a lot of resources on education and outreach to meet this goal. This includes developing introductory materials to the technical standards (such as the "intro pages") and other materials explaining how to understand and apply the concepts of accessibility.”

“Standards are covered by copyrights that are vigorously protected. This discourages text authors from using, reviewing or quoting them. There is a need for an easy approach to allowing text authors to find out about relevant standards.”

The respondents made the following suggestions on how to promote standards as a valued resource within the academic community.

“Step 1 must be to make academics aware of Standards and their importance. They will then be equipped to pass it on to their students.”

“Develop and promote more fully understanding of standardisation as a professional quality, even as a discipline. “

“Higher profile for academics who do use and work with standards and who contribute to the research that goes into standards (I previously mentioned recognition).”

## Follow on Research

The aim of Further and Higher Education is to develop the student's knowledge, skills and competences. Working with standards has a place in this, not as a rote learning exercise but as a way of understanding a field of work. Standards appear to be used in some courses in the areas of engineering and technology but less so in business and other softer areas. In order to maximise the use of standards in education it is recommended that:

- BSI should analyse its available data of the main (best selling) standards and create a map which links these standards to relevant curriculum areas. This would result in a prioritised list of standards and topics to promote to the academic community.
- Professional associations and skills councils have a key role in defining curriculum requirements. Research should establish connections to the activities of these bodies particularly in the areas of science and technology. This would reinforce and reinvigorate the connection between standards and science and engineering community.
- BSI needs to link with both the HEA and research councils to work to embed standards in all elements of academic practice. This piece of research should take notice of the way in which PhD students, as academics of the future, can be encouraged to work with standards. The spilt in the academic world can be identified by the different activities of the Higher Education Academy (HEA) for leading policies on teaching and the Research Councils for leading policies on research.
- Further investigation is needed into academic areas such as Business and other softer areas where there is currently low or no usage of standards. This research should focus on areas where existing standards are known to be used in the commercial world but not integrated into teaching practice.
- Practical research is required with small group of academics in each of the main sectors to see what specific resources they want and to collect examples of relevant material that already exist (e.g. teaching materials and exercises). Academics are likely to be prepared to have this material disseminated on behalf of the BSI (if they received appropriate acknowledgement). This could lead to the development of a BSI portal for educationalists to access teaching materials.
- Best practice in the teaching of standards should be shared Internationally.

## Appendix 1 Method and sampling

Data was gathered through the development of three surveys aimed at academics who teach standards, students who are learning about standards and employers who employ students with knowledge of standards.

The academic survey has addressed the main aim of the project to identify where teaching about standards is taking place, in what disciplines and at what level. More detailed questions include access to standards, experiences of the benefits and barriers of teaching standards and an open question on required changes.

Sampling was addressed by a number of routes. These include identifying academic contacts of the research team members and those already in contact with BSI education. We have also used a science and technology mailing list to invite librarians to link with academics where BSOL membership is held.

The industry survey covered some similar questions to the academic survey, to identify the source of the informant and industry sector. Subsequent questions invite a comparison between the required level of knowledge of standards, the actual level of knowledge demonstrated by students and subsequent staff training. An open question was included on required changes.

Sampling was addressed by a number of routes to identify possible respondents with experience of student recruitment and standards, including a university student recruitment office and link officer to CBI. Additional efforts were directed via BSI committees and towards trade and professional organisations to identify suitable respondents.

Finally, the student survey was developed to assess their experiences of the teaching of standards and availability. Suitable questions were initially piloted with students having recent teaching about standards. A quiz was added to further explore the knowledge of standards.

Sampling strategies included locations where standards are included in the teaching. Respondents to the academic survey were invited to encourage their students to participate, and librarians asked to use their social media networks to advertise the survey.

All three surveys were prepared and distributed using Survey Monkey. Analysis of the results was supported by Survey Monkey tools to provide spreadsheet data, response summaries, and individual survey results.

In addition two workshops were held – one at Loughborough University with the Design School Staff who had taken part in the survey with the addition of one student, and one at BSI London. This workshop was attended by five librarians and 4 students, with one academic respondent who presented an example of best practice in relation to teaching about a standard.

## Appendix 2 Results from questionnaires

### Academics – who, where, what?

The survey was completed by 45 academics with a further 18 completing it partially, making a total of 63 responses.

The academics originated from 24 UK universities, and two FE colleges. Five of the universities were overseas. The largest group response was from Loughborough University where 12 Design School academics completed the survey. There were 4 surveys returned from each of the Universities of Bath and South Bank, London. In most cases (two thirds), there was only one contribution per university.

The academics were asked to indicate their areas of interest using the domain and topic lists used by BSI. This question was completed by 57 people. There was strong support from engineering (44%), design (25%) and manufacturing (23%). Support from ICT was lower than expected (16%) and information management (9%). Most people selected from more than one domain or topic, with a third of the respondents selecting 5 or more topics.

Table 6 Top business sector interests (academics)

Business Sector	% (n=57)
Engineering	44%
Innovation and design	25%
Manufacturing and processing	23%
Automotive	21%
Electrical and electronic	21%
Construction and building	19%
Environmental management and sustainability	19%
Measurement and metrology	18%
Risk	18%
Energy and utilities	16%
ICT and telecoms	16%

Notably low representation was achieved in relation to business services such as Corporate Social Responsibility (CSR), customer service, facilities management, commerce and finance and data protection. This lack may be due to our sampling strategy although the higher proportion of responses from engineering, design and construction demonstrates traditional standards strongholds.

Two thirds of the academics were teaching students studying for Bachelor or Masters level qualifications. Nearly one third selected 'other' and indicated PhD, professional development, diploma and certificate courses and short courses. Just under 10% also had students studying at BTEC or HND.

One third of the academics participated in the development of new standards and just under half the academics said that they followed the development of new standards. Of the remainder, 13% thought that standards in their area were stable. Of the 20% claiming 'other' some admitted to not keeping up to date with new developments, or not having a need to do so.

**Table 7 Business sector, least interests (academics)**

<b>Business Sector</b>	<b>% (n=57)</b>
<b>CSR and governance</b>	7%
<b>Customer service</b>	7%
<b>Facilities management</b>	5%
<b>Fire</b>	5%
<b>Food and drink</b>	5%
<b>Welding</b>	5%
<b>Commerce and finance</b>	4%
<b>Data protection</b>	4%

### **Students – who, where, what?**

The survey was completed by 95 students; a further 13 partially completed it making a total of 108 students.

The students originated from 15 universities with particularly strong representation from Brunel University, and good representation from Middlesex, Greenwich, Brighton, University College London, and Loughborough Universities.

The students were from different programmes and analysis of their course titles indicates strong representation from various aspects of computing, engineering and design:

**Table 8 Student degree sectors and topics**

<b>Degree subject area</b>	<b>% (n=104)</b>
<b>Computing - science, networks, security</b>	29
<b>Design - product, industrial and engineering</b>	22
<b>Engineering - mechanical, civil and electronics</b>	20
<b>Engineering - aeronautical, aviation, aerospace and automotive</b>	8
<b>Acoustics</b>	5
<b>Ergonomics</b>	4
<b>Business, management, finance, quality</b>	4
<b>Architecture, construction, surveying</b>	3
<b>Other</b>	6

### **Employers – who, where, what?**

This survey was completed by 19 employers a further 6 partially completed it making a total of 25 employers. Of those starting the survey by giving personal details, 15 were from the UK, 6 were international. Half had an active role in standards development and nearly three-quarters said that British and International standards were very or extremely important to their business section.

The employers showed interests in manufacturing, engineering, construction industries, but none had declared interests in commerce and finance, ICT and telecoms, data protection or facilities

management. In general, interests were limited to one or two sectors. Those with more wide ranging interests appeared to have a strong role in standards creation or dissemination (2 people) or design (1 person).

Nearly two thirds of the respondents said they were actively involved in recruitment and completed the section of the survey about graduate recruitment.

**Table 9 Top business sector interests (employers)**

<b>Sector</b>	<b>% (n= 18)</b>	<b>Number</b>
<b>Manufacturing and processing</b>	33%	6
<b>Engineering</b>	28%	5
<b>Automotive</b>	22%	4
<b>Construction and building</b>	22%	4
<b>Customer service</b>	17%	3
<b>Electrical and electronic</b>	17%	3
<b>Environmental management and sustainability</b>	17%	3
<b>Fire</b>	17%	3
<b>Innovation and design</b>	17%	3
<b>Quality and business improvement</b>	17%	3
<b>Security</b>	17%	3

## Appendix 3 Standards Named in the Survey

### Standards mentioned by Academics

Text descriptions also included 'various'.

- |              |                     |                |
|--------------|---------------------|----------------|
| 1. BS0       | BSEN1995            | 47. BSISO55000 |
| 2. BS1377    | 26. BSEN1996        | 48. EN14801    |
| 3. BS18001   | 27. BSEN60404       | 49. EN1995     |
| ISO18001     | 28. BSEN60601       | 50. EN338      |
| 4. BS2782    | BSEN60601           | 51. EN408      |
| 5. BS4142    | 29. BSENforleadwork | 52. EN71       |
| 6. BS4163    | 30. BSENIEC60300    | 53. ENISO19011 |
| 7. BS4978    | 31. BSENISO2631     | 54. ISO13407   |
| 8. BS5228    | 32. BSENISO9001     | 55. ISO13674   |
| 9. BS5588    | BSENISO9001         | 56. ISO14000   |
| 10. BS5884   | ENISO9001           | ISO14000       |
| 11. BS5930   | ISO9000             | ISO14001       |
| 12. BS60068  | ISO9000             | ISO14001       |
| 13. BS6079   | ISO9000             | BSENISO14001   |
| BS6079       | 33. BSENISO10819    | 57. ISO14040   |
| 14. BS7373   | 34. BSENISO140      | 58. ISO16000   |
| 15. BS7445   | 35. BSENISO14971    | 59. ISO26000   |
| 16. BS7671   | 36. BSENISO27001    | 60. ISO27007   |
| 17. BS8233   | 37. BSENISO27002    | 61. ISO27008   |
| 18. BS8300   | 38. BSENISO31000    | 62. ISO4138    |
| 19. BS8555   | ISO31000            | 63. ISO7401    |
| 20. BS8888   | 39. BSENISO31010    | 64. ISO8317    |
| BS8888       | 40. BSENISO5349     | 65. ISO9241    |
| BS8888       | BSENISO5349         | ISO9241        |
| BS8888       | 41. BSIISO1087      | ISO9241        |
| 21. BS8900   | 42. BSIISO860       | ISO9241        |
| 22. BSEN131  | 43. BSIISO22134     | ISO9241        |
| 23. BSEN1991 | 44. BSIISO704       | BSENISO9241    |
| 24. BSEN1992 | 45. BSISO37         |                |
| 25. BSEN1995 | 46. BSISO48         |                |



## Standards mentioned by Students

1. BS 3443	10. ISO 4115:1997	Hydraulics and soil mechanics
2. BS 4142	11. ISO 9001	Loads of Swiss standards
BS4142	ISO 9001	Manufacture and food grade specifications
3. BS ISO 230-1:2012	ISO 9000	Material selection
4. BS8233	12. ISO14001	Methods of construction on a building site
5. BS8888		Noise and vibration
BS8888		Product for a disabled child
BS8888		Risk assessment
BS8888		Risk Assessment
6. CEN : TS 16555-1		Risk assessment
7. Eurocode		Security in computer networks
Eurocode 2		Technical Drawing
8. ISO 27001/2		Technical drawings
ISO 27001/2		
ISO27000		
9. ISO 31000		
ISO 31000		
ISO 31000		
ISO 31000		

The following descriptions were given with no standards number associated:

Building standards  
Construction  
Construction management  
Design of marine vessels  
Dimension my engineering drawing  
Disability and inclusive design coursework  
Engineering drawings

## Standards mentioned by Employers

1. BS 31100
2. BS 5013X Series
3. BS 8300
4. BS 8888
5. BS 9000
  - ISO 9000
  - BS EN ISO 9001
  - ISO 9001
  - ISO 9001
6. BS 9991
7. BS 9999
8. BS EN 1005 series
9. BS EN 547 series
10. BS EN 614 series
11. BS EN ISO 12100
12. BS EN ISO 14001
  - ISO 14001
  - ISO 14001
13. BS EN ISO 25999
14. BS EN ISO 9241
  - series
15. BS ISO 11228 series
16. BS OHSAS18001
  - OHSAS 18001
17. ISO 19011
18. ISO 27001
  - ISO 27001
19. ISO/IEC 20000
20. Customer Service standards
21. Electrical wiring standard to IEEE 17th edition
22. Equality and Diversity
23. Health and Safety Standards