

What is engineering education for? Listening to the voices of some Spanish building engineers

What is
engineering
education for?

897

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Received 10 April 2015
Revised 1 July 2015
Accepted 13 July 2015

Abstract

Purpose – Aristotle’s concepts of “episteme”, “techne” and “phronesis” are used to understand the relevance of the education that Spanish building engineers receive to their subsequent work as construction site managers. This paper aims to clarify the role of educational factors as they influence any disparities that building engineers who are working as site managers may feel. More specifically, the objectives are to explore the satisfactions and dissatisfactions they experience in doing their job; to describe the ways they find to cope with educational deficiencies; and to gather their suggestions for improving building engineering education.

Design/methodology/approach – Using an interpretive approach within the qualitative paradigm, this study draws on data obtained from semi-structured interviews with a sample of 34 building engineers working as site managers in Castilla-La Mancha (Spain).

Findings – According to the site managers themselves, Spanish universities mainly teach Aristotle’s episteme (abstract knowledge and general principles) and some techne (applied, technical knowledge and skills), which fall short of the expectations placed upon them by their employers.

Research limitations/implications – Because of the chosen research approach, the sample size is relatively small and results may lack generalisability.

Practical implications – The results have practical implication for building engineering curriculum design related to the enhancement of building engineers employability and job satisfaction.

Originality/value – The existing literature offers insight into job-educational mismatches of different occupations in different countries, drawing on survey questionnaires. There is, however, a gap in respect of Spain and the job of the construction site manager. This paper goes some way towards filling that gap, reporting on the experiences of some higher education “customers”: Spanish building engineers working as site managers.

Keywords Construction project management, Job satisfaction, Construction, Spain, Design education, Education and professional development, Curriculum development, Engineering education methods, Aristotle, Building engineering education, Qualitative methodology, Site management

Paper type Research paper



The authors wish to thank Dr David Seymour for his advice and comments on the previous version of this article.

1. Introduction

The role of universities in public life has evolved over nearly ten centuries in Europe. From their ecclesiastical beginnings, they came under the influence of the rediscovery of Greek texts, particularly those of Aristotle and his concept of doctrine or science (*episteme*) – knowledge and learning for their own sake (Weingart, 2010; Himanka, 2015). Certainly, there was recognition of practical applications, and progressively, preparation for liberal professions such as law and medicine featured more strongly. Education for careers in science and engineering varied throughout Europe. France and Germany, for example, established schools in the late eighteenth century where the study of mathematics and the use of experimentation and their applications became prominent. In Great Britain too, though the universities and “learned societies” fostered scientific research, for the most part, industrial and engineering developments originated in the practical skills acquired in a wide range of “applied” occupations like millwrights, masons and iron workers (Pollard, 1965; Kingsford, 1973). As late as 1967, in the UK, Christopherson felt the need to write a book “The Engineer in the University” *justifying* the acceptance of engineering as a bona fide academic discipline (Christopherson, 1967).

In the last 40 years or so, there have been many changes in higher education reflecting thinking about social/economic priorities. As Boni and Gasper (2012, p. 451) write: “increasing priority has been given to a narrow focus on contribution to supporting economic production and growth as part of an economy-centred and market conception of society”. They also note that “there is no consensus about what a good university is” (Boni and Gasper, 2012, p. 451).

With respect to the formation of people destined to work in the construction industry, historical questions about what a university is and what it is expected to provide are still very much alive. In South Africa, for example, concerns about the perceived mismatch between the industry requirements and graduates’ skills obtained at tertiary institutions has been recently outlined (Othman, 2014). In broad terms, the issues ranged are seen as follows:

First, do universities teach abstract knowledge and general principles, knowledge of the common and general laws of nature and Aristotle’s *episteme* (as in the French tradition of elite Grandes Ecoles)? Do they emphasise applied and technical knowledge and skills, and the “know-how” used when man tries to influence his environment – what Aristotle refers to as *techne* (as in the tradition of UK Polytechnics until they were reclassified as Universities in 1992)? Or do they emphasise *phronesis*, that is, knowledge which aims to reconcile abstract, practical and ethical considerations, recalling the original aims of universities when they were established many centuries ago (‘Universitas (Latin) = “a whole”’)? (Himanka, 2015; Flyvbjerg, 2001 and 2006; Salminen-Karlsson and Wallgren, 2008). According to Eisner (2002, p. 381), *phronesis* is “the ability to deal with what might be called the dynamics of practical situations”, and it is concerned with judgment for a good end in a particular situation. Salminen-Karlsson and Wallgren (2008) believe that *episteme* and *phronesis* should be considered as the goals of graduate education.

Despite the fact that the Spanish University of Salamanca was established in 1218, the celebrated philosopher Ortega y Gasset accused his fellow Spaniards of being “bumpkins” and urged them to recognise the potentials of science but also the human

spirit which made it possible.’ (Ortega y Gasset, 1992, p. 37). This could mean that he, too, applauded the concept of *phronesis*.

Second, if all these forms of knowledge are acknowledged to be important for socio/economic development, where are they to be acquired: at the university or via other agencies? For example, what is the most suitable division of labour between the university and on-the-job training and development provided by employers? As a case in point, a traditional model in the UK is that theoretical principles (*episteme* and *techne*) are learnt at the university and their application and professional and ethical implications (*phronesis*) are learnt on the job en route to becoming a chartered engineer. The responsibility for conferring this qualification is a professional body, for example, the Institution of civil engineers.

Boni and Gasper (2012, pp. 453-454) offer an alternative model:

[T]he view of the university we propose [...] is a vision of a university that takes an active role, that practises and disseminates a way of doing based on ethical principles, which is engaged with all social actors, looking not only for economic opportunities but also with the aim of empowering individuals and groups, increasing mutual understanding, and strengthening the relevance, reach and responsiveness of university education and research.

Having summarised the vast range of issues involved in this debate about what universities are for, a yet briefer summary is offered. On the one hand, there is the acquisition of knowledge for its own sake with the *possibility* of application, but on the other, there is prime commitment to issues of application, usefulness, and, importantly, ethical considerations about usefulness to whom. The question “who judges the latter?” is then faced.

2. Research aim

The research reported in this paper aims to answer this question with respect to a sample of “jefes de obra” (site managers) in the Autonomous Community of Castilla-La Mancha (Spain). In a sense, they may be considered the “customers” (using the Quality Assurance term), who, after centuries of discussion about and changes in what universities provide, were offered in this study the opportunity to say what *they* thought about it as university graduates and as it concerned their lives and the job they were required to do.

This paper aims at clarifying the role of educational factors as they influence any disparities that building engineers, working as site managers, may feel. Specific objectives are to explore the satisfactions and dissatisfactions experienced in doing their job; to understand and to describe how they feel; and to investigate the ways in which they cope. Finally, on the basis of their experience, they outline suggestions for improvement and for appropriate education.

The paper is organised as follows. The concepts of educational-job mismatch and job satisfaction are reviewed first. Then, the occupation under study, the construction site manager and the professional profile of building engineering within the Spanish context are described. Next, the research design and the methodological approach chosen are reported, followed by the results and their discussion. Finally, practical and research implications are considered.

3. Complex concepts and their relationship: “education-job-mismatch” and job satisfaction

With respect to the appropriateness of educational formation for entry into the job, referred to in the literature as education-job mismatch, “a plethora of definitions and conceptualisations have been developed, with a lack of consistency in the terminology used” (Scurry and Blenkinsopp, 2011, p. 644). As a result, terms such as “overeducation”, “overqualification”, “underutilisation” and “underemployment” are used variably and interchangeably.

Educational mismatch may refer both to over- and under-education (Verhaest and Omev, 2006). Workers are said to be overeducated if the skills they bring to their jobs exceed the skills required for that job (Battu *et al.*, 1999), or when their formal qualification is higher than that required for carrying out the job (Peiró *et al.*, 2010). Symmetrically, an individual working in a job where the required level of education is higher than his actual education is defined as undereducated (Mavromaras and McGuinness, 2007).

During the last decades, research on education-job mismatch has grown greatly (Kucel and Vilalta-Buñi, 2012). The findings have been that education-job mismatch is a common phenomenon in many countries (Allen and van der Velden, 2001) and that it causes undesirable effects in the labour market (Kucel and Vilalta-Buñi, 2012).

However, the use of the concept aims to reduce a complex set of issues to a single and simple category. Education, as well as formal training and work experience, (Kampelmann and Rycx, 2012) is considered as an investment generating different types of returns for individuals and for society as a whole (Mora *et al.*, 2007; Fabra and Camisón, 2009). Through education, individuals acquire knowledge, aptitudes and skills (Kampelmann and Rycx, 2012; Fabra and Camisón, 2009) and may therefore increase their productive capacity with monetary returns (Allen and van der Velden, 2001; Kampelmann and Rycx, 2012). Research has shown that there is a relationship between education and earnings (Allen and van der Velden, 2001; Verhaest and Omev, 2006). Other non-monetary gains associated with the concept of “job satisfaction”, such as carrying out stimulating tasks, increased job stability and autonomy, healthy working conditions or good social relationships have also been considered (Fabra and Camisón, 2009).

Given the plethora of definitions and given that the concept is reductionist, examples provided by informants about the suitability of their education/training for the job they do are provided for the purposes of this study.

As regards job satisfaction, it is also a complex notion, and its study has been approached from manifold viewpoints. Thus, some authors state that there is no universal and agreed-upon definition for the term (Bravo *et al.*, 2002; Navarro-Astor *et al.*, 2010; Aziri, 2011). Because the concept is an abstract and complex one, most definitions tend to reflect the multidimensional perception of the meaning of job satisfaction and of the final result of a psychological process (Gargallo, 2008; Oyewobi *et al.*, 2012).

Locke (cited by Kucel and Vilalta-Buñi, 2013, p. 1), for example, defines job satisfaction as the result of a subjective evaluation of the existing discrepancy between what people want from their job and what they perceive they get from it. For Spector (1997, p. 2), job satisfaction is how people feel at work, including a variety of aspects

related to it. It can be understood as an extension of what people like (satisfaction) or dislike (dissatisfaction) about their job.

As many factors affect job satisfaction, it can be examined from different viewpoints by using different categories (Schmidt, 2007). With the aim of finding out how site managers experience their work, questions were posed relating only to their educational preparation for it.

3.1 Educational/training preparation and job satisfaction

A literature review revealed a number of recently published studies in Spain focused on the relationship between the education-job mismatch and job satisfaction (Amador *et al.*, 2012; Fabra and Camisón, 2009; Kucel and Vilalta-Bufí, 2013; Peiró *et al.*, 2010). The study by Mora *et al.* (2007), centred on job satisfaction among young European higher education graduates, has highlighted that engineering graduates (in general) tend to be more satisfied in their jobs than graduates in humanities, social sciences and law. An explanation for this has been that graduates in engineering are more likely to work in posts which require a degree related to their education (Battu *et al.*, 1999).

4. The job of the construction site manager and the Spanish context

Of site management, it has been said that it is the most important middle management role in the construction industry (Styhre and Josephson, 2006) and that its role is crucial to the success of construction organisations and projects (Fapohunda and Chileshe, 2014).

Site management involves the planning, setting out and on-going control of the construction site. Its general aim is:

[...] to ensure that the optimum site layout is established at the very beginning of the project, and all necessary management provisions are in place to support effective and efficient production management (Sherrat, 2015, p. 84).

Site managers are required to have general construction knowledge and should be competent to surmount everyday barriers and constraints. Previous research has found that for them to meet a project's objectives and be efficient, the following are relevant:

- to integrate project objectives with work plans;
- to use resources efficiently;
- to communicate effectively; and
- to possess sound risk administration skills (Fapohunda and Chileshe, 2014).

In relation to the Spanish term “jefe de obra”, it might be considered synonymous with that of the site manager used in the UK and construction project manager used in Australia (Haynes and Love, 2004). Styhre and Josephson (2006, p. 523) write:

The site manager is responsible not only for technical and production-oriented matters on the construction site, but he/she also has to be trained in administrative work, legal matters, human resource management and some other activities generally functionally organized into different departments and work roles at firms.

Site managers occupy an intermediate position, having to mediate between the construction company and the property development company. The site manager acts as a project's communication bridge between clients, project team members (architects,

structural engineers, building services engineers, surveyors, suppliers, subcontractors) and the construction company. Because of its very nature, the site manager's position is a risky one. It is at the same time a pyramid's top and the end of a wide bottleneck, and he is also said to be a "piggy in the middle" (Sutherland and Davidson, 1989). The site manager has also been described as a:

[...] sandwich person, who has people above and below and then his results depend upon the ones on top and the ones below [...], it is one of the most complicated jobs (Navarro, 2009).

In Spain, the Royal Decree 1837/2008 (BOE, 2008) requires graduation from specified fields of competence for certain occupations (e.g. architect, lawyer, mining engineer). This is not the case for a site manager. In the Spanish labour market for the construction industry, Law 38/1999 of "Ordenación de la Edificación" (Town planning and development Act) (BOE, 1999), stipulates a contractor's responsibilities, among which are the appointment of the site manager. This professional is hired by the contractor to manage construction works on site and, due to his/her educational degree level or site trade experience, must have the necessary training according to the characteristics and complexity of the construction project. This implies that depending on the judgement of the contractor, Spanish site managers will have different educational backgrounds.

No official statistics informing on the qualifications of Spanish site managers have been found in the literature review. However, according to Portales (2007, p. 8) "building engineers are the most in-demand professionals for working as site managers", and Spanish site managers have a high level of university training (AEC, 2007, p. 42). In other words, there has been a positive evolution in Spanish site managers' training and, nowadays, most of them have a graduate background in building engineering.

The Spanish National Agency for Quality Assessment and Accreditation (ANECA) determines six professional profiles and their relative occupations for the Degree in Building Engineering, as shown in Table I (ANECA, 2005). This state agency controls the quality and adaptation of the curriculum for all Spanish universities. Members of different universities, representatives from professional bodies and construction companies were all involved in the development of the White Book of the Building Engineering Degree (ANECA, 2005). It defines the degree's main objectives, its general structure, the generic and specific competences and the credits assigned to different subjects. Based on this document and once the degree syllabus is officially approved, teachers define and specify subject programmes.

While countries such as Australia, Canada, South Africa and the UK are committed to the development and recognition of good practices in engineering education and work collectively through international engineering alliances such as the Washington Accord, the Sydney Accord and the Dublin Accord (International Engineering Alliance, 2014), this is not the case for Spain. In Europe, considering the diversity and richness of its higher education, a similar process has been developed called "Tuning Educational Structures". It offers a universal approach to higher educational reforms both at the macro level of entire higher educational institutions and at the micro level of subject areas. However, the initial subjects of "tuning" did not include engineering (Augusti and Soeiro, 2013).

Building engineers who work in technical site management are usually independent, self-employed, professionals hired by the client or developer, and they

Professional profiles	Occupations
Technical site management	Site execution director Site director Site planning and organisation responsible Quality control and management responsible Control and financial manager
Production site management	Site manager Production manager Studies Manager Purchasing and resourcing manager Quality and environment manager
Risk prevention and health and safety	Health and safety coordinator in project and execution stages Drafting technician of studies and safety plans Technician of risk prevention in the workplace Auditor in occupational risk prevention plans and their management
Building operation	Building operations manager Building maintenance and conservation manager Drafting technician of documents dealing with the use, conservation, and maintenance of buildings, as well as with emergency and evacuation plans Building technician expert on useful lifetime, energy efficiency, and sustainability estimation
Consultancy and technical auditing	Technical auditor of construction projects and site execution Auditor of quality and environment management systems Expert or technical consultant in property and real estate reports, valuations, assessments and viability analysis Urban consultant
Technical project drafting and development	Demolition projects technician Interior decoration, refurbishment and rehabilitation projects technician New building technician

Table I.
Career paths and
occupations for
building engineering

Source: White Book of Building Engineering Degree (ANECA, 2005)

are members of the building engineer's professional body. Membership of the professional body entitles them to sign construction projects or other works related to their professional profiles as liberal professionals. As opposed to what happens in other countries like the UK, this membership does not give individuals a chartered status, and there are no institutions such as the Royal Institution of Chartered Surveyors or the Chartered Institute of Building requiring them to follow specific practical experience or training (Sherrat, 2015).

After graduating in building engineering, individuals do not have to pass further exams, as the degree entitles them to directly start working. If they work in production site management, they are salaried professionals working for construction companies and do not have to become members of the professional body.

It could be assumed then that the education provided by a university degree in building engineering should teach the necessary knowledge and skills required by site

management for carrying out the tasks entailed. This professional profile, the site manager, is the focus of this paper.

5. Research approach

5.1 *The sample*

With the help of the building engineers' professional body ("Colegio Oficial de Aparejadores, Arquitectos Técnicos e Ingenieros de la Edificación") in the city of Cuenca, a request for participation in the study, detailing the objective of the research, was sent via e-mail. It was addressed to licensed building engineers working as site managers in construction companies. Only four of them answered directly that first e-mail; the rest of the interviews had to be arranged by asking these first four participants and university colleagues for the telephone numbers of building engineers they knew were working as construction site managers. In this way, the snowball technique was applied until a 34-individual sample was reached. The principle of saturation or redundancy was applied for determining when to stop interviewing (Flick, 2007).

The provinces where participants were working at the time were Cuenca (53 per cent), Albacete (26 per cent), Ciudad Real (12 per cent), Toledo (6 per cent), and Guadalajara (3 per cent). For identification throughout transcriptions, participants were assigned a number.

The sample consisted of 27 males and 7 females, with an age span of 23–63. A total of 15 per cent of respondents were under 29 years of age, 23 per cent were between 30 and 33, 47 per cent were between 34 and 37, 12 per cent were between 38 and 40 and 3 per cent were over 60. As regards their occupation, 9 per cent were working as liberal professionals in construction project management teams, 6 per cent had their own construction company and 85 per cent were working as site/construction project managers or as team directors. Additionally, 21 per cent had less than 3 years of professional experience as site managers, 26 per cent had experience from 3 to 5 years, 35 per cent had experience from 5 to 10, 15 per cent had experience from 10 to 16, and 3 per cent had more than 25 years of experience.

In terms of educational background, all of them had a degree in building engineering but had studied in various universities: 67 per cent in Universidad de Castilla-La Mancha, 12 per cent in Universitat Politècnica de Valencia, 12 per cent in Universidad Politècnica de Madrid, 6 per cent in Universidad de Burgos and 3 per cent in Universidad de Granada.

All interviews took place between July 2010 and May 2011, a time when the economic recession was severely afflicting Spain, causing a higher rate of unemployment than in many countries of the European Union (Navarro-Astor and Fuentes-del-Burgo, 2011). This fact was an obstacle for the gathering of the sample, as the number of construction works was small, and many building engineers around the area were unemployed. The general unemployment situation may have skewed the sample.

5.2 *Data gathering and analysis*

A semi-structured interview format was followed, allowing the interviewers to follow-up on question areas and for the interviewee to elaborate on things which were relevant to them. The purpose was to encourage the interviewees to talk around the

topics of interest with freedom rather than to give close-ended answers. Therefore a flexible question guide was used (Flick, 2007; Caven, 2012; Kvale, 2008).

Because of the qualitative nature of this research, the method of worker self-assessment was chosen by asking participants to consider and describe whether their education in building engineering had prepared them for site management. They were also asked to identify any sense they had of ways in which their education had not adequately prepared them and, to the extent they felt this was so, how they tried to remedy it and the effect it had on their job satisfaction. Likewise, they were asked openly about changes and modifications in building engineering education.

Participation was facilitated by arranging interviews according to personal time-place convenience. Interviews, with an average duration of 60 minutes, were carried out in a variety of locations: researchers' office in the Polytechnic School (38 per cent), offices/building site huts in place of work (38 per cent) and cafeterias (24 per cent).

All interviews were recorded with a voice digital recorder and transcribed verbatim, generating a document in text form. The transcripts were then read and reread by the researchers, and analysis was carried out using the qualitative research software ATLAS-ti, which assisted in the storage and interpretation of the data, generating quotes and codes and allowing us to find and compare the data (Friese, 2012).

According to Pratt (2009, p. 858) "quantifying the data does not serve most small-sample qualitative studies well". Hence, codes have not been quantified on purpose, and a precise number or frequency of interviewees has not been provided. In fact, the issue of trying to make qualitative data appear more quantitative has been avoided. A qualitative analysis of relationships among codes and the context has been carried out instead (Kvale, 2008).

6. Results and discussion

Few participants say that the building engineering degree had properly trained them for carrying out the duties of the "jefe de obra". The majority report that education had been partial or that it had not been useful. No differences have been found in interviewees' responses according to their gender. Two broadly distinguishable attitudes may be inferred.

6.1 Acceptance of the need to learn on the job

Some respondents thought that universities are not meant to meet employer requirements: "The Technical School offers you general training and you, listening to professionals on site, they are the ones who teach you, especially if you have little experience" (No. 33).

Spanish building engineering university degrees authorise graduates to engage in the professional practice of building engineering. Therefore, the subjects' programmes aim to provide a general knowledge. On the other hand, construction projects tend to be innovative and learning generated by on site problem solving remains with the individuals and the tasks concerned (Winch, 2010).

Practice and experience in building execution is a way of confronting educational deficiencies for more than one-fourth of the participants. At the same time, they carry out their daily site management tasks, devote time and effort to develop professionally and they acknowledge this with words such as perseverance, self-improvement,

progress, learning, studying, asking for advice, taking in, finding out about and being trained.

A few participants believed that starting work on site with the role of helping site management, either as site manager assistant or as production manager, was useful. They appreciate the time they spent carrying out these supporting tasks, as they had learnt from foremen, supervisors and subcontractors, paving their way to site management.

One site manager argued:

Becoming a site manager has to be a learning process outside (the university). You have to be site manager assistant, then production manager, you must fall down on site, you must walk on mud, you have to argue with the people and that is what marks the character of the site manager [...]. A university degree might just give you some guidance (No. 13).

Going through the career path outlined by participant No. 13 involves an on-site training period spanning from six months up to two years, something very difficult to attain as an undergraduate university student. This accords with the idea argued by [Styhre and Josephson \(2006\)](#) that becoming a skilful and professional site manager is the result of long-term involvement in the industry and is based on what [Bourdieu \(1990\)](#) calls a habitus.

6.2 Perceived deficiencies in university education

The majority thought that the university should have equipped them with the skills they need for the work and with topics such as business management, labour management, financial management, construction management, construction process development and site planning and organisation. These building engineers' lack of knowledge of management subjects was already pointed out many years ago by [Chandler \(1992\)](#), who warned the industry that many graduates were undertaking major managerial roles soon after graduation.

More than half of the interviewees also mentioned having little skills regarding the use and application of computer tools and as a consequence felt under-skilled. "I wish they had taught us, because we did not work at all with the tools that we used at work afterwards" (No. 17).

Considering the study programmes published in the web pages of the universities where participants had studied, an analysis of the credit distribution assigned to different basic subjects established in the White Book of Building Engineering Degree ([ANECA, 2005](#)) was carried out. The results are shown in [Table II](#). Indeed, it clearly illustrates that the percentage of credits assigned to subjects related to construction management is below that assigned to scientific fundamentals and graphic expression.

That subject syllabuses are an important tool in the development of students' competences has been already stated ([Navehebrahim, 2009](#)). [Table II](#) supports the idea that there is a direct link between the number of credits assigned to construction management subjects and the educational deficiencies identified by the participants. This fact should be taken into account when designing the Degree study programme.

6.3 Coping with perceived educational deficiencies

The strategies pointed out can be grouped in the following categories: use of the internet, asking colleagues and/or friends, bibliography research, queries to material suppliers or subcontractors, gaining experience on site, training, studying notes, asking professional

Topic	Subjects	UCLM (%) ^a	UPM (%) ^b	UPV (%) ^c	UGR (%) ^d	UBU (%) ^e	Mean (%)
Scientific fundamentals	Mathematics; physics	10.0	9.9	12.0	15.4	15.0	12.5
Graphic expression	Descriptive geometry; graphic expression; topography	12.3	16.5	15.3	18.5	18.0	16.1
Building techniques and technologies	Materials; construction; pathology; site equipment; construction history	26.4	26.9	27.3	24.6	26.0	26.3
Building structures and facilities	Structures; facilities	11.7	11.5	12.0	10.3	13.0	11.7
Process Management	Safety and risk prevention; quality; organisation, planning and control	5.9	8.2	9.0	5.1	5.0	6.7
Applied law and economics	Applied economics; measurements; legal aspects; valuation	8.8	8.2	9.7	11.3	11.0	9.8
Optional		19.2	13.2	10.7	8.2	4.0	11.1
Technical projects and final undergraduate project	Technical projects; final undergraduate project	5.8	5.5	4.0	6.6	8.0	6.0

Notes: ^aUniversidad de Castilla-La Mancha; ^bUniversidad Politécnica de Madrid; ^cUniversidad Politécnica de Valencia; ^dUniversidad de Granada; ^eUniversidad de Burgos

Source: Personal compilation

Table II.
Per cent credit distribution in building engineering degrees in different Spanish universities

associations of building engineers and subcontracting. However, many participants carry out a mixture of these actions.

When referring to specific actions followed to resolve their lack of knowledge, skill or competence at work, many used the following expressions: “sort myself out”, “do anything”, “find the way”, “make it through” and “do what you have to do”. These words involve a mixture of strategies or, at times, shortcuts to solve problems and succeed when facing difficult situations. Respondents described these behaviours as a personal disposition which had led them into building engineering in the first place; they see themselves as positive decision-makers with a commitment to acquiring life-long learning skills. According to [Yamazaki and Kayes \(2010\)](#), these strategies might be related to the culture, to the job environment and to other aspects of the construction industry environment, which force building engineers to develop their own learning modes to properly respond to and deal with site management.

The internet has become a fundamental source for remedying educational deficiencies and for supplementing the lack of information and vagueness of architectural projects. Around one-sixth of the interviewees had graduated before computers and the internet were extensively used. Hence, they appreciated the impressive advances in technology, and primarily the internet, and its applications in their field. Through its use, construction managers could have fast access to technical and commercial information, improving and making the task of document and record management much easier. As interviewee No. 8 explains: “It makes your life happier”, or according to another: “Internet which is a very useful tool, it has everything in it, lately I’ve been using it, you look it up in the internet and you find anything” (No. 10).

Looking for advice from colleagues and friends is the second most quoted strategy. Colleagues can be workmates from the same company or not, and friends are usually classmates from university. However, as site managers tend to work on their own, with few peers in close proximity ([Styhre and Josephson, 2006](#)), seeking for advice has to be done after work hours.

Advice required by site managers may be related to the intrinsic uncertainties associated with the design-implementation process of construction projects where many conventional planning and management tools are recognised to be inadequate ([Seymour, 2013](#)). Other matters have to do with information regarding subcontractors, material manufacturers or construction systems.

None of the Spanish participants come from a site trade background, and yet, they are managing construction sites. It seems natural then, that site work experience is considered another essential element for overcoming the lack of practical preparation. They use words such as determination, self-improvement, progressing, learning, studying, asking, taking in, gathering information or being trained in their daily working routines as site managers. They refer to the time and effort devoted to developing professionally.

Regarding training, respondents participate in courses, study from books and notes and browse the web looking for useful information. The common theme in all their responses is the effort, the cost when paying for courses, the additional work and the waste of productive time involved ([Fuentes del Burgo and Navarro Astor, 2013](#)). Apart from the perceived lack of preparation during their undergraduate studies, continuous technological improvements in the construction industry and their will to professionally develop have also pressed them to follow this course of action.

When referring to all these strategies, some building engineers use words reflecting a high level of individualism and a desire for life-long learning. After all, the process of studying and integrating new concepts is individual and internal: “Doing training on my account, being self-sufficient and self-taught [...]. When I’ve had an education gap I’ve trained myself and I’ve looked for training in that matter” (No. 24).

At times, the fastest alternative to solve problems is subcontracting. As a site manager argues:

It is not worth it. How much are they going to charge me for making the calculations or for recalculating the framework? How long will it take me to do it myself? 3 days? It isn’t interesting for the company, it does not interest anyone (No. 1).

In any case, the perceived disparity regarding both knowledge and skills, implies a waste of time, work overload and/or a decrease in the performance of the engineer. This research confirms other authors’ results, showing that a lack of preparation negatively influences site managers’ performance (Kucel and Vilalta-Bufi, 2012).

When the building engineer has the knowledge and appropriate training, the amount of time required to start being productive is reduced. The more educational the gap he has, the longer is the time the individual does not contribute with high performance:

At the end, education is important, it influences the time needed to adapt and adjust your knowledge to the site. That time gets shorter, ok? At times it never gets there since you’ve never had the knowledge (No. 20).

6.4 Educational preparation and job satisfaction

About one-third of the interviewees report that these disparities do not influence their job satisfaction. They believe that universities offers general training not specifically targeted at the professional role of the site manager, and therefore, they do not expect anything from an undergraduate curriculum. Other site managers acknowledge the impossibility of knowing everything: “you always have gaps” (No. 24). Others did not master some topics when they were undergraduate students: “there are things in life I have not been able to learn” (No. 1), or they have forgotten them over time. In all these cases, there is no dissatisfaction.

However, more than half of the participants report that their job satisfaction is negatively affected: “Shortages affect badly [...] not being well trained you have to invest in more education in order to balance out” (No. 8). This result accords with previous research (Allen and van der Velden, 2001; Allen and Weert, 2007; Kucel and Vilalta-Bufi, 2012).

This negative consequence is increased when graduate site managers have to give commands and supervise the work of experienced construction workers with a site trade background. The situation implies that the building engineer does not know whether the task is being executed well enough, how it must be done or even if the final result is correct. At times, feeling ashamed, they try to hide their lack of knowledge when talking to either subordinates on site or to subcontractors: “In some matters you are completely lost, and all you do is pretending. In front of the subcontractor you try not to show that you don’t know a thing” (No. 22).

Ignoring how to apply knowledge acquired at undergraduate education was an important reason for dissatisfaction, due to the lack of preparation for the practical aspects of construction works execution. The following words are revealing:

You've studied a university degree, but when you get to the site you feel that you don't know anything [...]. But at the technical school they don't explain many basic things, basic such as "you have to place the terrazzo, place the skirting board and then spread the plaster" [...] nobody tells you the basic ideas that could help when entering a site, you feel completely lost (No. 31).

Now and then, respondents used the metaphor of being "thrown in the deep end" when describing their transition into industry. Lack of knowledge becomes overwhelming and causes traumatic experiences such as the one described by a female participant when recalling her first job as site manager:

In those days my heart really sank, because I said to myself: "Oh my God! I've been studying for 8 years and now I am not going to apply anything because, honestly, this is really unsatisfactory and disappointing". On site, I felt like being punched up from all directions, the truth is I had no clue where the blows might come from (No. 30).

Another example of educational confusion is pointed out by participant No. 23:

It was the first thing that shocked me, I mean, when I graduated and started working they said: "Here you are, manage this site", and I asked "Am I responsible for this? I mean the matter of numbers, purchases, costs [...]". The boss replied "Yes, of course". And I thought "I have no idea about this, this has more to do with an economist".

Not knowing that site management also involved financial management made him feel impotent and aware of his lack of proper training. He had assumed that the task was carried out by another professional.

A few mention that the negative effects of insufficient knowledge on job satisfaction are greater at the start, evolving with time and diminishing with site experience. Over time, they learn to recognise the significance of the knowledge acquired at the university:

At least initially they (educational deficiencies) influenced my job satisfaction, of course. [...] You've studied a lot but you see yourself a bit inexperienced. As you make progress and learn, you make better use of the things you've learnt, and that generates satisfaction, of course. You have a good basis but you don't know how to apply it, but as you work you start using it (No. 12).

Other negative effects can be inferred from the following expressions: "feeling like an ignorant" (No. 4), "frustration" (No. 31), "seeing oneself as inexperienced" (No. 12), "feeling completely useless" (No. 17), "being lost" (No. 5, No. 31), "feeling uncomfortable" (No. 32) or "finding one self out of the game" (No. 32).

Additionally, some respondents point out that when having the adequate education for carrying out the required tasks, they feel both job satisfaction and personal satisfaction. Furthermore, they feel confident about how to do things correctly and develop a positive feeling that could be transmitted to subordinates, colleagues and company leaders. One site manager explains his satisfaction as follows:

The fact of being sure about what you're doing and that you're qualified is essential for your personal satisfaction and for other people to trust you, you know? That you're somebody who knows what you're doing (No. 22).

Finally, in disagreement with the previous results (Allen and van der Velden, 2001; Belfield, 2010), for some building engineers, over-education does not negatively affect

their job satisfaction and their workplace morale. As an example, for participant No. 7 “education is never in excess”.

6.5 An appropriate education for “Jefes de obra”

In accordance with their professional experience as site managers, participants have suggested for changes to be made in the building engineering undergraduate study programme in the subject syllabuses and in the way of teaching and types of practices offered. They would like to see a more application-oriented programme, a curriculum more applicable to the job market. Therefore, they defend a program redesign and adjustments that could help to address the gap between student’s knowledge and skill status and the requirements of the industry.

For instance, one site manager argued:

Regarding organization and planning you end up with technical knowledge, but since this knowledge has not been applied to the building site itself, we can say it is just general technical knowledge (No. 25).

Another one added:

The first day you see a floorframe and start counting bars, and say: “Oh, this is what they explained to me about what upper and lower reinforcing steel framework was”. Yes it’s true, you end up knowing very little. Classes should be taught in a different way, so that students could have more practical workshops and fewer theoretical sessions (No. 33).

This need for more practical training and more applied content to most subjects accords with previous results for Spanish graduates that show scarce practical training and a lack of basic professional knowledge and capabilities (Marzo-Navarro *et al.*, 2008; Gil *et al.*, 2009).

In line with the purpose of this study, Witt and Lill (2012) observe that education institutions could collect valuable information for defining and developing fields of knowledge according to industry needs. In this regard, Navehebrahim (2009, p. 296) believes that:

[...] graduates who have moved into the market are well placed to inform the university what should be added and what should be deleted from the curriculum to make it more applicable to the job requirements.

Owing to the fact that building engineering education provided in Spanish universities and other Latin-American countries gives a professional status to students (Osuna and Luna, 2008; Arce, 2013; Hernández *et al.*, 2013), the people responsible for developing university curricula and teachers responsible for subject contents, should keep in mind what the following participant states: “When hiring, what companies look for is a worker who is already half trained, they don’t want to start from zero” (No. 29). Thus, as Navehebrahim (2009) suggests, universities need to be constantly rethinking, restructuring and revitalizing their programmes with employment skills in mind.

Among the changes suggested, participants refer to the need for increasing the use of computer programs for all possible subjects, specifically for building structures, drawing, measurements and budgeting, organisation, programming and control, installations, facilities, safety and risk prevention and even legal aspects.

Another educational claim they make is related to human resource management and administration, negotiation, conflict solving, people relationships or simply professional

dealings with construction workers, foremen, subcontractors, architects, engineers, etc. All of these could be grouped under the heading “human relationships”, an item that is not included in the building engineering educational programme:

Who’s going to teach you how to treat a construction gang or a skilled worker in an undergraduate course? [...] this is the thing about this job, you have to relate to many people from different social stratum, well educated people, people that [...], people from construction, we all know that in construction there’re poorly educated people [...]. Who’s going to teach you that? Where do they teach you that? It’s impossible (No. 1).

Another said:

Without your own experience of the building site as such you will still lack something, no matter the academic formation you get. In the end nobody tells you about the importance of developing certain social skills (No. 16).

Likewise they ask for specific training or orientation in what they call “knowing how to do business” and deal with contractors. They aim at being able to contract at tight prices so that both constructor and subcontractor benefit, with suitable quality results on site. The significance of the financial aspects of construction works and the pressing need to get profits are also acknowledged. At worst, when site managers have undersold a contract in a public tender, they should be able to build the project without loss. Participant No. 7 summarises this as follows: “Money is what rules the site [...], and you have to be clear about that”.

They also call for more training in general business management applied to construction companies, where building engineers might work.

In reference to building engineering practical training, participants suggest an increase in the number of practical experiences on site. Participant No. 26, for example, believes they should be compulsory and take place outside the classroom and laboratories: “harsh real practice, not laboratory practice, since, of course, you feel fucking great there (in the laboratory)” (No. 21). This accords with [Othman’s \(2014\)](#) recommendations for South African construction management education: offering compulsory experiential training, to allow students to have real contact and exposure to the construction industry.

To be useful, site practices should be designed with the aim of providing the student with a global view of the knowledge acquired in different subjects. Instead, subjects often seem disconnected. Site visits should serve by applying the whole:

We are well trained in planning, safety, facilities, measurements; you know well everything regarding the building site [...], now then, what you don’t know once you get to the site is how to group all that knowledge and apply it little by little (No. 7).

The following activities are pointed out:

- occasional site visits for seeing different phases of construction works on the spot;
- monitoring the same site over a period; or
- an internship on site at a construction company over a period ranging from several months up to a year.

None of these activities are mutually exclusive, but can be mixed. [Table III](#) summarises their main characteristics.

Definition	Description	Duration	No. of students	Type of training
Site visits	Teacher and students one-off visit to study a specific construction task or work package at different sites	1 hour per visit	Large group	Inspection and verification of constructive elements and processes
Site monitoring	Visit to the same site over a period to learn about the progress of construction works and to identify constructive processes	1 or 2 weekly hours during a semester	Small group (1 to 4)	Inspection and verification of constructive elements and processes
Site internship	Part time or full time work period assisting the site manager	From several months to one year	1 student	On-the-job training

Source: Personal compilation

Table III.
Description of
practical activities
suggested by
Spanish site
managers

As many students view the undergraduate programme as a series of isolated contents, grouped together into unrelated subjects with no connection between them, applying knowledge on site becomes difficult, especially at the beginning. In this respect, [Arce \(2013\)](#) states that this view might have been generated by the historical evolution of the study programmes. Knowledge items have been added as separate elements in the hope that the students themselves will be able to connect them all in real construction projects.

In spite of the enrichment gained from site visits, some participants point out that just one-off visits do not allow them to see the realities of construction work and live the complexities of the whole building process. Hence, they suggest long-term internships or site monitoring (see [Table III](#)). These practices would help avoiding the “reality shock” that students might experience when having inadequate and insufficient practical training while holding unrealistic expectations of future work ([Pang and Lee, 2002](#)).

7. Conclusion

Previous research has analysed the effects of what has been called educational mismatches on earnings and job satisfaction. This paper explores this issue as it applies to building engineers’ education in their role as Spanish site managers. The findings reported are based on what the respondents actually said, using ordinary language, concepts such as education, the job they do and their job satisfaction. Other factors such as economic remuneration are not taken into account.

Sample size is relatively small, and generalisations have not been made. Furthermore, quantitative measures have not been attached to the findings. However, findings are considered sufficient to stimulate further enquiry into educational provisions. First, this study confirms the need for skills such as site planning and organisation, construction methods, human resource management and financial management. These may be due to the difficulty of transferring the real construction site environment to university classrooms. Nevertheless, the curriculum of building engineering degree programmes deserves to assign more credits to subjects related to the everyday practicalities of construction site management.

There are two implications for curriculum development. First, long-term practical stages in construction companies during the last years of the undergraduate program should be encouraged. Second, knowledge and skills should be taught with more application to daily practices on site, following the procedures and using the computer tools commonly used by construction companies. To make this curriculum adjustments easier, university-industry links should be strengthened.

Under-education has been reported as a source of feelings of insecurity, uncertainty, embarrassment, frustration, work overload and waste of time, all negatively affecting site managers’ productivity. To confront this situation, these professionals have developed different strategies such as delegating tasks, subcontracting, making use of their friends and the people they know and practicing their life-long learning skills by further studying and/or participating in training courses.

Although the interview question guide was focused on undergraduate training for site management, some participants are aware of the fact that building engineering allows them to carry out other type of jobs. To obtain a wider perspective on building engineering education, further research could be done. The same methodological tools

could be used to interview Spanish building engineering graduates working as liberal professionals in construction project management teams or as civil servants. This would allow them to explore differences and similarities in their responses regarding educational provision and further suggestions for improving the degree course.

One of the limitations of this work is that it has not compared participants' responses with the curriculum of each of the building engineering degree programmes under study. The number of universities involved, the number of study programme changes over the past 20 years and the differences in subject approach, length and requirements, due not only to teachers' view but also to the number of credits assigned, are some of the reasons for this limitation.

In sum, according to the site managers themselves, Spanish universities are mainly teaching Aristotle's *episteme* (abstract knowledge and general principles) and some *techne* (applied, technical knowledge and skills) which fall short of the expectations placed upon them by their employers. As regards *phronesis*, what many of these site managers say is that they are not adequately prepared in ways they admit to not fully know themselves. Hence, to compensate, they seek out friends, the internet and whatever other resources come to hand.

There are, of course, limits to what higher education can legitimately be expected to do. However, Boni and Gasper (2012) offer systematic, programmed curricular proposals as to how expectations can be brought in line with Aristotle's concept and meet the practical, everyday concerns the respondents have about doing their job well. Ancient Greek concepts, still highly relevant, have been used to present the findings. However, more prosaically and equally important, adopting the contemporary idiom that one should take seriously the Quality Assurance Standard (ISO 9000), as applied to higher education, is proposed. The customers must be listened to.

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