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REVIEW PAPER

Skill development in food professionals: a European study

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Abstract The food sector is the largest employer in the European Union, yet it ranks low in innovation and few educated young people pursue food careers. Updating both the skills and the image of food science and technology professionals (FSTs) first requires understanding the current situation. This work compares the view of currently employed FSTs (3,007) with that of food science and technology (FST) employers (602) regarding skills and when and where they should be developed. European FSTs responded to a web-based survey in 2011 and 2012, and FST employers responded to an e-mail-based survey and/or attended brainstorming workshops from 2009 to 2012. Soft skills, especially those related with *communication*, were the best evaluated by both groups, whereas technical non-food skills were in the lowest positions. FSTs were judged qualified by their employers in some food skills (*food safety and quality*, *product development*, *production)*, while others (*engineering maintenance*, *consumer and nutritional sciences*, *environmental issues*) were more poorly evaluated. In general, FSTs believe themselves to be well qualified by higher education programs, and most of them do not continue training once they are working, with the notable exception of those that achieve positions of high responsibility. However, employers appeared to disagree, recommending that education and training in soft, food and technical skills continue throughout working life. Additionally, they recommended more frequent reinforcement of soft than of food or technical skills. A competitive food sector requires FSTs of the highest quality, and understanding the view of FSTs and their employees can

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contribute to improved training and thus benefit the European food sector.

Keywords Education · Skill · Training · Lifelong learning · Food science · Food technology

Abbreviations

AST	Agriculture science and technology/engineering
BSc	Bachelor
CCL	Cross-curricular learning
CE	Chemical engineering
EdE	University and other school extracurricular activities
EdH	University degree course work
EdS	School course work before university degree
EE	Environmental engineering
ES	Economic science
FDI	Food and drink industry
FST	Food science and technology
FSTE	Food science and technology/engineering
FSTs	Food science and technology professionals
LS	Language subjects
MC	Marketing science/consumer behavior
MNG	Management (including quality and safety)
MSc	Master
n.a.	Non-available information
NH	Nutrition and health
PhD	Doctorate
PL	Personal life
PrO	Professional organizations
SE	Sensory science
SH	Safety and hygiene
SMEs	Small- and medium-size enterprises
SS	Specific subjects
TrC	Government/certification authorities
TrN	Non-formal training
TrNw	Non-formal training, including workplace
TrO	Training organizations
TrW	Workplace training
TrWf	Formal training at workplace

Introduction

The food sector is the single largest manufacturing sector in the European Union [1] and one of the most complex in terms of diversity of businesses.

The food and drink industry (FDI) is also the leading employer in the European Union manufacturing sector, directly employing 4.25 million people (15 %) [2]. Industry of all sizes and specialities, research institutes, government regulatory agencies and other, non-traditional enterprises all employ FSTs, but FDI workers are less qualified than the overall economy. Employees with low qualification account for 30 % in FDI versus 21 % in the overall economy, while the share of highly skilled employees is only 14 % in this industry versus 30 % for the overall economy [3]. These figures do not change with the age of employees, although the number of educated young people has been increasing, which leads to the conclusion that FDI is not attractive for young people. This may be due to the poor public image of FDI [4].

At the same time, on an economy-wide level, a polarization of skill demands has been predicted, with an increased demand for workers with higher education qualifications and a decreased need for those with low qualifications [5]. Applied to FDI, while many occupations require elementary skills demanding physical abilities, and increased process automation is requiring less handcraft workers [6]. On the other hand, more high-skill jobs are needed for process innovation, through the adoption of new more environmentally efficient and product protective technologies, and product innovation, due to dietary and nutritional changes driven by consumer.

Despite being the largest manufacturing sector in the European Union, FDI has been in the lower part of the innovation performance ranking and has been losing relative importance in the global food market. To invert the current picture and to improve the image (and not only) of the FDI sector, several changes must be promoted [7], including the certification of knowledge and skills of professionals, the attraction of the best students to pursue a professional FDI career and the update of FST skills. Skills are a main factor for economic growth because they raise employment levels and drives improvements in productivity [4].

Several reasons thus exist to focus on skill development of FSTs, either for attracting and preparing good professionals, with skills that push innovation of the FDI, or to upgrade skills of workers helping them to adapt to changes in the job market.

The identification of skills needed for future FSTs is not an easy task and has been the subject of several European Commission funded projects. The European Centre for the Development of Vocational Training worked on the forecast of future skill needs in Europe [5]. The European federation of FoodDrinkEurope and the European Federation of Food, Agriculture and Tourism Trade Unions [3] identified skills and good practice on education–business links. Flynn et al. [8] reported the skill needs for FSTs identified in brainstorming workshops carried out in 16 European countries. The identification and forecasting of skills is a hard job, even harder in the food industry due to its fragmentation, with 99.1 % of the companies being small- and medium-size enterprises (SMEs) and working in many sectors, from meat to fruit, from beverage to dough [2].

Skill can be defined as the ability, coming from one's knowledge practice, aptitude, etc., to do something well [9]. Skills can be subdivided into technical skills and soft skills. The latter ones influence how we interact with people and can be related also with the job performance [10, 11]. Based on the information collected in the questionnaires and workshops of the present work, it is convenient to classify the technical skills of FSTs as food skills and non-food skills, the latter being those which are not directly related to the FST knowledge area. This classification will be used in the descriptions that follow.

Skills can be difficult to assess as their variety is great: quantity, level and content, and their value is variable: sociological emphasis on practice to economic emphasis on human capital theory. These challenges can, in practical terms, be met by measuring skills in terms of the qualifications people hold and/or the jobs they do.

Before improving the planning of skills training, it is necessary to survey current FSTs skills and map when and where skills are and/or should be acquired. This work presents the comparison of current skills evaluated by FSTs (employees) and by employers and when and where they should be developed (the "employers" view) and are developed (the "employees" view).

Methodology

The information needed to carry out this work was obtained in the context of the TRACK_FAST European project (www.trackfast.eu), which ensured the collaboration of 27 organizations (universities, research institutions and professional associations) from 16 European Union and associated countries. Three sources of information were used, as follows. The surveys and workshops gathered a huge amount of information of which only a small part is possible to present in this work.

Web-based survey to European FSTs on their knowledge, skills, education and training

This survey was prepared in English by a team of food professionals and translated into French, German, Greek, Hungarian, Italian, Lithuanian, Portuguese, Romanian, Slovenian, Spanish, Swedish and Turkish by TRACK_FAST project partners. It was disseminated to currently employed FSTs from the TRACK_FAST partners' countries, by the partners to direct contacts to food associations as well as via blogs and social networks (Facebook, LinkedIn). The web-based survey tool used was SurveyMonkey®.

The survey was open between February and April 2011, and a second call was made in April 2012.

The survey had four parts:

1. The motivation and self-image of respondents.
2. The actual career paths of respondents, including features of their different (consecutive) workplaces, the most important features of their jobs (position length, job responsibility level, type of activity, salary, etc.), qualifications at their first job, and qualifications obtained during their professional careers at different workplaces.
3. The evaluation of their working conditions.
4. The basic sociological characteristics of respondents.

Results of the survey were analyzed by different subroutines of SPSS® software. To obtain a general overview, the standard descriptive statistics (e.g., frequency tables, average) and analysis of variance (one-way analysis with Bonferroni test, SD = 5 %) were used.

E-mail-based survey to European FST employers on the skills and competencies of the FSTs working for them

This survey was prepared in English by three FSTs (a university professor, a research association representative and an industry association representative) and translated into different languages as described in section "Web-based survey to European FSTs on their knowledge, skills, education and training". The survey contained three sections: organization profile, FSTs academic and career statuses and competencies and skills in FSTs. Surveys were distributed by e-mail from 2009 to 2011, and collection was closed in May 2012.

All questionnaire data were entered into an electronic spread sheet by one researcher and checked for accuracy by another. Comments were translated to English by the local partner. Questionnaires with missing or conflicting information were eliminated from the analysis. Questions concerning university degree and certifications were analyzed together such that total employees could be calculated and then percentages with different degrees. For questions concerning skills and job titles, multiple responses were possible and thus totals for each response were divided by total responses using an Excel® pivot table so that the top choices could be identified.

Brainstorming workshops for FST employers on the skills desired in their employees and how these should be obtained

Workshops were held in the 16 partner countries of the TRACK_FAST project in 2010 and 2011. Each was in English, led by the same person and following the same format: a brief introduction to the TRACK_FAST project, a review of survey data on skills of currently employed FSTs (section "E-mail-based survey to European FST employers on the skills and competencies of the FSTs working for them"), an introduction to brainstorming and two brainstorming sessions.

In the first session, data on desired FSTs skills were collected in a combined individual and group brainstorming in which participants listed all their ideas of the knowledge, skills and/or competencies desired in their employees (results published in [8]). The second brainstorming was a group work in which participants were separated according to employment area, instructed to choose a skill idea or skill category they valued and to complete a mind map in which they indicated all of the possible ways and times this skill could be attained.

The data were recorded in a spread sheet exactly as written by the participants. Each idea was associated with an FST level of responsibility and employment area. Three independent researchers then assigned a code to each skill idea using a list of 68 skills from *Knowledge and Skills Requirements for Careers in the Food Industry* [12]. For *where/how* skills should be obtained, codes were assigned using the following table constructed by a team of five researchers based on ideas generated at the brainstorming workshops. For *when*, each idea was assigned a frequency code of 1–4 where 1 equaled one time, 2 equaled occasionally, 3 equaled repeatedly and 4 equaled continuously. All researcher-assigned codes were compared, and only those ideas with at least two identical codes were included in later analyses.

For *where* data, the categories are as follows:

(A) School course work before university degree (EdS). Primary school, high school, technical school.
(B) University degree course work (EdH). Bachelor (BSc), master (MSc), doctorate (PhD).
(C) University and other school extracurricular activities (EdE). Teams, social activities, university seminars or courses (continuing education), study abroad.
(D) Workplace training (TrW). Mentor, workplace seminar or course, experience, postdocs, internship (professional or university).
(E) Training organizations (TrO).
(F) Non-formal training (TrN). Computer/internet resources, professional/government publications.
(G) Government/certification authorities (TrC). Government seminar or course, government internship.
(H) Professional organizations (PrO). Attendance at professional meetings, social activities with colleagues, participation in professional group projects, trade fairs.
(I) Personal life (PL). Family life, travel.

Results and discussion

Basic information on the surveyed employees and employers

By the end of May 2012, 3,007 questionnaires were collected in the survey to employees and 287 in the survey to employers representing at least 4,069 FSTs (Table 1). The number of employers attending the workshops was 315. It is important to note that in the survey to employees, FSTs answered about themselves. In the survey to employers and in the brainstorming workshops, FSTs answered about their employees and/or co-workers.

Considering employment area (Fig. 1), "industry, retailing and consultancy" were the most represented: 49 and 72 % of respondents in the surveys to employees and employers and 32 % of brainstorming workshop attendees. "Research institutions" were also well represented with 20 and 12 % of survey responses and 31 % of workshop attendees.

For the survey to employees, data on gender and age were collected. Respondents were predominantly women (near 60 %), and younger generations were overrepresented as 75 % were under 40 with 30 % under 30 years old. Data on gender and age for employers were not collected. In agreement with the age of employees, most have had a short career path: 55 % have only worked in one position, 24 % in two positions, 12 % in three positions and 9 % in four or more positions.

Also in agreement with age, most FSTs (39 %) had jobs with low responsibility (in charge of a group of tasks). Those with medium responsibility positions (in charge of a group of persons or department) were 29, 12 % were in high responsibility positions (in charge of several teams or of the company) and 20 % in other positions (administrative, advisor, consultant, independent entrepreneur).

Education and training of FSTs

About two-thirds of the surveyed FSTs (65 %) had a higher education degree (BSc, MSc or PhD) before starting their first job (Fig. 2). The most common degree was the BSc (29 %), followed by the MSc (28 %) and PhD (8 %). One-quarter (25 %) of FSTs acquired a higher education degree during working life: 10 % a MSc, 7 % a BSc and 8 % a PhD. Within this 25 %, only 6 % received their first degree during working life; the other 19 % were respondents with a BSc before work who received another BSc (3 %) or a MSc (6 %) or a PhD (3 %) during work, or those with a MSc before work who received a PhD (4 %) during work.

Employers' view of their employees' education was similar to the employees' view of themselves, with some variations based on degree type. Employers believed that 84 % of working FSTs had a higher education degree, while 71 % of employees stated that they had a higher education degree. Considering the BSc degree, employers stated 38 and 33 % of the employees had a BSc degree. Employers believed 29 % had a MSc, while employees stated 36 %; and with the smallest difference, employers believed 17 % had a PhD, while employees stated only

Table 1 Participants in the surveys and workshop activities

Country	Survey to employees[a]	Survey to employers[b]	Brainstorming workshops with employers[c]
Austria	14	15/192	7
Belgium	40	24/331	12
France	149	9/229	7
Germany	42	11/126	12
Greece	147	15/116	22
Hungary	212	35/227	25
Italy	610	12/172	10
Lithuania	79	18/232	22
Netherlands	0[d]	17/586	3
Portugal	309	17/385	26
Romania	111	30/522	23
Slovenia	98	20/170	23
Spain	410	20/224	16
Sweden	106	19/257	86
Turkey	477	18/145	14
United Kingdom	69[d]	7/155	7
Total	3007[e]	287/4,069	315

[a] Number of surveys received

[b] Number of surveys received/number of employees covered

[c] Number of employers attending the workshop

[d] Respondents of the Netherlands and UK computed together

[e] Includes 134 questionnaires not identified per country

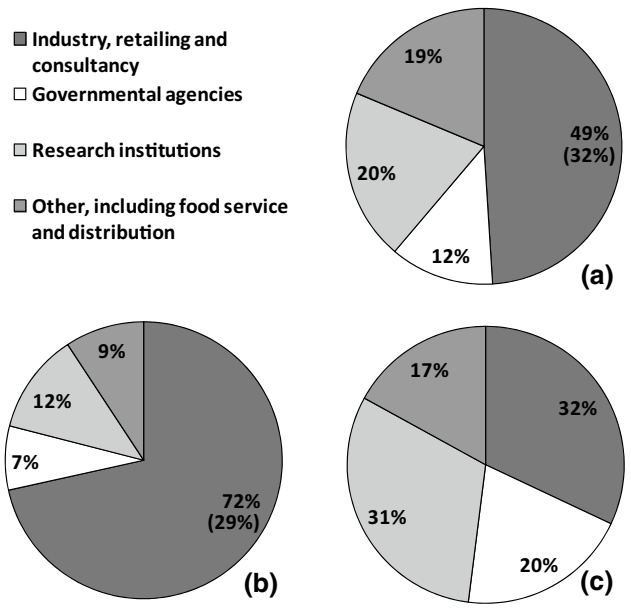

Fig. 1 Employment area of participants in the *a* survey to employees (last position), *b* survey to employers and *c* brainstorming workshops. In parentheses, share of SMEs (250 employees or below) over the total respondents

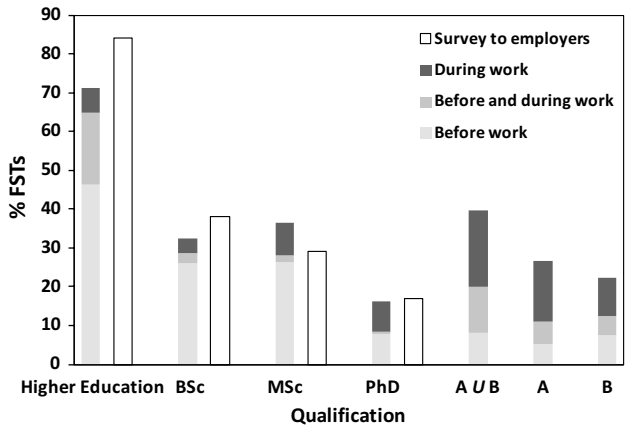

Fig. 2 FSTs with higher education qualifications (BSc, MSc, PhD) and other education/training activities. *A* = internships (before first job) or internal training (during work). *B* = courses (before first job) or other training (during work). In the case of the employees survey, percentages are referred to respondents with at least one qualification or activity. *A* and *B* data only available for the employee survey

16 %. The relatively high share of respondents with a PhD degree is reasonable considering that 20 % of respondents were working in the research sector in their last job, but also suggests a large number of FSTs with a PhD in industry, as this employment area had the most respondents both from employees and from employers (Fig. 1). However, the authors experience with industry shows that this percentage cannot be extrapolated to industry, particularly to less-rich European countries.

Extracurricular activities (internships, courses) were more commonly done during working life, 31 % of respondents, than before entering work, 20 %. Among those who did extracurricular activities, the ratio activities/respondent was 2.2 before work and 2.5 during work life (data not shown), again suggesting slightly more extracurricular activity during work. Extracurricular activities are often required for working FSTs both to cover gaps in

Table 2 Specialization areas of the higher education qualifications (BSc, MSc, and PhD), extracurricular activities (internships, courses) before entering the first position and training (internal, other) during work

Specialization area	Higher education qualifications before work (%)	Higher education qualifications during work (%)	Extra-curricular activities (%)	Training (%)
Food science and technology/engineering (FSTE)	56.6	45.2	10.4	9.6
Agriculture science and technology/engineering (AST)	14.8	11.0	4.2	3.7
Chemical engineering (CE)	6.4	3.9	1.4	1.4
Other[a]	5.9	10.0	14.8	18.1
Chemistry (Chem)	4.2	3.2	3.2	1.5
Nutrition and health (NH)	3.7	3.5	8.6	7.5
Safety and hygiene (SH)	2.2	7.1	19.0	17.3
Management (including quality and safety) (MNG)	2.0	7.3	17.5	18.9
Economic science (ES)	1.6	3.0	2.4	3.4
Environmental engineering (EE)	1.3	2.6	1.9	3.0
Marketing science/consumer behavior (MC)	0.8	2.8	6.4	7.7
Sensory science (SE)	0.5	0.4	10.2	7.9

Gray intensity increases with percentage

[a] Food Microbiology, Biotechnology/Bioengineering, food quality and safety and other

knowledge and technical skills and to update and upgrade the existing one. This is supported not only by the higher number doing such activities during work life, but also by the fact that internal trainings were the most common activities (Fig. 2).

Concerning areas of specialization before the first job, "food science and technology/engineering" (FSTE) was, by far, the most common degree specialty at 56.6 % (Table 2). Following were "agriculture science and technology/engineering" (AST) (14.8 %), "chemical engineering" (CE) (6.4 %) and "other" (5.9 %), i.e., areas not specified in the questionnaire (bottom of Table 2). All other areas were below 5 %. Apparently, before the first FST job, a degree in areas not directly related to FST ("marketing science/consumer behavior" (MC), "economic science" (ES), "environmental engineering" (EE), etc.) is less common. European countries present large differences in this aspect which can be consulted in another work (results not published).

It is interesting to observe that the most important areas of extracurricular activities (Table 2) were quite different when compared with higher education specialties. The most important areas were "safety and hygiene" (SH) (19.0 %) and "management (including quality and safety)" (MNG) (17.5 %). Interestingly, "other" was also very important, at 14.9 % suggesting that areas outside of the food-related choices provided here are also a common subject of extracurricular activity. FSTE (10.4 %), "sensory science" (SE) (10.2 %), "nutrition and health" (NH) (8.6 %) and MC (6.4 %) were also all above 5 %. Extracurricular activities appear to be oriented to complement higher education qualifications, perhaps making curricula more attractive to employers.

Similar to degree specialties before the first position, the most common degrees during working life (Table 2) were FSTE (by far the most important at 45.2 %) followed by AST (11.0 %). Interestingly, the next most common specialties were MNG and SH (at 7.3 and 7.1 %, respectively), both of which were near 2 % before the first job. It appears that only once employed FSTs look for training in these areas, perhaps to access leading positions inside the companies and/or to allow, more in general, a career improvement.

The ranking of training areas during work (Table 2) is very similar to that for extracurricular activities before the first job, so it can be said that training activities are selected to complement the knowledge acquired during the higher education degree.

An important observation is that respondents in high responsibility positions did more training activities; the ratio activities/position is 1.13 for high responsibility level, 0.76 for medium responsibility level and 0.68 for low responsibility level. It is not clear whether currently employed FSTs know the importance of continuous training activities. Nor is it clear whether more training leads to a higher responsibility position or whether those who are otherwise qualified for higher responsibility are also those who seek training activities. Concerning the areas of education and training, they are very similar for all responsibility

levels except for training in MNG, which increased slightly with responsibility level.

Employees may undergo training by self-interest but also by employer demand, often due to legislative and regulatory requirements for the industry; "employers often view training as a means of assessing competence to undertake a specific role rather than as a business development tool" [3]. In fact, more companies require more computer skills and soft skills when examining the applications of potential employees, while few actually invest in such skills training, choosing rather to focus on the development of food skills [3], probably required by regulations. Large companies are likely to have a more sophisticated approach to skills development, whereas small companies, which have fewer human resources, focus on short-term productivity [13].

As a short summary, most of the surveyed FSTs had a higher education qualification obtained before their first position and some of them did training activities in complementary areas once they were employed.

Assessment of actual skills of FSTs

Both employers and employees agree that communication-related skills (*written communication*, *oral communication*) are the strongest non-food skills in FSTs (Table 3). For *other languages*, the pattern is the same: employers believe 20 % are proficient while 23 % of employees state they are good or excellent. It is noteworthy that *English language* does not follow this pattern: employers believe that over 70 % of their employees are proficient at English (in non-native English countries) while only 55 % of employees self-evaluate at good or excellent.

It is very informative that both employers and employees evaluated the entrepreneurship skills for business and enterprise development (e.g., marketing and finance) rather low. It is important to emphasize that according to the self-evaluation of respondents, their main competences are in technical, scientific, and technological aspects of food production. This could be connected with the contents delivered by the courses in FSTE (Table 2) and highlights the relative conservative and traditional character of education and curriculum development in the training of food specialists. Only in recent years have agro-food economy and marketing courses been included in FST curricula, and only in some European countries (e.g., Italy). The lack of such competences may actually be hindering young specialists from establishing an enterprise or seeing product development and production process as part of the value chain, and therefore a lucrative activity. This, in turn, makes the communication between food technologists and economists harder.

For every non-food skill presented, employees were likely to think they have the skill, that is, they are at least sufficient, while employers do not always agree. In some cases, these differences are striking: For *group leader*, 92 % of employees believe they are at least sufficient, while employers believe only 42 % of their FSTs have this skill—a similar situation for *statistics and mathematical skills*, *marketing and consumer skills* and *financial skills*: 86 versus 32 %, 76 versus 34 % and 73 versus 19 %, for employees and employers, respectively. Employee and employer opinions on the possession of a skill get much closer when those self-evaluating as "sufficient" are not included in the sum. Thus, it seems that "sufficient" from the employees' point of view is not enough from the employers' point of view; employers do not believe their employee has a particular soft skill unless the employee is good or excellent at that skill. Importantly, more than 50 % of employers believe that five important non-food skills (*group leader*, *other languages*, *statistics and mathematical skills*, *marketing and consumer science* and *financial skills*) are not found in the common FST professional.

Non-food skills of FSTs were also evaluated by the responsibility level of their job (Table 4). Here, it is clear that for most non-food skills, the more responsibility an employee has the more likely he/she is to self-evaluate as having the skills, with the exception of languages, where the opposite trend is observed. This is perhaps related to age: Older respondents have less languages skills (data not shown) and these occupy higher level positions.

Significant differences ($p < 0.05$) in gender show up on self-evaluation of *written communication* and *group working*, both higher for women, as well as *financial skills*, *marketing and consumer science* and *statistics and mathematical skills* all higher for men. A clear tendency was observed on *computer literacy* showing a decrease with age, *project management* and *other languages* showed the opposite tendency (data not shown). No other meaningful age-related differences were observed.

Within language skills, English was the most common foreign language, with 89 % of FSTs with at least basic knowledge, followed by French (32 %), and then by Spanish and German (21 and 20 %, respectively). These results agree well with those from a survey coordinated by the European Commission in 2012, where it is reported that the five most widely learned foreign languages in Europe are English, French, German, Spanish and Russian and the most useful languages for personal development are in this order English, German, French, Spanish, Chinese and Italian [14]. Concerning English, respondents younger than 30 have more advanced English knowledge than those over this age, also in agreement with the aforementioned European Commission Survey in 2012 and related to the low number of respondents with English skills according to responsibility level of the job shown in Table 4, if it can be assumed that higher responsibility is mainly linked to senior professionals.

Table 3 Non-food skills of the FSTs evaluated by employees and employers

Skill	Employees scores[a]				Employers scores[c]
	Sufficient	Good	Excellent	SUM[b]	
Written communication	12.4	55.2	31.2	86.4	80.4
Oral communication	15.2	54.6	27.0	81.6	84.3
English language	26.7	39.0	15.5	54.5	72.2
Computer literacy	24.2	52.7	20.2	72.9	76.9
Group worker	11.0	52.4	34.0	86.4	70.5
Presentation skills	20.8	53.8	22.0	75.8	64.8
Project management	25.1	50.4	17.8	68.2	57.7
Group leader	23.4	47.0	21.8	68.8	42.0
Other languages	24.1	16.8	6.1	22.9	19.9
Statistics & mathematical skills	37.5	36.2	12.0	48.2	32.4
Marketing & consumer science	39.2	28.9	8.1	37.0	34.2
Financial skills	40.0	27.0	6.2	33.2	18.5

Gray intensity increases with percentage

[a] Percent of employees that self-evaluated as "sufficient," "good" or "excellent" each skill, total evaluations included also "unsatisfactory" and "poor."

[b] Sum of the "good" and "excellent" shares

[c] Percent of employers that believe the skill is found in the common FST professional in their organization

The food skills that employers believe are most common in their FSTs were similar overall to the most common areas of employee education and training. These were *food safety management*, *food hygiene and food safety control*, *product development*, *quality management*, *quality assurance and quality contro*l and *production management/operations* in this order; more than 65 % of employers believe those skills are found in the common FST professional (Table 5). In agreement, FSTE and SH were the most common areas of employee education and training (Table 2). At the lowest positions in the table were skills related to *consumer and nutritional sciences*, *health*, *safety and the environment*, and *transportation*, indicating that employers do not believe that many of their FSTs have those skills.

Although four of the food skills of the list are under 50 %, this result is quite reasonable since food skills are more specific for each job position than non-food skills, making it very difficult to find all food skills in a common FST professional.

Notice that current food skills were not evaluated in the employee survey. This evaluation was not done because such an evaluation would be biased by the relation between each employee and his/her qualifications and activity type. For example, many quality managers answered this survey; if they were asked to evaluate their food skills, they would likely evaluate well the quality management skills, whether obtained in education and training or during work life. This information would not mean necessarily that, in general, FSTs have good quality management skills.

Actual and recommended ways of acquiring the most required skills

At the 2006 Lisbon conference, FDI representatives listed ten core competencies most desirable in their sector, most of which were soft skills, with only two being hard skills [15]. Based on brainstorming workshops on ideal skills of FSTs held in 16 European countries, Flynn et al. [8] reported that the vast majority (76 %) of the required skills were soft or non-food skills, interpreted as an employer satisfaction with food skills of FSTs. This is in line with the Bologna process and worldwide demands, in several subjects, that require the development of soft skills together with technical skills on future graduates [16, 17]. Lack of soft skills has been attributed to "rote learning" in education due to a focus on examination-based results of only technical skills [18].

More training is clearly needed for soft skills. Flynn et al. [8] reported that *communicating* (including language skills) was the most desired skill overall (13 % of the over 3,000 ideal skill ideas); this was followed by four other soft skills: *thinking and solving problems*, *demonstrating positive attitudes and behaviors*, *being responsible* and *working with others*. The only food-specific skill on the top ten list was *product development* and the only non-food technical skills were *managing information and computer literacy* and *business planning and strategic management*.

Table 6 shows *when* (frequency) and *where* the most important food and non-food (soft and technical) skills

Table 4 Self-evaluation of non-food skills by FSTs as a function of the responsibility level of their job

Skill	Low level[a]	Medium level[b]	High level[c]
Oral communication	76.3	82.6	87.8
Written communication	84.8	90.9	87.8
Presentation skills	70.4	81.3	80.9
English language	62.4	64.2	51.0
Other languages	23.1	27.2	22.0
Computer literacy	71.3	71.9	74.1
Project management	62.0	77.2	80.8
Group worker	88.8	88.4	84.0
Group leader	55.6	76.3	83.2
Financial skills	26.2	32.2	47.3
Marketing & consumer science	27.1	37.3	53.8
Statistics & mathematical skills	40.6	43.9	59.1

Values refer to those respondents with at least a qualification of "good." Gray intensity increases with percentage

[a] In charge of a group of tasks/activities

[b] In charge of a group of people/a department

[c] In charge of many groups or the company

Table 5 Food skills of the FSTs evaluated by the employers

Skill	%
Food safety management, food hygiene and food safety control	80.2
Product development	74.3
Quality management, quality assurance and quality control	67.2
Production management/operations	65.6
Food legislation and control	62.5
Research	55.3
Engineering maintenance	41.5
Consumer and nutritional sciences	34.4
Health, safety and the environment	32.0
Transportation	18.2
Other	3.6

Percent of employers that believe the skill is found in the common FST professional in their organization

demanded by employers should be learned, according to employers, as well as the actual ways of learning the skills as reported by employees. For an easier comparison, information has been given by skill groups. Average values of each skill group are calculated from those skills with more than ten inputs. Specific information on each skill is found in Table 7 (ten most demanded skills) and Table 8 (ten most demanded food skills) in the "Appendix" of this work.

Data for actual ways of learning the skills were obtained from the survey to employees; it indicated the most important education and training areas of FSTs. Additionally, information in the "actual ways" columns comes from personal comments of the authors of this work, as accepted general knowledge in the food science world. It is reasonable to accept that some skills are acquired by:

- Cross-curricular learning (CCL). The acquisition of some skills forms part of the whole curriculum in schools and/or university degrees, and all teachers are supposed to take responsibility in the teaching process. CCL is characterized by sensitivity toward, and synthesis of, knowledge, skills and understanding from various subject areas [19].
- Formal training at the workplace (TrWf). Events, courses, activities or seminars performed at workplace.
- Non-formal training, including workplace (TrNw). Mentor, experience, postdocs, internships, computer/internet resources, professional/government publications.
- Personal life (PL). Family and social life, travel, etc.

Please note that workplace training (TrW) in the recommended "where" column includes both formal and non-formal training, that is, the non-formal training explained above and events, courses, activities or seminars performed at workplace.

It can be also observed in Table 6 that, in general, skills are acquired in different ways, though these data do not comment on the effectiveness of different methods.

It was recommended that soft skills be acquired mainly from secondary or even primary school, and their acquisition continued and updated during higher education and at the workplace (formal and non-formal training, TrW). The frequency of activities to improve these skills is recommended to be quite high, an average score of 3.4 (range 3.1–3.8), in a 1–4 scale where 3 is "repeated events, courses, activities or seminars" and 4 is "continuously." Soft skills are acquired in a more or less deliberate way by cross-curricular learning (CCL) from the beginning of education (primary school) and then regularly throughout. Workplace (non-formal training, TrNw) and personal life (PL) are also important ways of acquiring these skills. There are rarely specific courses for learning soft skills, with the exception of languages (if we include language

Table 6 Recommendations on where and when (frequency) skills should be learned versus actual ways of skill learning

Skill group	Recommended ways of learning									
	Where[a] (% inputs)									FREQ[b]
	Education			Training				Other		
	EdS	EdH	EdE	TrW	TrO	TrN	TrC	PrO	PL	
Soft	13	27	6	30	8	1	0	7	8	3.33
Technical	10	36	0	28	8	0	9	9	0	2.76
Food	7	27	2	28	18	3	2	12	1	2.69

Skill group	Actual ways of learning, where[c]						
	Education			Training		Other	
	EdS	EdH	EdE	TrWf[d], TrO, TrC	TrNw[e]	PrO	PL
Soft	CCL LS	CCL LS	<1	<1	n.a[f]	<1	n.a.
Technical	CCL SS	CCL SS	<1	<1	n.a	<1	n.a.
Food		SS:98[g]	98[h]	97[i]	n.a	97[i]	

CCL cross-curricular learning, *LS* language subjects, *SS* specific subjects

[a] Three highest shares underlined

[b] Frequency as average of inputs, where 1 = one specific time; 2 = occasional events, courses, activities or seminars; 3 = repeated events, courses, activities or seminars; 4 = continuously

[c] Percentage of inputs or authors comments

[d] Formal training at the workplace

[e] Non-formal training, including workplace

[f] The skill is learned in this way, but information from the questionnaire is not available

[g] All areas of knowledge in higher education in Table 2 but ES

[h] All areas of knowledge in extracurricular activities in Table 2 but ES

[i] All areas of knowledge in training in Table 2 but ES

in communication skills). Occasionally, there are extracurricular activities at university (EdE) devoted to training students in these skills. Currently, training organizations (TrO) have a wide offering of activities to teach soft skills. However, there is very little information about soft skills in the survey to employees, and the responses about specific activities devoted to soft skills training before and during the working period are nonexistent or in the best of cases lower than 1 % of inputs. In summary, soft skills should be developed before higher education, but, as already pointed out, this has not been the case in recent curricula [18]. Education policy makers should have this in mind when reviewing curricular objectives throughout the entire education path. Training organizations (TrO) may also make a strong contribution here, mainly to food skills but also to soft skills, and professional (PrO) or governmental (TrC) organizations may also have a role. Employers recommend starting training for technical skills at school and continuing at university and the workplace (formal and non-formal). The recommended frequency of the respective training activities is 2.8 in a 1–4 scale (close to 3 "repeatedly").

Managing information and computer literacy is one of the skills likely acquired primarily by cross-curricular learning (CCL), from primary school to working life. Although it is well known that the offer of training courses is abundant, there were few responses on courses by employers specifically dedicated to this skill. It is also true that the use of computers always goes with the acquisition of computer skills, so the skill is practically acquired daily in different ways: personal interests, high school, university [including specific subjects (SS) in any of the knowledge areas considered in Table 2], non-formal workplace training (TrNw) and extracurricular activities (EdE) and training events related to practically all the knowledge areas.

Business planning and strategic management is a more specific skill, acquired in university courses or projects and training activities before and during working life. The specific courses and training activities can be included in some of the knowledge areas considered in Table 2, such as MNG, ES and engineering/technical areas (FSTE, AST, CE and EE). It should be noted that technical skills are in

fact obtained as an outcome of education and training, and therefore, the inputs received for university as the starting point of education and training in these skills are to be expected.

Food skills are also associated with knowledge obtained through education; in fact, scientific education is a prerequisite for FST jobs, and the following results and comments can be seen in this way. In general, it is recommended that food skills begin to be acquired at university and training should be continued and updated at the workplace. For this group of skills, training organizations (TrO) should also play an important role. The recommended frequency of training activities is the lowest within the three skill groups, with an average value of 2.6 excluding *research* and *consumer and nutritional sciences* (only two inputs), which is between occasionally (2) and repeatedly (3). University is the first place where food skills are acquired. Most are learned in the FSTE degrees, but they are also acquired in courses for other specialization areas. Due to the high proportion of respondents with a degree in FSTE (see section "Education and training of FSTs"), an equally high proportion of employees must have at least a basic-medium knowledge level of food skills. Extracurricular (EdE) and training activities were more focused on current critical skills for the industry: *product development*, *food legislation and control*, *food safety management*, *food hygiene and food safety control*, *quality management*, *quality assurance and quality control* and *consumer and nutritional sciences*. While most respondents did not do training activities for any type of skill, it seems that for food skills at least, FSTs have a sufficient level of knowledge from their education, supported by the fact that their employers did not report a need for training in these skills. Also notice that neither employers nor employees considered non-formal training out of workplace as a possibility for training, additionally employees never considered personal life (PL) as a source.

Conclusions

Employees and employers agree in general on the survey of higher education degrees and on the evaluation of the current skills of European FSTs. In general, FSTs are well qualified by higher education studies, but most of them do not continue training during their job. It is noteworthy that training activities were related to higher responsibility positions suggesting that if an FST professional wants to move to high responsibility positions, he/she should do training in general and particularly in soft skills.

Soft skills and especially those related with *communication* are the most important from both employer and employee points of view, whereas technical skills are in the lowest positions. Concerning food skills, and in agreement with reported information on education and training, employers stated that FST professionals are qualified (e.g., those related with *food safety and quality*, *product development*, *production*). More specific skills, with relation to food (*engineering maintenance*, *consumer and nutritional sciences*, *environmental issues*, *transportation*), were more poorly evaluated, likely because these skills are more specific to particular positions and it is less likely to find them in a common FST professional. Also, skills such as *marketing and consumer science* and *financial skills* were evaluated rather low by both employers and employees, a situation which may be hindering entrepreneurship.

Gender differences were found only in the self-evaluation of written communication and group work, both higher for women, and financial skills, marketing and consumer science, and statistics and mathematical skills, higher for men.

Although employers and employees agree that the current FST professional has soft skills, employers ask more for soft skills. Only two technical skills and one food skill appear in the top ten list of most required skills, showing that employers feel a skills gap in soft skills. It is recommended that:

- Soft skills be acquired at the start of education and continuously updated during higher education and at the workplace. Due to the importance of these skills, education and training activities should be well designed from elementary through higher education and beyond.
- Education and training for technical skills should start at high school and continue at the university and at the workplace.
- Food skills should be acquired at the university and training should be continued and updated at the workplace. For this group of skills, training organizations should also play an important role in the training process.

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Conflict of interest The authors declare that they have no conflict of interest.

Compliance with Ethics Requirements This article does not contain any studies with human or animal subjects.

Appendix

See Tables 7 and 8.

Table 7 Recommendations on where and when (frequency) the ten most required skills should be learned versus actual ways of learning the skills

Skill (number of inputs, skill group)	Recommended ways of learning									
	Where (% inputs)									FREQ[a]
	Education			Training				Other		
	EdS	EdH	EdE	TrW	TrO	TrC	TrN	PrO	PL	
Communicating (103, soft)	25	26	7	17	8	0	4	6	7	3.3
Demonstrating positive attitudes and behaviors (16, soft)	13	6	6	44	13	0	0	6	12	3.6
Thinking and solving problems (33, soft)	3	42	0	33	4	0	0	18	0	3.1
Being responsible (16, soft)	19	25	0	50	0	0	0	0	6	3.6
Working with others (43, soft)	12	35	7	28	4	0	0	2	12	3.2
Product development (59, food)	7	24	5	34	15	0	3	12	0	2.6
Managing information and computer literacy (28, technical)	14	36	0	25	3	18	0	4	0	2.8
Business planning and strategic management (33, technical)	6	36	0	30	13	0	0	15	0	2.8
Being adaptable (5, soft)		40		60						3.8
Providing leadership (11, soft)	9	27	18	9	18	0	0	10	9	3.2
Skill (number of inputs, skill group)	Actual ways of learning, where[b]									
	Education			Training				Other		
	EdS	EdH	EdE	TrWf, TrO, TrC		TrNw		PrO	PL	
Communicating (103, soft)	CCL LS	CCL LS	<1	<1		n.a		<1	n.a.	
Demonstrating positive attitudes and behaviors (16, soft)	CCL	CCL	<1	<1		n.a.		<1	n.a.	
Thinking and solving problems (33, soft)	CCL	CCL	<1	<1		n.a.		<1	n.a.	
Being responsible (16, soft)	CCL	CCL	<1	<1		n.a.		<1	n.a.	
Working with others (43, soft)	CCL	CCL	<1	<1		n.a.		<1	n.a.	
Product development (59, food)		SS: 84[c]	25[d]	28[e]		n.a.		28[e]		
Managing information and computer literacy (28, technical)	CCL SS	CCL, SS : 100[f]	<1	<1		n.a.		<1	n.a.	
Business planning and strategic management (33, technical)		SS : 83 [g]	<1	<1		n.a.		<1		
Being adaptable (5, soft)	CCL	CCL	<1	<1		n.a.		<1	n.a.	
Providing leadership (11, soft)	CCL	CCL	<1	<1		n.a.		<1	n.a.	

[a] Frequency as average of inputs, where 1 = one specific time; 2 = occasional events, courses, activities or seminars; 3 = repeated events, courses, activities or seminars; 4 = continuously

[b] Percentage of inputs or authors comments

[c] Areas of knowledge in higher education in Table 2: FSTE, AST, CE, other

[d] Areas of knowledge in extracurricular activities in Table 2: FSTE, other

[e] Areas of knowledge in training in Table 2: FSTE, other

[f] All areas of knowledge in higher education in Table 2

[g] Areas of knowledge in higher education in Table 2: FSTE, AST, CE, MNG, ES, EE

Table 8 Recommendations on where and when (frequency) the ten most required food skills should be learned versus actual ways of learning the skills

Skill (number of inputs)	Recommended ways of learning									
	Where (% inputs)									FREQ[a]
	Education			Training				Other		
	EdS	EdH	EdE	TrW	TrO	TrC	TrN	PrO	PL	
Product development (59)	7	24	5	34	15	0	3	12	0	2.6
Food legislation and control (41)	2	20	0	29	17	7	10	15	0	2.4
Food safety management, food hygiene and food safety control (6)	0	83	0	17	0	0	0	0	0	2.7
Quality management, quality assurance and quality control (36)	19	11	0	31	28	0	0	11	0	2.6
Research (23)	0	52	5	17	13	0	0	9	4	3.2
Health, safety and the environment (0)	–	–	–	–	–	–	–	–	–	–
Engineering maintenance (4)	0	50	0	25	25	0	0	0	0	2.5
Production management (0)	–	–	–	–	–	–	–	–	–	–
Consumer and nutritional sciences (2)	50	50	0	0	0	0	0	0	0	3.5
Control operations (0)	–	–	–	–	–	–	–	–	–	–

Skill (number of inputs)	Actual ways of learning, where[b]					
	Education			Training		Other	
	EdS	EdH[c]	EdE[d]	TrWf, TrO, TrC[e]	TrNw	PrO	PL
Product development (59)		84 (FSTE, AST, CE, other)	25 (FSTE, other)	28 (FSTE, other)	n.a.	n.a.	n.a.
Food legislation and control (41)		87 (FSTE, AST, NH, SH, MNG, MC, SE, other)	62 (FSTE, SH, MNG, other)	64 (FSTE, SH, MNG, other)	n.a.	n.a.	n.a.
Food safety management, food hygiene and food safety control (6)		86 (FSTE, AST, NH, SH, MNG, SE, other)	62 (FSTE, SH, MNG, other)	64 (FSTE, SH, MNG, other)	n.a.	n.a.	n.a.
Quality management, quality assurance and quality control (36)		89 (FSTE, AST, CE, MNG, ES, EE, SE, other)	43 (FSTE, MNG, other)	47 (FSTE, MNG, other)	n.a.	n.a.	n.a.
Research (23)		100 (all areas)	<1	Postdocs, experience, < 1	n.a.	n.a.	n.a.
Health, safety and the environment (0)		85 (FSTE, AST, CE, EE, other)	17 (EE,other)	21 (EE, other)	n.a.	n.a.	n.a.
Engineering maintenance (4)		85 (FSTE, AST, CE, EE, other)	31 (FSTE, AST, CE, other)	33 (FSTE, AST, CE, other)	n.a.	n.a.	n.a.
Production management (0)		87(FSTE, AST, CE, MNG, EE, other)	48 (FSTE, AST, CE, MNG, other)	52 (FSTE, AST, CE, MNG, other)	n.a.	n.a.	n.a.
Consumer and nutritional sciences (2)		82 (FSTE, AST, NH, MC, SE, other)	15 (NH, MC)	15 (NH, MC)	n.a.	n.a.	n.a.
Control operations (0)		85 (FSTE, AST, CE, EE, other)	33 (FSTE, AST, CE, EE, other)	36 (FSTE, AST, CE, EE, other)	n.a.	n.a.	n.a.

[a] Frequency as average of inputs, where 1 = one specific time; 2 = occasional events, courses, activities or seminars; 3 = repeated events, courses, activities or seminars; 4 = continuously

[b] Percentage of inputs (Table 2) or authors comments

[c] Percentage of inputs correspond to higher education subject specific areas of Table 2 indicated in parentheses

[d] Percentage of inputs correspond to extracurricular activities areas of Table 2 indicated in parentheses

[e] Percentage of inputs correspond to training areas of Table 2 indicated in parentheses, or author comments

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