

Developing Soft Skills in Engineering Studies – the Experience of Students’ Personal Portfolio

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Abstract - We present and analyse a work experience, now in its fifth year, to help students in developing soft skills, through execution and reporting, during a period of six semesters, of extra-curricular activities that are validated and evaluated by the faculty and, in a certain way, integrated in the curriculum throughout in the form of a ‘Personal Portfolio’. The global objective of the Personal Portfolio is to develop the student’s soft skills through the practice of extra-curricular activities and the reflection on that practice. In this paper we clarify the initial design of the learning environment, the objectives and regulation of Personal Portfolio, the information system that supports the activities and the evolution of students’ numbers and of the faculty. We comment on the major activities that have been developed, the main results obtained, the differences between the experiences in two campuses and the evolution of the Portfolio concept resulting from the adoption of the Bologna Agreement.

Key Words- learning by doing, personal portfolio, reflective practice, soft skills.

INTRODUCTION

In the course of the regular evaluation of the five years degree in Information Systems and Computer Engineering (LEIC) of Instituto Superior Técnico (IST) of the Technical University of Lisbon, when interviewed, employers of the graduates would typically say that they have very good scientific and technical skills but weak soft skills (namely, writing and oral communication, teamwork, capacity to dialogue with non- technical co-workers, understanding of organisations, management and leadership, international awareness, etc.).

Unlike some other countries, the Portuguese school system (from the elementary school through to University) gives no incentive to students to engage in extra-curricular activities, where they could gain soft skills. Neither is the curriculum organised to give students the possibility to follow optional subjects from areas different from the main ones students have chosen.

The participation in extra-curricular activities is even more difficult in courses, like LEIC, which are highly intensive especially as students have no time management skills and have no incentive to learn them.

The soft skills missing from graduates are the ones covered by the section of ‘Personal Skills and Competences’ of the ‘European Curriculum Vitae’ (Europass), proposed by Cedefop [1]. The instructions of this document state that

these skills can be gained in the course of one’s life and career as well as from extra-curricular activities and mention specifically sports, cultural and artistic activities, students’ organisations, projects, multicultural experiences, etc.

In this context, and in order to solve the problems referred to by employers, the Co-ordinators of the Department responsible for the degree decided to create a context in which students could gain professional soft skills, through the realisation of extra-curricular activities, and the reflection on these practical activities, in order for each student to create a Personal Portfolio. These activities take place, one per semester, during the last three years of the degree and are supervised, evaluated and certified by the professors.

From an administrative standpoint, there are six successive modules, with 2 ECTS’s each, where the students are evaluated with ‘pass’ or ‘fail’, with no quantitative grades and no contribution to the students’ overall mean.

The Personal Portfolio has been introduced gradually since the academic year of 2002-2003 with a first small group and then extended to two different degrees in two campuses, and involves approximately 1000 students in the academic year of 2006-2007.

About 60% of the students are following the Information Systems and Computer Engineering degree (LEIC) at the Alameda campus in Lisbon. The other 40% are studying at the new Taguspark campus (near Lisbon) following LEIC or the recently created degree on Networks and Communication (Redes e Comunicação Informática – LERCI).

HOW TO DEVELOP STUDENTS’ SOFT SKILLS

The lack of professional skills by recently graduated engineers is also recognised by other Engineering Universities when they question employers [2]. However, when this problem is addressed the most common solution is to add to the curriculum one or more modules on professional soft skills whereby the professors teach students these skills [3].

This solution has a certain number of advantages: the experience is fully controlled by the professors that can teach students in a conventional way and resort to current evaluation methods based on examinations, tests and papers.

This solution accepts a model of the University as being mainly concerned with the ‘impart of knowledge’ and assumes that professional skills are ‘transferable’ through lessons.

But when we analyse professional soft skills we have to conclude that they are behavioural in nature, and are gained

by professionals through their practice in real work situations and their reflection on that practice [4].

Professional soft skills are mainly tacit and hence, according to Polanyi [5], they can not be made explicit, and so they are not easily transferable through lessons and classes. On the contrary, they are learned by doing, through socialisation [6], in a professional social context.

On the other hand, soft skills are very diverse and they cannot be fully mastered through classes or in the period of one semester.

In order for students to develop and master professional soft skills, one must create a context of practice (what Schön [7] calls a 'reflective *practitum*') that simulates some of the conditions that professionals encounter in their real professional work, when they are part of communities of practice [8] and work for companies that facilitate, or on the contrary restrict, their capacity to learn through practice.

If we consider that the companies that facilitate individual and organisational learning [9] are the ones that resemble what has been called 'learning companies' [10] or 'learning organisations' [11] then the 'reflective *practicum*' proposed to students, and later developed with their own contributions, must also resemble that standard.

The first author developed in the mid nineties, at the University of Coimbra, in the context of a two semesters Management Course for Engineering Students, a learning environment to promote the acquisition by students of organisational and management skills [12].

These skills are indeed a subset of the professional soft skills addressed by the Personal Portfolio and hence that previous experience created a model that could be expanded and adapted to the new context. That experience will be referred later in this paper in comparison with the more general Portfolio experience.

OBJECTIVES AND REGULATION

As there are many degrees of freedom in the choice and reporting of activities by the students, there was a need to clearly clarify the rules to be followed.

This has been obtained with a (short) 'Regulation of Personal Portfolio Activities' that defines the objectives and rules to be followed by students that will be summarised below.

At the outset we defined the general objective of the Personal Portfolio as follows: to stimulate the students to gain behavioural skills and knowledge, in diverse domains, through the realisation of extra-curricular activities and the reflection and reporting on these activities.

The more detailed objectives include:

- To learn by themselves, individually and cooperatively, out of the context of the curriculum.
- To learn to reflect on practical activities as a way of fully profiting from the Portfolio and in order to prepare students for the professional life and life long learning.
- To obtain personal skills, team work, organisational and social skills.
- To acquire progressively greater maturity, responsibility, professionalism as well as skills in management and leadership.

- To contribute to a greater students' participation and responsibility in the life and image of IST and in the management of the Portfolio activities.

The kind of skills that students can explore and develop in the six semesters include, among others, cooperative learning, self-learning, citizenship, social skills, organisational skills, creativity, entrepreneurship, time management, international awareness, leadership, management, professional relationship, team work, systemic perspectives, reflection on practice.

To obtain these skills students can develop many kinds of activities. About 50 types of suggested activities are provided to the students, however they are also able to propose other activities. The most common activities include: organisation of events, internship in enterprises, development of software or web sites to 'customers', sports, cultural activities, attendance of professional or non technical courses, monitoring educational or training activities, etc.

The Regulation also states that students must develop a diverse Portfolio during the six semesters, engaging in different kinds of activities in order to develop different skills.

At the beginning of each semester students must propose one activity and state the objectives of the activity and the learning objectives they expect from the experience. The majority of the proposals comply with the regulation and are accepted by the faculty. A small number are rejected and, in some cases, students are asked to develop, clarify or change the focus of the proposal.

In the beginning of each semester professors of the Department, companies and even students can make suggestions of activities that can be selected, or not, by the students and incorporated in their proposals.

The activities can be developed individually or in groups of students, the dimension of the groups being related with the complexity of the activity.

During each semester the faculty for Personal Portfolio is available to support all the students or groups that are developing their activities. In some cases the faculty can take the initiative to call in students or groups, normally when they have chosen more problematic activities. There are also some activities that are directly supported by professors - normally this includes large organisational activities that will be referred to later.

In the very first semester of the portfolio activity (i.e. the first semester of the third year of the degree) there is a one hour weekly theoretical class to explain the main concepts of the Portfolio activities and regulation, to give guidance in skills with relevance for the development of activities or reporting them and to analyse problems in the students projects.

To create a framework where students have to reflect seriously about their activities and the experiences and skills they have gained, and for evaluation purposes, at the end of each semester students must provide:

- An 'Activity Report' describing the activity they have developed. That report is collective when the activity was developed in group.

- An individual 'Learning Report' where each student must describe the knowledge obtained through the realisation of the activity and the soft skills gained or increased.

For evaluation purposes students must also prove that they have done the activity. This can be a certificate from an external source or other type of confirmation negotiated with the faculty.

The reports are commented by the faculty and the written annotations are made available to the students. As there are no quantitative marks each semester the faculty attributes 'honourable mentions' to the most relevant activities and/or the best reports.

In order to allow for certain types of activities, namely international experiences and some internships in companies, students can also develop activities during the holiday period, which will count towards the next academic semester. The Regulation also states that it is expected that during the course of the six Portfolio activities students progressively develop activities of greater complexity and responsibility and that the fourth and fifth year students can be involved in the management of the Portfolio activities or act as consultants, mentors or facilitators to younger students.

The support given to Personal Portfolio including classes is the same for all students involved and all the suggestions and internships available in enterprises are announced to all students, independently of campus or degree.

Finally it must be mentioned that the Regulation has been submitted to some minor modifications (such as invalidating some activities initially accepted), however it has by and large remained the same since the beginning.

INFORMATION SYSTEM SUPPORT

With the number of students enrolled, the fact that there are no formal classes except in the first semester of the students involvement in the Portfolio and the complexity of managing students and activities, the system cannot be based on paper circulating between students and faculty. Because of that a sound Information Systems support was needed.

This System was developed in the holiday period after the academic year of 2002-2003 as the Portfolio activity of a group of two students and later developed by them as a voluntary activity.

This is a Web application that students, faculty and other interested parties can access with a browser over the Internet. At the moment it is written in Portuguese only.

The application has three main areas:

- A public space where there is access to announcements, documents, FAQ's, contact information of the faculty, previous students' reports and a page where one can put forward suggestions of activities.
- A students' space which students can access through login, with an user id and password, and have access to a personal area where they can make their proposals, upload their reports, supply questions to faculty, etc.
- A faculty space, where professors can access the information of all the students, access and evaluate

proposals, download and evaluate reports, answer to FAQ's, upload documents, create announcements, approve suggestions, etc.

The current application does not provide statistics. That possibility was considered, but the development of new functionalities to help the students and the faculty always had to take priority.

Each time a student registers on the site he is also subscribing to a portfolio mailing list that is used mainly for announcements from the faculty and from students (mainly announcing public activities being organised). Due to the large number of users subscribing to the mailing list, it is not used for discussion purposes. Discussion takes place in a public Web forum.

The faculty also has to use a different Administrative Information System to publish objectives and class summaries and to submit final evaluations. Unfortunately there is no integration between this system and the Portfolio Web application and the former is organised by degree/campus/year.

INTRODUCTION OF PERSONAL PORTFOLIO AT IST

IST is an Engineering School created in 1911 in the campus at Alameda, in Lisbon and until the year 2000 stood only in that campus. With the creation of new courses the space became more and more limited. LEIC began at the Alameda campus in 1989.

The campus at Taguspark, located in an enterprise park, began its activity in the academic year of 2000-2001, offering only at the time the first year of the degree that is now known as LEIC-Tagus (but had then a different name). LERCI began its first year in 2002-2003.

The decision to include Personal Portfolio in these courses, fully or partially under supervision of the Department of Information Systems and Computing, was taken in 1999. The Portfolio was included in the Curriculum of LEIC-Tagus and LERCI since the beginning of these courses, and would take effect when they would reach their third year.

The Personal Portfolio began at LEIC-Alameda in 2003-2004, for third year students during the course of the reformulation of that degree. In all of the mentioned degrees the Personal Portfolio took place in the third year and it was later extended to the fourth and fifth years.

Under these conditions the evolution of the number of students involved in Portfolio activities has been (approximately): 2002-2003: 30 (third year of LEIC-Tagus, then LESIM); 2003-2004: 300 (200 at LEIC-Alameda, 100 at LEIC-Tagus); 2004-2005: 600; 2005-2006: 900 and 2006-2007: 1000.

In order to support the Portfolio, the faculty has provided one Invited Professor working practically on a full-time basis and two graduate students, giving support of two hours per week, in 2004-2005 and five graduate students in 2005-2006. In 2006-2007 another Invited Professor was involved (on a 0.5 basis) and the number of graduate students dedicated to the Personal Portfolio has decreased to four.

STUDENTS ACTIVITIES

In this section we will refer globally to the activities developed by students. Some activities of greater strategic impact will be further analysed in the next section.

In the first semester of the academic year 2006-2007, 993 students enrolled in Portfolio. Of those students 800 (80%) effectively proposed and developed an activity and presented reports and certificates of execution (as and when they were needed). Only those have been evaluated and have passed 97% of them. There are no significant differences between campuses or courses.

To facilitate analysis each student activity is categorised at the time of approval in a number of different types. The most chosen types of activities are referred to below in decreasing order for the academic year of 2006-2007. There has been a slight variation during the years with an increase in more enriching activities. Again there is no significant difference between campuses and/or courses, except when especially referred to.

20% of the students chose activities of the type that includes internships in companies as well as professional activities (normally part-time for regular students and full-time for working students) and also the monitoring of courses. Another 16% of the students chose activities that included developing software and/or Web sites, normally to customers (12%) that develop important skills of negotiation and dialogue with external parties and analysis of requirements in real life situations.

16% of the students have chosen to organise events or participate in the management of students' organisations, including the ones referred to below. The percentage has been significantly greater at Taguspark.

Also 16% of the students chose to attend courses. From those only less than 10% followed technical courses (normally professional ones). The great majority (90%) followed non-technical courses, including foreign languages and a Portuguese language course provide by the Faculty.

10% of the students chose sports activities, mainly collective sports. The percentage is greater at Alameda campus as they offer better facilities for such practice. 6% have developed research activities (especially on technical matters, but also on management and education). 4% engaged in mentorship activities for first year students, 4% engaged in international experiences and 4% in self-study activities (technical and non-technical with roughly the same participation). Finally 4% developed activities not included in the previous types.

ACTIVITIES OF STRATEGIC IMPORTANCE

From the experience in Coimbra referred to above [12], we could conclude that there are some activities that not only give relevant soft skills to the students, but can also create new activities for (different) students in the following years. These are the organisation of an annual Conference by a large group of students, the organisation of many different types of events by smaller groups, students organisations and student driven laboratories (The Management Laboratory –

LAGE), which proposes and co-ordinates other activities or acts as consultant to them.

IST Students have an old-established and strong Association working from the Alameda Campus, with a small delegation at Taguspark. Portfolio students have been involved in some areas of the Students Association, and have even revitalised some of them, but these activities have no continuity and depend on the dynamism of the elected students' representatives.

When the Portfolio experience began there was already a big event being organised each year by the students of LEIC at the Alameda Campus – a 'Week of Informatics' (Semana Informática – SINFO). This event was mainly organised by fifth year students. That organisation has continued and the XIV SINFO took place in March 2007. This organisation is independent from the Portfolio Faculty but today the majority of organisers report the organisation as a Portfolio activity.

Also at the Alameda Campus, following an open session to introduce the Personal Portfolio, in April 2003, a group of 11 students took the initiative of creating a Students' Informatics Society (Núcleo Estudantil de Informática do IST – NEIIST). This is an independent student body created by Portfolio students in the academic year of 2003-2004, at Alameda, with a small delegation at Taguspark.

In 2004-2005, with the first elected direction NEIIST organised a number of events, namely:

- The 'Cycles of NEIIST Presentations' where students make presentations or give small technical courses to others students on matters of which they have a relevant knowledge.
- With LAGE of the University of Coimbra and a students' organisation from the University of Évora organised the first National Meeting of Informatics Students (ENEI) which had recently its third event in Guarda.

But, unfortunately, in 2005-2006 and 2006-2007 the number of NEIIST members has decreased, the delegation of Taguspark has been closed and only the 'Cycles of NEIIST Presentations' are still being organised each semester.

Also, at the Alameda Campus, a group of six students developed in the academic year of 2005-2006, an important field study on the "Skills and Roles of IST Informatics Engineering in the Workplace", and that represents an important reference on the value of soft skills in industry.

At the Taguspark Campus, when we consider the academic year of 2003-2004, the total number of students in the campus was still very small, and with the exception of the delegation of the IST Students Association that had a very light presence, there were neither students organisations nor events organised by students.

The majority of such events and students' bodies now present at Taguspark have been born within the Portfolio activities. The most important are referred to below.

Third year students from LEIC-Tagus and LERCI organise each year, under the supervision of Portfolio faculty, a two day Conference with invited speakers from the industry. The fourth edition took place in March 2007. This involves about thirty students each year.

A Students' Network and Communication Engineering Society (Núcleo de Estudantes de Engenharia de Redes e Comunicações Informáticas – NERCI) was created in 2004-2005 and has created activities since then. They are currently organising an IST students' delegation of IEEE.

There are cultural cinema and photography societies, which organise regular activities on campus as well as an entrepreneurship group.

Since 2004, that a group of students with renewed composition each year promotes the relationships between University and Enterprises (mainly the ones installed in the Taguspark or close to it) and promotes students short internships that are announced to all Portfolio students. Under that influence a similar group has been created at Alameda in the current academic year.

Aggregating all these bodies at Taguspark a Laboratory for Counselling on the Organisation of Extra-curricular Activities (Laboratório de Apoio à Gestão de actividades Extra-curriculares dos Estudantes – LAGE2) was created in the academic year of 2005-2006 and it has been active ever since then.

LAGE2 is coordinated by a group of students, under the supervision of the Portfolio faculty, and:

- Co-ordinates many of the activities mentioned above.
- Acts as a consultant to the organisation of the referred seminar.
- Co-ordinates others activities, mainly the organisation of various types of events.
- Each semester suggests activities to be organised by the Portfolio students.

TAKING STOCK OF PORTFOLIO ACTIVITIES

The Portfolio experiment is now in its fifth year and some conclusions can be drawn from the activities described above and from the reports received from students each semester. The main conclusions are as follows:

- There is a clear evolution of the activities chosen by students according to the number of years they have been involved – third year students, except those involved in the organisation of big events (namely the Tagus Seminar), typically choose simple activities (like sports or the mentorship programme), but they choose more demanding activities in the following years – contacts with enterprises, internships, development of software to customers and part-time work experiences develop significantly in the fourth and specially in the fifth year.
- The quality of the reports produced by the students have a similar evolution – there is a majority of superficial reports by third year students, but the clarity and capacity for reflecting on the activities and making explicit the details of the skills gained grows in the following years.
- The importance of the reports, and especially of the 'learning report', is recognised by many students and the faculty as having the merit of obliging students on the type of reflection processes that improve the skills they can gain from the activities; this conclusion begins to be

recognised by many students and also by some of the employers of our graduates.

- There are, however, some difficulties in the Portfolio activities. Many students do not show the capacity to learn from the experience and to reflect seriously on their learning – even if there is an evolution, the departing level is low.
- The other major difficulty is related to the fact that both degrees involved are very demanding and often students have not got enough time to dedicate to the Personal Portfolio activities. Sometimes they choose an activity and during the semester they approach the faculty to propose a change to a less demanding activity.
- Another difficulty is related to the students' lack of time management skills. Interestingly, students that choose a demanding activity and persist in its realisation as well as in the other subjects, report that they learnt to manage time and their academic marks have been better than in preceding semesters.
- In some cases the capacity to gain relevant soft skills is more related to the capacity of the student to reflect in the experience than on the experience itself or more precisely, on the type of activity chosen by the students. In some cases, activities which the faculty was reluctant to approve yield more significant outcomes than other more complex activities – the reason being probably because students have not had enough time to engage in reflection on the experience.

Finally there are some differences between the two campuses that will be analysed in the next paragraph.

DIFFERENCES BETWEEN THE TWO CAMPUSES

As it has been said before the guidance and classes are the same in the two campuses and for the two degrees. There are no significant differences either in the pass/fail ratio or in the overall quality of the reports. Nevertheless there are other differences between the two campuses. The organisation of events, of group activities that continue from year to year and the number of student organisations, is much greater and dynamic at Taguspark than at Alameda. A snow ball effect has already begun at Taguspark but is not yet visible at Alameda. Also the subjective acceptance of the Portfolio activities by the students is greater at the Taguspark Campus.

According to our analysis there are two main reasons for these facts. The first is 'historical'. When the students enrolled to LEIC-Tagus and LERCI degrees they knew already that Personal Portfolio was included in the degree. While for the first students involved in Portfolio activities at Alameda, those activities were considered to be a fifth (smaller) module in each semester of an already heavily loaded degree. This created a 'resistance to change' that was easily propagated to younger students, especially due to the high retention level in the first years.

This fact has been addressed by the faculty that planned to obtain some 'quick wins' that would help to gain acceptance for the Portfolio activities. But it has been easier to obtain these 'quick wins' at Tagus (a new campus) than at Alameda where a lot of extra-curricular activities were

already in place. A significant change in attitude is only now beginning to happen at Alameda.

To explain this one must refer to the concept of 'Ba', originally proposed by the Japanese philosopher Nishida and introduced by Nonaka and Konno in the organisational theory. 'Ba', that can be roughly translated into English as 'place', is a 'shared space for emerging relationships', and a 'platform for advancing individual and collective knowledge' hence a context more than a place [13].

Nonaka and Konno consider that 'Ba' can be thought as a space with three categories – a physical space (offices, for instance), a mental space (shared experiences and ideas, mental and social relationships) and a virtual space. The physical space influences the mental space and the quality of 'ba'.

If one applies the concept to the two campuses they begin to be seen in a very different light. The campus at Alameda is an old campus, which has grown over the years in a small confined space, with a large number of buildings and many degrees, and it is over populated. Due to the restrictions of space, during the week students may have classes in five different buildings. With a *numerus clausus* of 170 for the LEIC degree and a high level of fail grades in the first years, students do not have classes with the same group and frequently do not know more than a couple of other students until the fourth or fifth year. As many professors do not have offices in the campus, but at a nearby associated research institution, students and faculty only meet during classes.

On the other hand, the campus at Taguspark has only one building with all the offices and classes over a very large internal space, where the only cafeteria is situated. With a much smaller *numerus clausus* students get to know one another much earlier. They have the opportunity of meeting other students and faculty at all times and can easily engage in conversation.

In these conditions it is easy to understand that the two 'mental spaces' are very different and the collective activities are much easier at Taguspark than at Alameda.

ADAPTATION TO BOLOGNA

In the academic year of 2007-2008 the courses at IST will be restructured to comply with the Bologna Agreement. The referred degrees will be divided in a B.Eng in the first three years and a M.Eng including the fourth and fifth years.

The Portfolio activities will decrease to four semesters – two in the last year of the B.Eng. (third year students) and two in the first year of the M.Eng. (fourth year students). The development of soft skills for fifth year students will be included in the context of the Master dissertation (that counts for 42 ECTS).

This implies that the objectives of the Portfolio activities will have to be concentrated in two years and the acquisition of maturity and responsibility from students will have to be fastened. Due to that some activities will not be authorised (to count as Portfolio activities) and some activities that can now be continued during two semesters will be considered only for one Portfolio activity.

CONCLUSIONS

In this paper we have described an experience in developing students' soft skills, through the realisation of extra-curricular activities and the reflection and reporting of those, organised during six semesters of Students' Personal Portfolio.

So far the experience has been successful and students are acquiring relevant professional soft skills. Details of the experiment in the two campuses have been presented and analysed.

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