The Bologna Process as a Motivator for Change

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The implementation of the Bologna Declaration in Portugal brought the necessity for several changes in course curricula. Based on the work conducted at our institution, this paper shows how those changes were also seen as a major opportunity to improve student learning at different levels, namely through the improvement, creation, and promotion of new administrative and teaching practices. The paper focuses on the Computer Science course. It briefly presents the changes in curricula, and focuses on the new practices we have implemented by taking advantage of the window of opportunity left open by the need to comply with new legislation. These new practices have allowed and encouraged a kind of learning that is perceived as closer to the necessities and motivations of the local community, the students, and the School itself. The paper concludes with a set of lessons learned and already planned future work.

Keywords

CS Curricula, Bologna declaration.

1. Introduction

The implementation of the Bologna Declaration in Portugal was conducted along the academic year 2005/2006. The first academic year with "Bologna curricula" was 2006/2007. The new legislation forced the change to 3 + 2 + 3 year degrees. Portuguese higher education system (tertiary education) is a binary system with polytechnics and universities. The Bologna process brought a significant change, especially at universities where there were no 3 year degree, the typical being 5 years licentiate + 2 years master + 5 years PhD (*Doutoramento*). The application of the Bologna Declaration forced universities to radically change their curricula. On the other hand, polytechnics already had 3 years bachelor + 2 year licentiate degrees. Now, after the application of the Bologna Declaration, and depending on the respective human resources, polytechnics can offer 3 years licentiate and, eventually, 2 year master degrees. Again depending on the available resources, universities can also

offer PhD degrees. Due to Portuguese sociological reasons, the name bachelor was abandoned in favour of the more popular licentiate (*licenciatura*) degree.

This paper presents the work conducted, at a small polytechnic school, while adapting its computer science course to the new "Bolonha Legislation". Besides the required bureaucracy, several initiatives were conducted to improve the learning experience at different levels, namely through the improvement, creation, and promotion of new administrative and teaching practices. This paper focus is on the Computer Science course.

The implementation of the Bologna Declaration in Portugal was conducted along the academic year 2005/2006. The Institutions that decided to immediately adopt it had very little time, in practice a few weeks, from the publication of the main Legislation to the deadline for submitting the newly revised curricula. This was only possible, because most of the new Legislation was already known, as a proposal, three months before. In spite of this, the time was undoubtedly very short for the institutions that decided to start the new curricula in 2006/2007. In spite of this, most institutions decided not to wait one more year. Anecdotal evidence indicates that the main reason for this generalised adoption was the entrenched idea that Institutions with Bologna would be more appealing to candidate students. As there has been a significant reduction on the number of student candidates to higher-education in Portugal, and the financing of public higher-education institutions in Portugal directly depends on the number of new students, this fact alone was considered enough reason for not waiting one more year. Since 1996 the number of candidates has decreased and since 2003 there are more positions than candidates [1].

Section 2 presents our School, namely some data about its environment and students. Section 3 presents the old curricula, and Section 4 presents the changes in curricula, and the new practices we have implemented by taking advantage of the window of opportunity left open by the need to comply with new legislation. These new practices have allowed and encouraged a kind of learning that is perceived as closer to the necessities and motivations of the local community, the students, and the School itself. Section 5 details the newly introduced practices. Finally, we present a list of lessons learned and conclude pointing to foreseen future changes.

2. The Institution

The Escola Superior de Tecnologia e Gestão at Instituto Politécnico de Beja is a small higher education institution in one of the poorest regions of Portugal. This means that the neighbouring community is mostly comprised of small and micro enterprises and no industrial partners, which brings increased difficulties to find good field experience to final semester students.

The school was created in 1995. Presently, the school has a total of 1366 students divided in five degrees. The Computer Science degree is a bachelor degree (currently named *licenciatura* in Portugal) with 180 European Credit Transfer System (ECTS) credits. There are approximately 380 students in the Computer Science course split between the daytime curricula (approximately. 260), and the night-time curricula (approximately 120). About one-third of the students also work. Before, the compliance with the Bologna regulations the school had a 3+2 years degree in Computer Science. Due to the new regulations and the available resources, we had to drop the second cycle. Basically, we have adapted the old 3 year degree (the first cycle) to the new first cycle (licenciatura) foreseen in the new Bologna based legislation.

3. The New Curricula

To aid the several groups that redesigned the curricula, the polytechnic president designated a group of professors; the *Bologna Group*. They gathered the significant documentation, including the new legislation, and had an influential and very important role evangelizing the faculty in all the polytechnic schools, including ours, especially about student-centred learning and competency-based curricula. While controversial to other teachers, their role was of great importance and clearly opened the doors to more specific policies inside each school and degree. All new curricula were redesigned also according to their general instructions regarding the necessary paperwork and generic curricula structure for the whole polytechnic. The big change was the move to competency-based curricula. That was also the big change in the Computer Science course.

Our previous 3 year degree were designed taking has its main reference the Computing Curricula 2001 [2]. It emphasized programming and databases, but it also included an introductory course on artificial intelligence, two on operating systems, and two on networks. Yet, the curricular unit content, and the respective projects that were proposed to students were often perceived as inadequate to the particular characteristics of the neighbouring community, which is mostly comprised of small and micro enterprises and no industrial partners. For this reason, we decided to drop the artificial intelligence course, and reduce around 5 ECTS credits in programming, mathematics, and physics. There was also an overall reduction in the number of contact hours. All the computer science courses have 60 contact hours in one semester. Basically, all this allowed additional space to the final project and to introduce a portfolio and group communication courses which did not exist. Especially the portfolio, where the students have to accomplish some extra-curricular activity or project, is still quite unusual in Portugal.

Also, each course (curricular unit) was defined as a somehow mandatory, list of contents. This seemed to hamper new ideas, especially the reorientation to competence based curricula. By forcing the redesign of the curricula, the implementation of the Bologna process allowed us to change not only the curricula contents, but more importantly to motivate the faculty to change to competency-based curricula. The implementation of the new curricula was presented within a package where student-centred approaches, competency-based curricula, and practical work along the whole semester is seen as fundamental for student learning (e.g. .[3]). The changes in the curricula had two driving forces: (1) the need to

comply with national legislation; (2) the intent to capitalize on the opportunity for change created by new legislation. The following sections present these two motivations.

4. The National Legislation

Regarding Polytechnics, the national rules clearly demand the following:

1. 3 + 2 years cycles (here we only present the 3 year cycle);
2. 60 European Credit Transfer System (ECTS) credits for each year and 30 for each semester;
3. 1500 to 1680 hours/year for student work;
4. The ECTS credits depend on the student workload;
5. The first cycle should especially value the competencies that prepare students for the professional practice.

The national Law defines 1500 to 1680 hours/year for student work, as the allowed values. These hours must be distributed along 36 to 40 weeks. Our institution, and all other schools in the Polytechnic, defined two 20 week semesters and a total of 1620 hours. On average, this results in a total of 40 hours and 30 minutes for student work in each week for each of the two 20 week long semesters in a year. As the number of ECTS credits is fixed, based on the work hours definition, we get 1620/60 = 27 hour per ECTS credit.

Point 4 has its origin in the ECTS system definition [4]. Somehow surprisingly, point 5 is specific to polytechnics: for universities, it appears replaced by the statement that their curricula should emphasize student mobility.

Another important detail appears in one of the legislation preambles where it is cleared stated that the student plays the central role at several levels: not only when specifying the curricular units quantity, credits, and types, but also when defining the assessment rules in each course. Although this commendation can be easily overlooked by conservative faculty, we took it very seriously. The following section details the applied new institutional practices that were used to counter these resistances.

5. New Institutional Practices

Differently from other universities and polytechnics in Portugal our institution has decided, for each course, to use between 15 to 20 weeks with the same timetable for the contact hours of each course. There was a significant discussion about the inclusion of assessment time as part of the student contact hours. That approach was used, but that is going to be rethought, as discussed later. The following section lists the introduced planning activities. Most were supervised by the course director, a position occupied by an elected professor.

5.1 Planning

Due to the momentum created by the implementation of the new regulations, the course director was finally able to convince a much larger number of teachers about the importance of the following procedures:

- Publication of the **full assessment calendar** in the beginning of the semester (Figure 1). This includes delivery dates and hours for each of the assignments, namely for each written test, exams, oral presentations or other forms of assessment. This clearly improved and motivated students for a responsible planning of their semester. Although not showed on Figure 1, the weight of each assessment for the final grade in each course was also specified as a way to aid in the student workload distribution along the semester.

Computer Science, Year 2, Daytime															
		Apr	Apr	Apr	Apr	Apr	Apr	Apr	Apr	Apr	Apr	May	May	May	
				Week	8						Week	9			
		21	22	23	24	25	26	27	28	29	30	1	2	3	
Courses	Teacher	S	S	M	T	W	T	F	S	S	M	T	W	Q	
Database Systems I	Elsa Rodrigues					H						H			
Software Engineering	Isabel Brito			Work Presentation		H					Work Presentation	H			
Human-Computer Interaction	Luis Garcia					H						H			
Operating Systems	Luis Garcia			Group Assignment 1		H	Group Assignment 1					H			
Computer Networks I	Miguel Tavares					H					Assignment 1	H			

Figure 1 – Assessment Calendar showing week 8 and part of week 9.

- A **minimum of three assessments** was defined as mandatory for all courses, favouring the use of different flavours: tests, written reports, oral presentations, programming assignments, etc.. The assessments were typically spread along 20 weeks trying to balance the quantity in each week. This allowed a more uniform workload for the student and an increased application of new contents. In fact, this was a huge change for some courses, especially outside Computer Science, where all the assessment was traditionally positioned at the end of the semester in the form of a final written exam.

- The **Tuning approach** [5] is now being applied by a few teachers (Figure 2). These should allow the teacher and the students to adjust the effort levels required for each curricular unit. Yet, some difficulties in the application of the respective enquiries were already identified, namely its intrusiveness versus lack of precision if done less frequently. The aid of the e-learning system seems to be the best solution to allow minimal interference with the curricular activities. Presently, the student sends the updated Tuning formulary together with the completion of each assignment. The adoption of the Tuning approach was slow, but seems to be steady. It forces a deep level of planning and the need to ask students about their effort levels along the whole semester. Those two factors are probably the reasons for stronger resistance to adoption by faculty. Yet, all faculty were advised to take into account student workload, even if not yet applying the Tuning approach.

Information Available to Students								Information Available to Teachers Only			
Operating Systems Scheduling Total Hours: 162 Contact Hours: 60 (3h * 20 weeks)						Students must fill in cells with this color					
Module	**Week**	**Pedagogical Outcomes**	**Activities**	**Assessment Contribution (%)**	**Students Total Work Hours (students)**	**Students Contact Hours (students)**	**Students Autonomous Work Hours (students)**	**Students Total Work Hours Estimative (teachers)**	**Students Contact Hours Estimative (teachers)**	**Students Autonomous Work Hours Estimative (teachers)**	**Week Total Hours**
Basic Linux Operation	Week 1	Understand the operating system role in a computer system.	**Lecture:** Introduction to operating systems. Introdution to Linux operating system. Linux commands.		0			2	1	1	
		Use Linux graphical interface.	**Exercise:** Exercises with Linux basic commands.		0			4	3	1	
	Week 2	Use Linux line command interface.	**Lecture:** Linux file manipulation commands.		0			3	1	2	
			Exercise: Exercises with Linux file manipulation commands.		0			5	3	2	
	Week 3		**Lecture:** Processes. Linux process manipulation commands.		0			3	1	2	

Figure 2 –Tunning Formulary

5.3 Teaching

The following list presents the new teaching practices that were proposed to all faculty:

- The e-learning platform, **moodle**, has been of even greater importance now, as the new curricula have fewer contact hours. There has been a steady increase in the number of users.

- **Assessment as part of the learning process**. The multiple and variegated assessments are part of this effort. This should be applied together with an initial careful planning towards an alignment between assessments and learning [3].

- We are trying to motivate the teachers to include assignments more obviously related to **non-academic projects**, as a way to improve student motivation. One of those specific areas is the special needs and accessibility, and, more generally health related technologies. As an example, Figure 3 depicts a screenshot of an application to help Portuguese people with hearing difficulties to learn driving theory. This application was developed by students in the Human-Computer Interaction Course.

- The **assessments that traverse several curricular units** have been done in the past, always with great initial and final acceptance and even enthusiasm by the students. For example, one of those assessments has been conducted integrating the software engineering course, which emphases requirements' analysis, the human-computer interaction course, the database course, and the web applications course.

Figure 3 – An applied project in the Human-Computer Interaction course.

- Extra support is now being given to students that demonstrate a weak **preparation for the first programming course (CS1)**. To that end we are using the ACM Java Task Force library [6] that allows simple manipulation of appealing graphical objects, while allowing the use of the Java™ programming language, which is latter used in CS1. Figure 4 depicts screenshots of two simple programs developed in this course: the first uses s simple recursive function to draw the Sierpinski carpet (e.g. [7]); the second draws wheels with random position, diameter, colour, and number of radius.

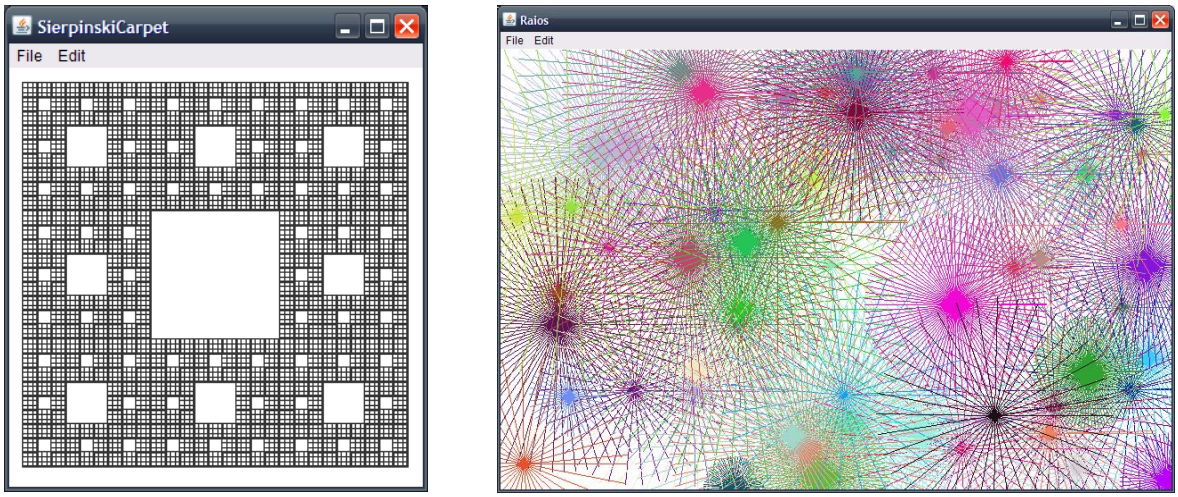

Figure 4 – Two example programs output in the preparatory programming course.

- An annual **presentation of final student projects to the neighbouring community**. This motivates all students and promotes further interaction between all the stakeholders and the community in general.

6. Lessons Learned

The new curricula have been applied only once. Yet, it is already clear that some improvements should be made. Next, we list the aspects we have already identified as deserving further attention:

- Better support from local and national companies in the adjustment of courses curricula.

- Most faculty, ourselves included, are now convinced that the use of a similar student workload along the whole 20 week semester is not really possible and even undesirable. It is not possible because, for each course edition, students have the right to have another chance to conclude it (without waiting for the next edition). As it is an extraordinary assessment, it has to be conducted outside the 20 weeks semester. This has brought unnecessary disturbance. It is undesirable because many teachers and students perceive this 20 week long semester as too long and to different from any other institution that they know of. Hence we have changed to 15 to 17 weeks per semester, with classes and assessment included.

- Some regulations should change to motivate student responsibility and work practices. In particular, clear rules and applicable penalties for fraud and plagiarism should be defined and applied. In Portugal, it is often the case that a failing mark or course is the only penalty for a student fraud. Hence, the faulty student does not mind to take a chance.

- The implementation of a credible comprehensive faculty evaluation system. This is extremely difficult to achieve with a sense of justice as different teachers can have totally different contractual situations. Yet, it would be useful to further motivate all teachers.

7. Conclusions

In this paper, we have briefly presented the main changes our institution has been able to conduct at the level of the Computer Science Course by taking advantage of the mandatory implementation of the Bologna Declaration in Portugal. Although the changes in the curricula were relatively small, as it is still based on the Computing Curricula 2001, the set of newly introduced practices were clearly significant and beneficial. Our institution was able to swiftly move to competency-based curricula. Yet, we guess that a few years will have to pass until all teachers are motivated to really apply it. The teachers' willingness to allocate time to pedagogic matters is often insufficient. We believe the absence of a credible comprehensive faculty evaluation system, assuming the importance of teaching, is the main reason. Presently, we teach but the evaluation is mostly (or only!) about scientific research outside education. Even so, the end result is clearly positive as many faculty who probably had never

thought seriously, or even heard about(!), such things as, e.g., student-centred approaches, competency-based curricula, assessment as part of the learning process, are now aware of it, and many are already applying it.

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