

Initiatives for quality improvement in Portuguese Engineering Education

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Abstract

This article aims to illustrate a range of different experiences, all aimed at innovation in engineering education, and in spite of their divergent nature, all related to an increased involvement of students. The different projects, coordinated by the Council of Engineering Courses, will be described to illustrate the variety in quality initiatives taken at different levels of engineering education at the University of Minho. All of the projects described are based on a perceived need for structural change towards more involvement of students in their own learning process.

The first project is a Project Led Education experience at the Industrial Management and Engineering course. The second project is aimed at assessment methods that increase involvement and responsibility of students in their own assessment process, whereas the last project, takes place at the Business Informatics course of the University of Minho. This project is aimed at supporting the collaborative learning projects of students.

The article will point at the importance of a coordinated approach to innovation, leaving enough freedom of own initiative and interpretation to (groups of) teachers and providing adequate pedagogical support to facilitate educational change.

Keywords: curriculum design, assessment, project led education, quality

1. INTRODUCTION

This article discusses change in higher education, illustrated with three innovative projects in which the Council of Engineering Courses of the University of Minho participated. The Council of Engineering Courses is the entity that is responsible for the management of courses at this university. Unlike at other universities, departments of the University of Minho are not the responsible body for undergraduate and graduate courses. The Council, consisting of the Course Directors of all Engineering Courses of the university, 14 in total, is responsible for the organisation and management of each course. This different structure facilitates the management of courses that consist of subjects from various different areas, like engineering, mathematics, physics, informatics and management. Teaching staff from different department teaching at a course, are not accountable to a specific department, but to the Council of Courses. Because of this structure, the Council of Engineering Courses has a central role in educational change.

This article intends to explore the role of the Council in the management of educational change. After a closer look at innovation in higher education, the characteristics of innovative projects are explored. These characteristics are used to outline three projects that are taking place at three different engineering courses at the University of Minho. The innovations are delineated in detail. In the penultimate section of this article, the role of the Council in educational change is examined. In the final discussion, the current and possible future role of the Council in the implementation of educational innovation is discussed.

2. INNOVATION IN HIGHER EDUCATION

Institutions of higher education have been undergoing a diverse range of changes in teaching and learning over the last decade due to pressures of various external and internal forces like decreasing public funding, increasing student numbers, demands of the Bologna process and because of developments like globalisation, commercialisation and the availability of information and communication technology. Scott [1] outlines a diverse range of forces that have led to changes in higher education and mentions e.g. the decrease in government funding, the rapid spread of information and communication technology and the growing awareness of students with regards to their demand for quality of education. Some of the innovations that have been implemented as a result of the pressures on higher education have their origin in top-down university initiatives, whereas others started with staff that felt the need to change the existing situation. The results of innovative projects in higher education depend not only on the intrinsic quality of the innovation itself, but also on the conditions that are created by the institution of higher education.

McNaught, Phillips, Rossiter and Winn [2] identify three critical factors that affect the management of educational change. Firstly they argue that policy is important, being identified with a top-down approach and referring to leadership, the existence of specific institutional policies and the degree to which these policies were coherent, and the (financial) measures that were taken based on these policies. Culture is a second factor to influence educational change. This factor stands for a bottom-up approach and includes aspects like collaboration with other institutions, the personal motivations of the staff involved in the innovation and characteristics of the university like staff rewards, teaching and learning models and the approach to innovation. The third element McNaught *et al.* [2] refer to is the range of institutional infrastructure designed to assist and facilitate the change process, like the library and information technology services, student support, professional development of staff, educational design support, and information technology literacy support for staff and students.

Cummings, Phillips, Tilbrook and Lowe [3] have not only found top-down and bottom-up approaches in their research on change in higher education, but observed a third approach, focusing on middle management, the so-called 'middle-out' approach. The top-down approach imposes central policies and uses power to reach desired goals. Change can be imposed through financial or strategic means. The bottom up-approach on the other hand can arise from early adopters and innovators. In a democratic way, policy makers and teaching staff participate in a decision making process. Both processes play a role in educational change, where central implementation decisions are often taken at a top level and the success of the implementation depends on the involvement of departments and staff [4]. The middle-out approach is described by the authors as (...) "one led by middle managers, responding to demands from innovative members of the teaching staff but operating in the absence of strong and consistent leadership from either the senior executive or the academic policy-making body" [3]. The middle-out approach is in fact closely related to the support component as identified by McNaught *et al.* [2]. Management at this level has access to central support, has a university-wide focus, and operates collegially. A middle-out approach may also take place alongside other change management approaches. The problem orientation and the operational level of the approach distinguish it from top-down or bottom-up approaches. In this article the role of the Council of Engineering Courses in the management of educational innovation projects is analysed and reflected upon.

3. CHARACTERISTICS OF INNOVATE PROJECTS IN HIGHER EDUCATION

Hannan, English and Silver [5] describe 11 types of innovations found in a study at 15 universities in the UK. The vast majority of the innovations were related to the use of computers and the development of skills. Nowadays, many of the innovations taking place in higher education are directly related to the Bologna process and concern curricular changes.

The reasons for innovation as identified by Hannan *et al.* [5] can be divided in four categories. Firstly the need to improve student learning. Teaching staff implements innovations to motivate students, to find a

better way of teaching their subject, or because they were not satisfied with the traditional method. They also referred to a better preparation of students on the labour market or society, the need to help students with difficulties and the desire to give more responsibility to students for their own learning. A second reason to innovate is the change in student intake. With decreasing funding and increasing student numbers, classes are growing larger. Teachers need to be able to deal with larger and more heterogeneous groups. Not only the numbers are changing, the characteristics of the students are also changing and a preparation of students on a more efficient working method asks for change. The demands of external agencies are also identified as a possible reason for change. Industrial pressures and specific demands from the labour market can provide a reason to implement a major change. The Bologna process needs to be mentioned in this context, as it has proven to be a strong external force to implement changes in teaching and learning as well as in the curricula of courses.

Curriculum change and internal reorganisation is mentioned by Hannan *et al.* [5] as a fourth reason for innovation. Modularisation and other curriculum changes were identified as a reason for change. The Bologna process can be considered as an external pressure resulting in curriculum changes. The increased attention for quality as expressed in the Bologna Declaration urges universities to not only implement different curriculum structures based on the European Credit Transfer System, but also to pay attention to quality assurance including systems for internal evaluation and external review (see e.g. Amaral & Magalhães, [6]).

Apart from formal reasons for innovations, teaching staff can also identify more personal sources of encouragement and inspiration. Experiences at a previous institution or in previous circumstances like another university or a company where a certain method was used can serve as an encouragement for later innovation. Support from colleagues, the department or school or from the university is also regarded as a stimulating and contributing to the implementation of change. Staff development can serve as a strong stimulation for educational change as well. As also argued by Smyth [7], staff development has a specific role as a facilitator of transformation of education. In the study of Hannan *et al.* [5] teaching staff also referred to personal involvement and strongly held beliefs with regard to the nature and the success of the change as sources of inspiration, as well as to examples from other institutions, concerns to improve their job satisfaction and attempts to include finding of their own research in their teaching. Personal support from leading figures, funding from within the university and recognition of the benefits of the changes were regarded as important to innovative practices.

4. INNOVATIVE PRACTICES AT THE UM

At the University of Minho in the north of Portugal, the Council of Engineering Courses is involved in a number of changes in teaching and learning. This article intends to give an outline of three projects and identify the characteristics of the changes as defined by Hannan *et al.* [5]. The first project in which the Council of Engineering Courses is involved is the implementation of project led education in the Industrial Management and Engineering Course. Five out of six subjects that had been given in a traditional way were integrated in one project that reflected the course contents of all of them. A project on Biodiesel was designed to integrate Topics of Production and System Engineering, Programming Languages, Physics II, General Chemistry and Fundamentals of Microinformatics. Students worked in groups of around six students on a project that was aimed at the production and commercialisation of Biodiesel. Part of lectures and lab classes were replaced by project work and a positive result for the project was conditional for a passing grade on the individual subject. The assessment of the project consisted of a final public group presentation and oral exam and exams and test for the five participating subjects.

The type of innovation can be categorised as a team project. Working in teams was an essential characteristic of the innovation. The reason for innovation was in the first place a felt need to improve student learning. In traditional education, students lack a number of skills that were regarded as important for future graduates like communication skills and personal development. The staff that started the project focussed strongly on active learning of students, integration of course content of the different participating subject and a strong link with the professional practice of future engineers.

In this project, staff development served as the most important source of inspiration. Teaching staff attended several workshops given by Peter Powell on Project Led Engineering Education [8]. The first group of teachers participating in the workshop was inspired by the impact of Project Lead Education (PLE) at other universities as explored in the workshop and decided to start a project in the second semester of the first year. They started off with three teachers, but integrated two other teachers later on. The workshop, documentation given during the workshop and talks with the trainer served as a strong encouragement to the teachers. In a later stage, funding from the university also served as an incentive to continue with the implementation of the innovation. The university's Vice-Chancellor provided some funding to facilitate the project.

Looking at the kind of staff members involved, the categories as identified by Hannan *et al.* [5] do not entirely represent the teaching staff in this project. Although staff members are relatively young, there is no apparent career related external incentive to be involved in innovations.

The second project takes place at the Civil Engineering Course of the University of Minho. It is aimed at improving student learning through influencing the assessments method. The traditional assessment of four first year subjects changed towards frequent assessment in which peer and self assessment were used as a way to give more responsibility to the students with regard to the assessment process. Teaching and learning changed from teacher centred to learner centred by giving students more responsibility in their own assessment processes, as described by Dochy [9] in his studies on student-centred assessment. Students helped to define assessment criteria, assessed the work of their peers or groups of peers, attributed grades, wrote justifications for the grades and gave feedback to their peers. Most of these activities used to be the full responsibility of the teacher, but were now shared responsibilities with a large emphasis on the role of the student. At three or four assessment moments, students assessed reports written by peer groups, oral presentations of peer groups and individual assignments or tests. They discussed the criteria and used an assessment form to facilitate the process of grading. For each given grade, a justification had to be written to avoid unfair grading.

This project is a typical example of an innovation in the area of (peer) assessment. The reason behind the innovation is a directly felt need to deepen student learning. Based on experiences of teachings in various engineering departments, students used to study in rather superficial way in a sense that they studied just before the exam and did not use approaches to learning that promoted a deeper learning as identified e.g. by Marton & Saljö [10], Entwistle [11], Biggs [12]. Teachers were faced with the superficial learning approach of students especially in later years of the course. Students who were supposed to be prepared for third, fourth and fifth year subjects, lacked basic knowledge, due to an inadequate learning approach. This was an evident reason to implement changes in the assessment method, as assessment is a powerful tool to change student's learning approach.

In this project, research outcomes served as the inspiration and encouragement for the project. In earlier research project, changes in assessment had proven to be an effective instrument to change student learning [13]. Studies that included the identification of approach to learning before and after the implementation of student centred assessment through a learning styles questionnaire showed a significant deepening of regulation strategies. These research findings were the main source of inspiration for the change of assessment methods.

The teaching staff involved was diverse. Participation in the project was voluntary, to guarantee an active and cooperative attitude of the teaching staff. Teachers were of different ages and different teaching careers.

The third project, the Business Informatics Project, takes place at the third year of the Business Informatics course. The goals of this project are to develop an information system related to two subjects, Databases I and II and Information Systems III and IV, working out general technical reports and specific reports for the stages of the development of information systems, establishing interpersonal relationships, between students of the same group as well as between the analyst and the client, assuming responsibilities for work and developing an autonomous attitude with regard to working. ABDON served as a tool to support these goals. ABDON is a learning environment that provides a platform for teachers and students. Teachers and students present themselves and their contact details. Teachers can make course material available and schedule meetings with students of groups of students. Teachers and students can be contacted through mailing lists by e-mail and by using chat programs. Students can also use the tool to assess each other.

They can evaluate the performance of their peers and in that way contribute to formative process assessment of project work.

The ABDON part of the Business Informatics project is a typical example of an ICT innovation. A large part of innovation in higher education is ICT related and have to do with e-learning or new technologies. The reason for the development that can be identified in this project is firstly the change in student intake. Due to large student numbers, teaching staff was forced to find solution for the two courses to do business simulations. Frequent contact between students and between students and staff was necessary and ABDON provides various tools to facilitate communication between students and staff. The inspiration for this project was the success of the integration of the two subjects in previous years. The cooperation between the subjects had a long history of more than a decade and had been fruitful to students as well as teachers. The teachers were satisfied with the intensive cooperation. The staff involved in the ABDON project was of different age and different teaching careers.

Looking at the innovation as supported by the Council of Engineering Courses, they are of a different category. Learning by projects, student-centred assessment and the use of information and communication technology are three different types of innovations. The reasons to implement a change are also diverse. The first innovation, referring to project education, is related to a number of different reasons to change, both internal as well as external. The felt need to change exiting the practice, based on earlier teaching experiences, changes in the labour market and the need for active learning that promotes student participation are direct reasons for the implementation of the innovation. The reasons for the change of assessment methods as described in the second project rather similar, although no specific problems in specific subjects can be appointed. A general consensus on the need for improvement of student learning in the Civil Engineering Course can be identified. The increase in student numbers is a direct reason for the implementation of the third project.

The sources of inspiration or encouragement of the three projects are also different. Staff development was a very strong inspiration for the group of teacher implementing project led education. All of the teachers starting the project participated in a workshop and became highly motivated to change the existing situation and try to design a project for the Industrial Management and Engineering Course. Without initial external encouragement, three members of the teaching staff from two different departments joined up and decided to design a project. They used the guidelines as provided in the workshop for the materials to be developed. The assessment methods project is clearly research based and inspired on results of earlier projects. The Business Informatics project is driven by previous experiences.

With regard to staff, it is not possible to identify general characteristics of the teaching staff involved in the project looking at gender, age or years of teaching career. The strong beliefs in the positive effects of the innovations and the confidence in a successful implementation can be regarded as common feature of the teaching staff involved. In the assessment methods project, previous successful experiences facilitated the confidence of teachers in a positive result of the changes. In the other projects however, there were no personal previous experiences in similar situations that directly lead to a strong commitment to the innovation. When using the rough typology as outlined by Silver [14], the three projects can all be categorised as individual or group innovations that are classroom and/or course related.

5. THE ROLE OF THE COUNCIL OF ENGINEERING COURSES

The Council of Engineering Courses played a role of each one of the three projects as described above. For each one of the projects, the Council served as an intermediate between the project staff and the Vice-Chancellor's Office. The Council prepared the proposals for funding and facilitated contacts. The Council defended the projects and argued in favour of financing that, in very different ways, facilitated the implementation process of the educational changes. In the case of the assessment project, the Council had a leading role in the development of the assessment method and the coordination of the staff and students involved. The coordination and planning of assessment moments at the Civil Engineering Course and the research on student grading behaviour at peer and self-assessment moments was the responsibility of a researcher at the Council. The evaluation of the PLE Project also involved the participation of the Council. An evaluation of the first pilot project was performed and presented at the teaching staff. If we look at the three different innovative projects that were implemented with the support of the Council of Engineering

Courses, we can say that although they are of very different nature, the role of the Council can be defined as a middle-out management approach.

As Cummings *et al.* [3] link eight factors for success to six characteristics of change management and identify the characteristics of the middle-out approach for these characteristics. Leadership, the first component of effective educational change, is characterised by problem solving and facilitation. Middle-out leadership is related to personal inspiration and strategies based on emergent practice. Convincing the top level of the educational change and supporting the teaching staff is a typical managerial role. Davies, Hides and Casey [15] argue that leaders in educational change should develop the mission, vision and values and are role models of a culture of excellence. They are also personally involved in the development and improvement of the management system, in society and motive, support and recognise the institution's people.

Related to the concept of leadership, Cummings *et al.* [3] refer to change champions, people who are in a middle-management position and focus on problem solving and operational matters. They normally operate in support centres like teaching and learning units. The approach to planning of middle-out managers is pragmatic and opportunistic, aimed at problem solving. They react in a pragmatic way to internal and external pressures. A next component, the purpose for change, is crucial in educational change management. The understanding of the purpose of the educational innovation at all levels of the institution is a key to successful change. The middle-out management is not based in individualism or in institutional policies and can therefore serve as an intermediate to disseminate the knowledge about the reasons for and the purpose of change.

An institutional culture in which the middle-out managers promote collaboration, partnerships, negotiation, and distribution of authority is also contributing to the success of the implementation of change. A last factor as identified by Cummings [3] is the support for change that can be provided. In this case, a top-down approach is rather similar to a middle-out approach as funding usually comes from central bodies, but the middle-out approach is more aimed at targeted funding focussing on specific problems.

Looking at the characteristics of the middle-out approach to management of educational change, the role of the Council of Engineering Courses in the projects described in this article are to a large extent congruent with this approach.

6. CONCLUSIONS AND DISCUSSION

The innovative projects as supported by the Council of Engineering Courses, are all initiatives taken by (groups of) teaching staff of engineering courses or by the Council. The motives for implementation come directly from existing situations in teaching and learning. The current role of the Council can be defined as an intermediate role between strategic university decisions and individual staff initiatives, as outlined in the middle-out approach to management of change [3]. In addition to an intermediate role, the Council could also help to promote innovative approaches to teaching and learning by a process called appropriation, as described by Taylor [16]. He points at the risk of the so-called lone ranger, the academic who is energetic, innovative, an early adopter of innovation and motivated by the desire to improve quality. Apart from the positive impact of innovations put into practice by these staff members, there might be a lack of articulation with the broader institutional context and the strategies as defined by the university to work on quality of teaching and learning. Cowan, George and Pinheiro-Torres [17] emphasise the importance of strategic change management at institutions of higher education and defend strong and explicit links between the declared strategic plans of the institution, curriculum development and staff development. The relevance of a proactive role of senior management refers to the top-down management approach, whereas support for curriculum development and staff development are directly related to the middle-out management approach.

Embedding individual initiatives in an institutional framework and offering specific support in the different stages of implementing educational change can be an important task for the Council that can serve as the stimulator of organisational learning. Providing opportunities to discuss and reflect on innovative ideas, analysis of existing and possible practices and the development of a shared vision for engineering courses are the activities that are part of the initial stage of support of ideas, the orientation stage. The second stage

concerns technical support, staff development and resource development necessary for successful implementation. After that, the evaluation of the innovations, based on educational theory as a framework of reference is suggested by Taylor [16]. The support of teaching staff during implementation of changes and the institutionalisation of practices by influencing policies and encouraging staff continuously would also be valuable activities of the Council. At the moment, the Council plays an important coordinating role in the support of innovation in teaching and learning in engineering courses at the University of Minho

References

- [1] Scott, G. Effective change management in higher education. *Educause Review*, **38**, 64-80, (2003).
- [2] McNaught, C., Phillips, R., Rossiter, D., and Winn, J. *Developing a framework for a useable and useful inventory of computer-facilitated learning and support materials in Australian universities* (Evaluations and Investigations Program). Canberra, ACT: Department of Employment, Training, and Youth Affairs. Retrieved February 1, 2006 from: <http://www.dest.gov.au/highered/eippubs1999.htm>, (2000).
- [3] Cummings, R., Phillips, R., Tilbrook, R., & and Lowe, K. Middle-Out Approaches to Reform of University Teaching and Learning: Champions Striding between the Top-Down and Bottom-Up Approaches. *International Review of Research in Open and Distance Learning*. Retrieved February 1, 2006 from: <http://www.irrodl.org/content/v6.1/cummings.html>, (2005).
- [4] McNaught, C. Innovation and change in higher education: managing multiple polarities. *Perspectives*, **7**, 76-81, (2003).
- [5] Hannan, A., English, S., & Silver, H. Why innovate? Some preliminary findings from a research project on innovations in teaching and learning in higher education. *Studies in higher education*, **24**, 279-289, (1999).
- [6] Amaral, A., & Magalhães. Epidemiology and the Bologna saga. *Higher education*, **48**, 79-100, (2004).
- [7] Smyth, R. Concepts of change: enhancing the practice of academic staff development in higher education. *International journal for academic development*, **8**, 51-60, (2003).
- [8] Powell, P. & Weenk, W. *Project-led engineering education*. Utrecht: Lemma, (2003).
- [9] Dochy, F. A new assessment era: different needs, new challenges. *Research Dialogue in Learning and Instruction*, **2**, 11-20, (2001).
- [10] Marton, F., & Saljö, R. On qualitative differences in learning - I: Outcome and process. *British Journal of Educational Psychology*, **46**, 4-11, (1976).
- [11] Entwistle, N. Approaches to learning and perceptions of the learning environment. *Higher Education*, **22**, 201-204, (1991).
- [12] Biggs, J. *Teaching for quality learning at university* [2nd edition]. Buckingham: Open University Press, (2003).
- [13] van Hattum-Janssen, N. Pacheco, J.A., & Vasconcelos, R. M. The accuracy of student grading in first year engineering courses. *European Journal of Engineering Education*, **29**, 291-298, (2004).
- [14] Silver, H. Managing to innovate in higher education. *British Journal of Educational Studies*, **47**, 145-156, (1999).
- [15] Davies, J. Hides, M. T., & Casey, S. Leadership in higher education. *Total Quality Management*, **12**, 1025-1030, (2001).
- [16] Taylor, P. G. Institutional change in uncertain times: lone ranging is not enough. *Studies in Higher Education*, **23**, 269-279, (1998).
- [17] Cowan, J. George, J. W., & Pinheiro-Torres, A. Alignment of developments in higher education. *Higher Education*, **48**, 439-459, (2004).

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Curricula

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