

Project based learning in Mechatronics

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This case study has been developed from data gathered through observations of the teaching component and interviews with both the tutor and a student focus group.

Background

The aim of the module is to provide experience of the integrative nature of Mechatronics. On completion of this module “students should have a comprehensive understanding of the design of mechatronic systems and the application of microcontrollers for embedded sequential and continuous control of mechanical systems.”

The module runs for 12 weeks, with approximately 15 MEng students taking the module each semester. In week one the students are given a one hour introductory lecture followed by a series of structured laboratory exercises to familiarise themselves with the equipment and programme development tools which they will be using throughout the module. Students are divided into groups of three and tasked with designing and building a small robotic vehicle which can complete a circuit of a strip track within given tolerances. The subsequent sessions are described as “studio based teaching” by the tutor. Students have access to the lab and the support of teaching and technical staff who act as consultants on the projects for one day a week. Outside the timetabled lab sessions additional support materials and diagnostic programs are available through the University’s VLE, LEARN. The learning outcomes are assessed through submission of individual tasks and log books, group presentations and the performance of the group’s robot.

Reasons for introducing this teaching method

The School describes Mechatronics as “Mechanical Engineering for the 21st century” and has made the module compulsory for all MEng students. The tutor has strong industrial links in this area and runs a condensed version of the module as part of the Graduate Training Programme offered by an international aerospace company. The tutor was keen to provide a project brief which reflected a real industrial product development scenario and the students are expected to respond to assignments and presentations with a customer focus, preparing them for their potential future roles.

Lecturer’s perspective

The tutor has developed a series of activities which consist of both individual and small group work packages designed to foster group work but “without the often experienced drawback of passengers”. Learning is strongly student centred with a philosophy based on “learning by doing”. The balance between the availability of tutorial and teaching materials online and timetabled access to support staff to discuss specific topics with individuals, or to provide seminars to group members working on a common part of the task, aims to offer a teaching approach which is “flexible and responsive to student need.”

Students' perspective

Those participating in the module noted the student centered approach: "How you go about doing it is entirely up to you." "You're very much on your own with this module, it's the first one that's sort of like driven by yourself." The tutors were seen as facilitating learning: "Generally they won't look at your code, they'll ... try and get you to explain what you're trying to do." "They won't do it for you, you've got to do it – which is good." "They step back and try and get you to see the big picture." Students reflected that they had learnt more as a result of the approach: "You learn more as well. When you struggle, when you find out how to do it you won't forget."

The module was seen as "a good balance" with the teaching and learning approaches on the rest of the programme. The activities and assignments were seen as going beyond Mechatronics with a focus on project management. The project gave the students the opportunity to consolidate what they had learnt in other areas: "I think some of the things we did last year in Engineering Design Management, like the planning stuff, you really use that." "I think it helps you develop skills you already have, like time management." The tasks were structured in such a way that the students felt they were "working in your teams constantly."

As the module progressed, students were able to reflect on the approach and appreciated the link to industrial practices: "After that presentation [part of the module assessment in week five] I probably had the best feedback that I've ever had on a presentation. They told you exactly what the company would want to hear." "I think for a final year you're going to be aiming at customers, so I think that was a good way of doing it."

Issues

The time constraints on the lab usage were a challenge for the teams, in particular students would have welcomed time to reflect on a problem rather than a focussed effort over a single day: "You can only go in the lab at certain times, so it's all about your time there." "That's sort of our main contact time with the lecturers as well ... that's the only downside, not being spread over two days."

The module was first put forward as conventional teaching in a morning session, laboratory exercises in the afternoon session for five weeks. The project part then followed. This was a "disaster" as students could not see the point of what they were learning until it came to be applied later. The tutor therefore "threw away the lot and started again!", introducing robot building in week one so that students could see what was going to happen. This has evolved over time to the current state where there is one week of graded exercises to build confidence with the equipment followed by a longer robot building project commencing in week two.

The mechanical equipment is mostly "off the shelf" components which have been used "to keep the cost down." The electronics and microcontroller parts (as well as the software operating system) are designed by the tutor and manufactured by commercial electronics companies. The teaching team have established a rolling program of updates/enhancements to keep the projects up to date and are currently using 18th generation robots.

Benefits

The studio based teaching approach and small group activities have improved the relationships between fellow students: “I’d say I’ve probably spoken to more people on my course through this module” and impacted on how students sought help and support for their work: “I don’t think I’ve asked for as much help from lecturers before now...I was a bit afraid to keep asking questions.”

The tutor has seen the challenges provided as enabling the students to acquire excellent reasoning and troubleshooting skills to locate problems in multitechnology systems. Such skills are generic and highly transferable.

The module takes students “outside of their comfort zone” and enables them to develop excellent team skills under pressure. This aspect is much appreciated by employers and often forms a topic of discussion at job interviews. The tutor has introduced the use of peer assessment (through WebPA1) which also gives the students an insight into how other team members view them. This provides a basis for them to modify their behaviour to improve their interpersonal skills and enhance their team performance.

Reflections

The approach has helped students understand the processes involved in software engineering as much as the actual programme they needed to generate to complete the task: “When we got stuck before, I’d be like ‘I can’t do it, I can’t do it’, whereas now when I get stuck I try and think it through, taking logical steps through the problem.” As final year students the customer focussed approach was welcomed as “the next step between being a student and getting a job”.

¹ WebPA is an open source online peer assessment system, developed at Loughborough University.
<http://webpaproject.lboro.ac.uk/>

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