Teaching Robotics at the Postgraduate Level: Assessment and Feedback for On Site and Distance Learning

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***Abstract*—The MSc Intelligent Systems (IS) and the MSc Intelligent Systems and Robotics (ISR) programmes at De Montfort University are Masters level courses that are delivered both on-site and by distance learning. The courses have been running successfully on-site for 7 years and are now in the fourth year with a distance learning mode. Delivering material at a distance, especially where there is technical and practical content, always presents a challenge but the need to deliver a robotics module increased the challenges we faced significantly. There are two robotics modules though the second one is only available to those on MSc ISR. We have chosen to make the first robotics module, Mobile Robots, the focus of this paper because it was the first that had to be delivered and it is delivered to students on both programmes. This paper describes the assessment of students' work and the subsequent feedback given to students within the course as a whole and more specifically, the Mobile Robots module. The approaches maximise the use of electronic methods and as such there is a specific focus on those students that are studying in distance learning mode. We believe it serves as a model for others attempting to assess students studying robotics courses at a distance.**

I. Introduction

The MSc Intelligent Systems (IS) and the MSc Intelligent Systems and Robotics (ISR) programmes at De Montfort University are Masters level courses that are delivered both on-site and by distance learning. The courses are delivered mainly by the members of the Centre for Computational Intelligence (CCI) at De Montfort University. Their development enabled us to capitalise on the research taking place within the CCI and therefore on the strengths of the staff delivering the modules.

The MScs each consist of 8 taught modules and an independent project which is equivalent to 4 modules. The MSc ISR includes two mobile robots modules whilst MSc IS replaces one of these with a Data Mining module as an alternative application area for those less interested in pursuing mobile robotics work. A Research Methods module is delivered in semester 1 to ensure that students are equipped with the necessary skills to carry out literature searches, write project proposals and so on; and a module titled 'Applied Computational Intelligence' enables students to pursue an appropriate area of their own interest in greater depth. In this paper we discuss recent enhancements to our approaches for assessing work and providing students with timely feedback. The full structure of the course is illustrated in Figure 1.

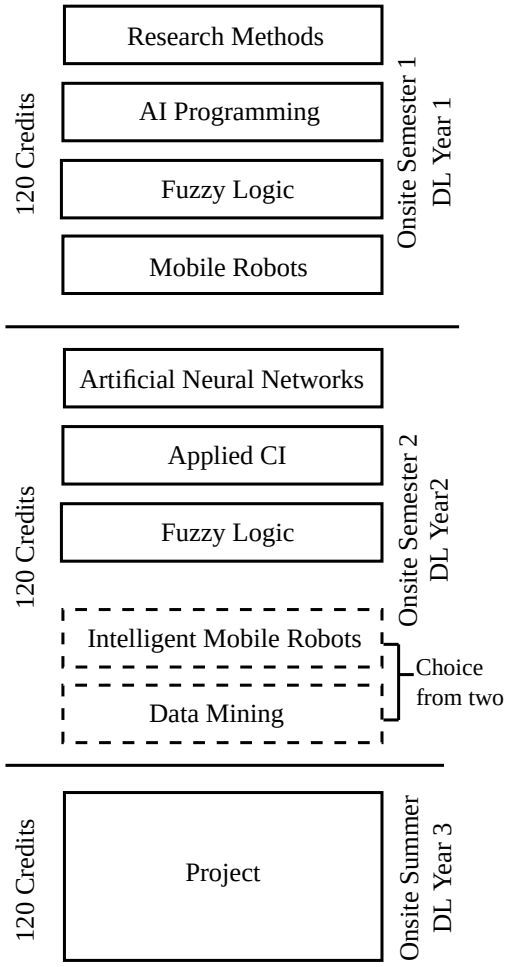

Fig. 1. Course Structure for MSc IS and ISR.

The remainder of the paper is structured as follows: Section 2 discusses the literature associated with assessment and feedback in e-learning; 3 describes the approaches to assessment

and feedback that we have adopted for the course; Section 4 gives an account of student opinion regarding the recently adopted electronic approaches to feedback; Section 5 gives a detailed account of assessment and feedback within the Mobile Robots module and finally Section 6 draws conclusions from this work.

II. Assessment in Postgraduate e-Learning

This section reviews approaches to assessment and more specifically, feedback to students, in e-learning. The Quality Assurance Agency (QAA) for Higher education in the UK provides codes of practice for all types of learning. There is a section of the documentation that is aimed specifically at flexible and distributed learning and within this they include e-learning [1]. These codes of practice are observed by all higher education institutions in the United Kingdom and there are government led procedures in place to monitor their appropriate application. Precepts are stated in the QAA documentation that define what the students should be able to expect from their institution, their learning materials, their tutors and so on when engaged in flexible, distance or electronic learning. Also of particular interest for this study are those precepts that relate to assessment and feedback of student work [2].

One area of attention is that of formative feedback, where students are given feedback on their work but that feedback does not relate to any marks or grades for the course or module. One of the ways that we address this is using regular discussion board activity; this is described more fully in [3]. Another area of attention to highlight is that of plagiarism detection and prevention. We adopt various strategies for this including the use of TurnitinUK for checking authenticity, the use of vivas or presentations/demonstrations and the discussion board is also a substantial aid in both prevention and detection. In addition to this we set assignments that can be approached in a variety of ways, which reduces the opportunity for students to work too closely together. Prevention and detection of plagiarism is beyond the scope of the work presented here so will not be addressed further.

The QAA suggest that excessive amounts of summative assessment should be avoided. They state that "it is good practice to provide students with sufficient, constructive and timely feedback on their work" [2, p. 20] and this is the area that we have been addressing recently. Timing has been an issue on our course as there has been a significant delay before the students receive their marked work. Our new approach addresses this and is described fully in section 3.

As well as the need for feedback to be timely it also needs to be of a high quality in order for learners to be able to use it to determine further actions. This is identified in case study 4 of the Joint Information Systems Committee (JISC) which states that "feedback must:

- Be helpful, detailed and appropriate to learners' current understanding
- Provide more detail with each failed attempt
- Identify a means of rectifying errors
- Invite an active response. " [4, p. 1]

The report emphasises the particular importance of this with respect to distance learning students. Adding quality to feedback is also highlighted by [5] where studies are de-scribed that show that explanatory feedback resulted in improved learning compared with the effects of corrective feedback, explanatory feedback being where some explanation is given in the feedback when something is incorrect. The authors in [5] also go on to state that such explanations ideally should be succinct and positioned so that they are close physically to where the error in the students work took place. Other studies, notably [6] and [7], also promote explanatory feedback by referring to it as descriptive and emphasising how it provides useful information to enable the gap to be filled between the current student performance and the desired performance.

In order to offer good quality courses we aim to provide appropriate feedback that adheres to the codes of practise identified by the QAA and promotes students learning as described in the previous paragraph. Student numbers have grown on the courses and government spending cuts in the UK put a greater strain on the available resources which means that the course team need to increase efficiency but without losing (and whilst still improving) the quality of the provision. With this in mind, approaches to assessing students' work and providing feedback have been adapted and the new methods that are now in place on most of our modules are described in the next section. Section 5 considers the mobile robots module specifically.

III. Assessment and feedback strategies on the MSc IS/ISR

We aim to adopt an approach to our delivery of the courses that embraces modern technology in such a way that the students have appropriate learning experiences whether they are studying on-site or at a distance.

De Montfort University already uses the Blackboard learning environment as a platform for providing e-learning materials for all students and this is used extensively though not exhaustively in all faculties. It was therefore an obvious choice as the main platform for the MSc. Decisions about the best way to use Blackboard and which other resources to employ alongside it were necessary and as both on-site and distance students study the modules concurrently the experiences need to be as similar as possible.

Assignments are made available to students on Blackboard and they are asked to submit them for assessment to Blackboard for electronic marking. The students submit their work twice - once to Turnitin, which checks for plagiarism and once to an assignment submission link. This work is then marked using electronic methods, and the annotated scripts with provisional marks are posted in a feedback space on Blackboard that is generated when the students submit their work. Multiple files can be uploaded to this space both by students and the marking tutors. This means that the students get feedback as soon as the work is marked.

In previous years, the second form of electronic assignment submission was not used, instead students either posted or

Marking Scheme for essay/report - worth 50% of overall mark

	0–44% Fail	45–49% Marginal Fail	50–54% Pass	55–59% Pass	60–69% Merit	≥ 70% Distinction
Coverage of area including literature review	Not acceptable	Some attempt to cover the area but with serious limitations	Brief with significant limitations	Good coverage, but with some noticeable limitations	Very good coverage of area and associated issues with good review of literature	Excellent coverage, showing a sound understanding of topic. Excellent critical review of literature
Practical (e.g. implementation or experimental work)	Very little of value	Weak, with substantial limitations. Some effort evident.	Satisfactory amount of work. Significant limitations in design & documentation	Good work, with some limitations	Very good work, very good documentation and design. Only minor limitations	Challenging work, well documented, well designed
Conclusions, recommendations, critical evaluation, new ideas, etc.	Missing, poor or not meaningful	A minimal attempt with serious limitations. Not acceptable	Satisfactory but with significant limitations.	Godd, but with some notable limitations. Lacks depth	very good, comprehensive, with good ideas	Excellent, follows logically from body of report and contains excellent and original ideas
Structure and presentation, references and bibliography	No clear structure and presentation very weak. Poor or no bibliography, reference list, citations in report	Weak structure, poor presentation. Poor bibliography, reference list, citations in report	Satisfactory approach to structure and presentation. List of references present with significant limitations	Well structures and presentation good. Most references in correct format with both web and traditional resources	Very well structures and prepared with only minor limitations. References cited in correct notation from both web and traditional sources	Highly professional approach; excellent structure. Thorough reference citation from a variety of sources

Fig. 2. Example marking grid

physically brought in their work and handed it in to the student office. This meant that the work was marked by hand and although students were given provisional marks, they did not receive their annotated scripts until after the departmental assessment board which could be some weeks later.

The methods adopted for marking the electronic submission vary. Most tutors make use of a marking grid, an example of which is shown in Figure 2 and some staff write summary feedback to go with the annotated grid. In such cases this forms the entire feedback and can be made available quickly even when marking paper based copies of the assignment. Most tutors prefer to write comments on the students' work in addition to the use of a marking grid and it is this that has posed problems in the past for returning the feedback in a timely manner. Staff now all have Adobe Acrobat Professional installed on their computers and in addition to that they have a pen tablet (See Figure 3.). With Acrobat Professional annotations on the students work can be carried out by using the typewriter tool, or by hand-writing comments using the pen-tablet, by inserting electronic sticky notes or even by adding voice recordings. The number of different ways of adding feedback electronically enabled by providing this software and hardware has meant that all staff have adopted one of the electronic methods for semester 2 of the 2010/2011 academic year. Two modules used electronic methods for assessment and feedback in semester 1, these were Fuzzy Logic and Mobile Robots.

The following section describes a short survey undertaken to find out the opinions of the students on the use of the electronic methods in the Fuzzy Logic module of semester 1 and the Applied CI module of semester 2. Section 4 considers the assessment and feedback mechanisms adopted in the Mobile Robots module in greater depth.

Fig. 3. Pen Tablet

IV. Results of student Survey

Thirty-five students were emailed that studied either the Fuzzy Logic module or the Applied CI module (or both) to give their opinions of the new method of feedback compared to the previous. The questions asked are contained in Figure 4. Students responded and a discussion of the results is given below.

Approximately one third of the students responded and all of them had the same responses (a.) for questions 1, 2, 3. This leaves us in no doubt that the electronic marking is an improvement. We have yet to investigate if there are preferences between the methods used though allowing staff to choose from a selection of methods has encouraged staff to move to a new form of marking and has resulted in a much greater take-up of the new approaches than might have been achieved if only one approach had been allowed.

Interestingly there was a mixture of on-site and distance learners amongst the responders. This demonstrates that even for on-site students, such methods are an improvement even though they would previously be able to collect work physically from the marking tutors. The comments collected in response to question 5 were generally supporting the answers in questions 1–3, though one person commented that hand writing had been an issue in some place on one assignment where the pen tablet had been used. The next section examines the Mobile Robots module and the specific approaches taken in that module to assessing and feeding back on the students' work.

V. The Mobile Robots Module

To be successful the mobile robotics module must combine hands-on practical work with advanced theoretical concepts. The teaching and assessment strategies have to work face to face and at a distance. For many students this module is their first exposure to programming robots and the first time they have come across the inherent challenges such as hardware limitations, behavioural debugging and dealing with uncertainty. To best support our diverse student population we have developed a clear delivery strategy which we believe serves as a model when delivering a first semester postgraduate

The questions below relate to the electronically marked assignments for the Fuzzy Logic & Applied CI modules.

1) Compared to the usual methods of receiving marks and feedback, was the speed of receiving the electronically marked work:
   a) noticeably quicker?
   b) the same?

2) Was the quality of the feedback:
   a) better?
   b) worse?
   c) the same?

3) We plan to extend the use of this so that eventually it will eliminate the need to physically post your assignments to us (you will be able to upload multiple files to Blackboard including program files etc.). Do you see this as:
   a) good thing?
   b) a bad thing?
   c) neither good nor bad?

4) Are you studying as:
   a) a distance learning student?
   b) an on-site student?

5) Do you have any additional thoughts/comments you would like to add regarding electronic marking?

Fig. 4. Survey used for Fuzzy Logic and Applied CI modules, and also the Mobile Robots module.

robotics module. Our strategy is depicted in Figure 5 and fully explored in [3].

Nineteen students on the Mobile Robots module were emailed the same survey content shown in Figure 4. Fewer students responded, approximately one sixth, and the survey results are positive and have provided promising feedback from both on-site and distance learning students.

From the responses, the majority thought the speed of receiving feedback was noticeable quicker in question 1. This included both on-site and distance learning students, which supports the responses to the Fuzzy Logic and Computational Intelligence modules. The importance was noted on one survey that this greatly helped to prevent making the same mistake for the next assignment. This is crucial since some of the assignments were issued on a weekly basis.

The quality of feedback was deemed to be the same according to the responses for question 2, although, in one case it was considered better. This module uses physical robots that distance leaning students have at home. On-site students often discuss the electronic feedback with tutors in laboratories where it is possible to provide a physical demonstration to further support and clarify feedback. When a distance learning student wishes to clarify feedback in more detail, the current approach is for them to request a phone conversation that is typically conducted with VoIP and without a physical demonstration. For this reason it is important to carefully consider the content of electronic feedback, particularly for the distance learning students who can not share a physical demonstration in the same way as the on-site students do.

To overcome the difficulties with physical demonstrations of the robot for the purposes of feedback there are several options that are under consideration for the next cohort. The VoIP call could be enriched by also using video for communication with a webcam. This would allow both staff and students to perform robotic demonstrations during a discussion to enhance the conversation and support the understanding of the feedback. For software demonstrations that do not involve the robot there are a variety of software packages to share the view of a

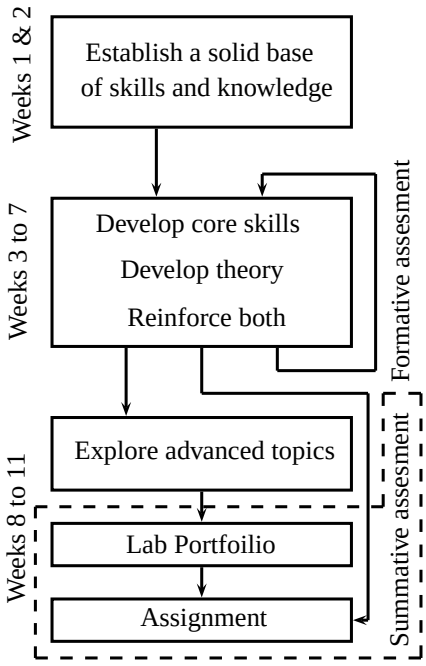

Fig. 5. Teaching and Assessment Strategy for Mobile Robots.

computer desktop with another computer.

For question 3, all respondents agree that this method of electronic feedback is a good thing. One respondent's comment was that this was very much a positive move and a step in the right direction.

An Interactive questions and answers session was held in the last quarter of the module. Students were invited to email questions one week before the session that cover any aspect of the Robotics material studied up to that week. These questions are then collated to form the structure of a lecture which answers the questions. This lecture is videoed and posted on the Universities streaming site for the students to access.

VI. Conclusions

Delivering courses at a distance is a topical area. With the many available mechanisms for interacting with learners electronically there are a number of choices to be made regarding the approach to take. In this paper we have described some of the approaches taken to assessment and feedback on the MSc Intelligent Systems and the MSc Intelligent Systems and Robotics for on-site and distance delivery. We have provided a case study of how this applies to one of the most practical modules, namely, Mobile Robots.

We have discussed our strategy for the assessing of students work and providing timely informative feedback to students. We believe that by following this model and the delivery model identified in [3] it is possible to deliver and assess a technical, practical subject by distance learning and that a lack of contact is no obstacle for well motivated and determined students. The module and the course are successful and sustainable with a total of 64 students currently enrolled

(5 on site, the rest as distance learners). The course continues to evolve as the available technologies improve; additionally we gather feedback from our students regularly, using the responses to inform future developments. We hope to continue in this way ensuring that our students benefit from a carefully crafted course that makes appropriate use of current e-learning research and associated technology.

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