

Postgraduate Certificate in Higher Education
Nottingham Trent University

Module 2 - Assessment and Programme Design
and Development in the University

Assignment 1 - Evaluation of a module and related
assessment task

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Background

The task here was to evaluate the design of a module on which I have taught. As I am part time and have not been involved in such teaching this semester I have evaluated a module which I will teach next semester. This was agreed in advance with the module leader.

Problem Solving is a 20 credit, year long, second year module for BSc (Hons) Mathematics students. It has no pre-, post- or co-requisites. One semester of the module is taught as statistics and the other as mathematics. The module has been taught previously over approximately ten years by an experienced member of staff who is no longer with the university. A module box was available with a wealth of information but discussions with the previous tutor were not possible so I do not have information on all aspects of module operation. This essay will draw on information from the module box on the operation of the mathematics part of the module last year and inform my teaching of this next semester.

Evaluation of Problem Solving

Following the ideas of Biggs on constructive alignment (see Biggs and Tang, 2007), Kahn (2002) suggests a design for a module starts with "a set of outcomes" which "comprises a concise statement of what it is intended that the students learn during the course" (p. 93). Kahn then has the module made up of teaching and learning methods and assessment and each of these are designed to "match the chosen learning outcomes" (p. 93). Kahn finds this a useful approach but warns this is "relatively simplified" and the learning outcomes will "never fully characterize" a student's understanding of the topic (p. 93). Deep learning in mathematics requires, as Kahn puts it, "the development of a rich network of connections between ideas" which requires "sustained study." So, he says, outcomes from a module should "always be seen in this longer-term context" (p. 93).

1. Module aims and outcomes

The module specification has the following stated aims:

This module will extend and develop your skills and experience in applying mathematical and statistical techniques to open-ended applied problems. You will gain further experience of working in small groups and as an individual on mathematical and statistical problems. You will learn to select and apply appropriate techniques and specialist mathematical and statistical software to help solve problems. You will gain further experience of reporting and presenting your results.

The module specification lists the desired learning outcomes:

Knowledge and understanding. After studying this module you should be able to:

1. Express problems in the language of mathematics.
2. Select, adapt, and apply standard techniques in a variety of problem areas.
3. Identify assumptions in a mathematical argument.
4. Evaluate, select, and implement appropriate numerical and software techniques for a range of problems.

Skills, qualities and attributes. After studying this module you should be able to:

5. Use reference information from a variety of sources.
6. Communicate effectively using reports and presentations.
7. Work effectively as an individual and as part of a small team.
8. Collect, evaluate and analyse data.
9. Effectively manage your time.
10. Reflect on your learning and personal professional planning skills and goals.

The QAA Benchmark Statement for Mathematics, Statistics and Operational Research (MSOR) (see The Quality Assurance Agency for Higher Education, 2002) suggests skills MSOR graduates possess include: "the ability to learn independently... work independently... time-management and organisation... able to transfer knowledge from one context to another, to assess problems logically and to approach them analytically... general communication skills, such as the ability to write coherently and communicate results clearly" (p. 11). The Statement suggests it is because of these skills that MSOR graduates "find employment in a great variety of careers and professions" and consequently, "teaching and learning methods should assist the development of these skills, by encouraging... the students' capacities for independent and self-motivated learning [and] problem-solving skills" (p. 11). Hibberd (2005) agrees that mathematics graduates "play an important role in meeting the demands of employers for skilled personnel to ensure the UK can maintain its competitive edge in a global market" (p. 6). While Kahn (2002) regards it as "essential" that modules are "built around mathematical considerations," he suggests module designers also need to take account of "wider considerations" such as "preparing students for employment" (p. 92). The 2009 NTU prospectus for BSc (Hons) Mathematics says the degree prepares students for "specialist professional employment in industry, business, government service, research and education" (see Nottingham Trent University, 2009) which is in line with the QAA Benchmark Statement.

Beevers and Paterson (2002) describe "key skills" as "what is left after the facts have been forgotten" (p. 51). Challis, et al (2002) define a subset of key skills as "transferable" (p. 80) and say as well as academic knowledge, professional mathematicians require these skills to "use their knowledge effectively" (p. 89). They say it is "incumbent on us, as teachers, to help our students to learn and develop these skills" (p. 80). Lowndes and Berry (2003) agree, saying that employers have "voiced their perceptions/criticisms that students/graduates are technically competent but lack professional skills, awareness of business issues, communication skills [and] problem solving skills" (p. 20). Disagreement with this was found by some of the staff and students interviewed by MacBean, Graham and Sangwin (2001) who "questioned the assumption that the purpose of a mathematics degree was to develop such 'skills' at all" (p. 3). However, supporting students developing these skills cannot be avoided if we wish graduates of mathematics to be employable and mathematics courses to be attractive to potential students (Hibberd, 2005; p. 5).

On the Module Leader Report Form for 2007-8 the Module Leader describes Problem Solving as "a non-traditional, non-didactic module where students are able to develop generic as well as subject specific skills." So this module is intended to develop mathematical modelling and transferable skills broadly similar to those in the QAA Benchmark Statement. Neither the aims nor outcomes refer to any particular mathematical topic.

Challis, et al (2002) advocate that the development of transferable skills "should be embedded in the mathematics curriculum" (p. 80) otherwise, they say, skills-based assignments risk being seen as "an 'add on' rather than "an integral part of a mathematician's life" (p. 90). The 2009 NTU prospectus for BSc (Hons) Mathematics says the course includes a project dissertation and an optional placement year (see Nottingham Trent University, 2009). It is not clear from the module box information where this course fits into a wider provision and certainly it is not clear whether, as Challis, et al recommend, all modules includes an element of transferable skills development. However, Kahn (2002) notes that "skills are difficult to develop within courses structured around a systematic presentation of ideas from a given area of mathematics," and suggests designing a module "entirely around the development of a given skill" (p. 97), which is the case with these learning outcomes. Looking at the longer term context, it can be said that this module is in a position to build on the mathematics studied in other modules and to provide the skills training ready for a placement year and/or final year project dissertation.

The module aims and outcomes should be assessed in terms of inclusion and issues related to disability. By listing skills attributes as module outcomes we are saying that, if the module is well aligned, in order to complete the module the student must be able to demonstrate these attributes. The post 16 education Code of Practice accompanying the Disability Discrimination Act 1995 and relevant legislation (Disability Rights Commission, 2007) says "courses and teaching practices should be designed to be accessible so that only minimal adaptations need to be made for individuals" (p. 161). Specifically, the Code of Practice says "education providers" who apply "a competence standard which results in direct discrimination... will be acting unlawfully" (p. 166). They give an example in which a learning outcome is "speaking clearly in a customer service environment" and "a disabled student whose impairment affects her speech does not achieve the qualification because of this criterion" saying this is unlawful practice (p. 166). The duty of education providers to adapt courses for students with disabilities is an anticipatory duty (Disability Rights Commission, 2007; pp. 167-8). It is vital therefore to consider how flexible the module design, teaching and learning methods and assessment may be for a student who has a disability which affects any of the module outcomes or methods.

Constructive alignment can help greatly in accommodating students with individual needs. The Code of Practice notes assessments must rigorously test students against some competencies. If the method of assessment used would exclude a student this may need to be adapted so they have "an equal opportunity to demonstrate their competence" (p. 172). In this case, an alternative assessment may be agreed in negotiation with the student which assesses the same module outcomes. Modules which are not correctly aligned will experience problems here: should the adapted assessment assess what the regular assessment is assessing, or what the learning outcomes say it *should be* assessing? Only a correctly aligned module will be able to assess students with differing access needs to the same standard.

In the case of Problem Solving, regardless of the teaching and learning methods used several of the skills outcomes provide specific difficulties for some students with disabilities, in particular: communication using written reports (Fuller, Bradley and Healey, 2004; p. 461; Disability Rights Commission, 2007; p. 165); communication using oral presentations (Fuller, Bradley and Healey, 2004; p. 462); independent individual working (The National Autistic Society, 2008); working as part of a group (Sargisson, 2002; Fuller, Bradley and Healey, 2004; p. 460; The National Autistic Society, 2008); and, time management (Disability Rights Commission, 2007; p. 176). There are also general issues which are common to all modules, such as provision of written materials in alternative formats and access to lecture facilities. It is important to remember students may not be very comfortable seeking support and so the opportunity must be made for them to come forward (Fuller, Bradley and Healey, 2004; p. 465).

2. Teaching and learning methods

This module has been taught previously using student-led group and individual projects with a strong independent learning focus assessed by oral presentations and written reports.

What can and cannot be achieved with group work and projects?

Hibberd (2005) notes "much of the teaching and learning in an undergraduate mathematics curriculum is provided by traditional lectures and problem workshops and assessment is dominated by examination" (p. 5). He suggests this method is "strong" for "the attainment of knowledge" but makes "more limited contributions to other elements" (p. 6). Hibberd (2002) suggests project-based work can bring together "mathematical ideas and techniques from differing areas of undergraduate studies" which allows "a much more extensive provision that leads students into a more active learning of mathematics, and an appreciation and acquisition of associated key skills" (p. 159). This active learning and connection between different areas of mathematics can help develop deep learning (Kahn, 2002; pp. 99-101). However, Hibberd (2002) suggests "for a realistic expectation that students will be able to grasp... the wider skills base, it is advisable to concentrate on the application of existing mathematical knowledge rather than to expect students to learn new mathematical techniques" (p. 163). Kahn agrees, suggesting using mathematics "the students have already understood" to avoid the "difficulties" for students of applying new knowledge directly to project work. In this case, he suggests the module outcomes will not refer to "the initial mastery of the mathematics concerned" (p. 96).

Hibberd (2002) goes on to point out the "significant advantage" of making the project a group activity to address additional skills (p. 164). He suggests that skills are "not readily taught in, for example, a lecture/seminar environment, but are best accommodated within student-based learning activities" (p. 159). Ahmed, Holton and Williams (2002) say that projects "all foster organizational and research skills, communication and mathematical insight." They say: "Individual projects allow students to tackle a broad mathematical topic and see its connections with other areas. Group projects, where students work together, also foster cooperation and oral communication" (p. 47). Methods which include individuals and groups working on projects through independent learning and supervised sessions are clearly indicated.

MacBean, Graham and Sangwin (2001) claim that much has been written on the use of group work in other disciplines but they note "many people view mathematics as an individual mental pursuit" and a subject in which "something is either right or wrong" so that it is "difficult to discuss or debate and one that is not open to differing opinions" (pp. 1-2). One of their student participants commented: "In psychology it works very well in groups, because you get [to] discuss things... we can actually have a discussion about that, my views and their views,... but in maths you can't really do that. What is there to discuss?" A staff participant commented that "at the end of the day what goes on inside your head is what matters. It is an individual world. It is a mental world. It is my mental world, I have to operate it." (p. 2). Therefore, they say "one of the first issues to be addressed here is the purpose of group work in undergraduate mathematics teaching" (p. 1). They suggest group work can be used to develop "social interaction, a support mechanism, a means of consolidating of prior work, introduction of new concepts, or the development of 'skills'" (p. 11). However, they report "considerable disagreement amongst both staff and students" over whether group work can be used to introduce new topics and concepts. Some of their participants "did see group work as an opportunity for students to develop communication, teamwork and organisational skills" and say that "giving presentations was one type of task that was cited" (p. 3).

Here the module aims and outcomes relate to the development of key skills and so the use of group work and projects is in accordance with the findings in the literature. However, an introduction sheet for a previous year of the mathematics section in the module box states explicitly: "The problems will NOT necessarily be directly related to work covered in other modules of the course, and may involve some extra reading on the problem

area" (emphasis in original). We have seen the suggestion group work is not a very effective method for introducing new mathematical knowledge and that by doing so within project learning we risk obscuring the skills development. Since the module learning outcomes only relate to skills development and not to the mastery of a new topic, this aspect of the module teaching and learning would seem to be incorrectly pitched against the intended learning outcomes. In addition, by not directly relating the project to knowledge gained during other modules the opportunity is missed for the consolidation of knowledge that could lead to deep learning.

In terms of adapting the teaching and learning methods to meet the individual needs of a student with a disability, the use of an approach in which several of the learning outcomes are addressed en masse by an integrated teaching and learning method has potential issues. As all or most of the learning outcomes are addressed by group projects then a student whose disability affects, for example, their ability to work as part of a group will need alternative methods for all learning outcomes, not just the one relating to effective group work. This is a clear weakness of this teaching and learning method.

3. Module content

This module features much self-directed learning and the development of skills rather than the mastery of a specific syllabus and we have seen above that skills-based modules are not best used for the acquisition of new knowledge. It would be tempting then to say the module content should consist only of the assessment specifications and criteria. However, this should not be the case. As seen above in the findings of MacBean, Graham and Sangwin (2001), some students may need convincing that they need to develop employability skills at all. Challis, et al (2002) say mathematics students "are often surprised to see the emphasis placed on the acquisition of transferable skills" and so "the reasons for this emphasis must be clearly explained at the beginning." Additionally, they recommend teaching students how groups operate, saying "transferable skills must be taught as explicitly as are all other aspects of the course: it is not sufficient to put students into groups and ask them to undertake tasks" (p. 89). MacBean, Graham and Sangwin (2001) also make this recommendation, saying "many of the students will not have worked as groups in a university environment before and simple guidance like this can be helpful" (p. 9). MacBean, Graham and Sangwin suggest the information given to students could include: "the brief for the task and submission details, the composition of the group, details of facilities that could support the group work, advice on working in a group [and] assessment criteria for the task" (p. 10).

In the module box for Problem Solving, the assessment briefs contain a large amount of content on the particular mathematical topic, which we have seen may not be appropriate for these teaching and learning methods. There is a section of a module introduction document on problem solving technique which seems to be appropriate to the subject-specific aims of the module. There is no content in the module box relating to general skills or group working. If indeed no such content were made available to students this would be what Challis, et al describe as "not sufficient" for skills acquisition (p. 89).

4. Assessment methods and criteria

Harding and Craven (2001) liken the interaction between assessment and learning to a "three-legged race", in which "neither can move forward without the other." Sangwin (2002) says, "if we fail to ask the students to practice some technique... we can hardly complain afterwards that they have failed to develop this skill" (p. 814). Kahn (2002) says "given the way in which assessment drives student learning, it is particularly important to make a careful choice of methods of assessment and feedback" (p. 102).

The module specification suggests assessment will include written reports and oral presentations. Beevers and Paterson (2002) give mathematical modelling as an example of an assessment task that covers Bloom's higher order learning objectives (p. 59), suggesting project work "can motivate students" and "in constructing the project the student can be encouraged into a deeper learning approach" (p. 57). They highlight project work as suitable for group work and say this "provides a different learning environment where the students can support one other," but warn care is needed that each student contributes to the overall project (p. 57). They say presentations "allow the student to demonstrate a deep level of learning" and in addition to communication skills, can show "analytical and organizational skills and critical thinking" (p. 57).

For this essay I will focus on the group project tasks and assessment based on documentation from the module box. This involved groups of up to three students. Assessment was by group presentation or report. Work was assessed under two headings: "Solution", the implementation of a method and accuracy of the solution; and, "Presentation/report", the presentation skills, organisation and clarity of materials. There are several specific assessment briefs in the module box in three numbered types:

- Type 1 problems are in depth and involve a guided process of derivation of some algorithm, implementation of that algorithm computationally and an oral presentation of findings. These problems are broken down into a series of "milestones" and a hand written note on one assessment brief says "the documentation is released to the students a milestone at a time." Different milestones have different assessment techniques including oral interviews, written solutions, written reports and oral presentations. Each milestone begins with the solution to the previous milestone and sets some further questions.
- Type 2 problems begin with an introduction giving some background to the topic and a worked example of the technique to be applied. Then a series of "initial tasks" are posed followed by a smaller number of more in depth tasks. Type 2 problems are less involved than Type 1. Assessment is by oral presentation and a written "executive summary of findings".
- Type 3 problems give a more in depth description of a theory followed by a series of tasks to perform. Assessment is by written report.

It is not clear how time was allocated between the types of project but it seems types 1 and 3 involve more work than type 2. A module introduction sheet indicates four numbered tasks, with task 4 (at 20%) being a CV writing exercise on which no further information is available. If we assume the numbering of tasks 1-3 relate to the assessment briefs in the module box, types 1 and 3 comprise 30% of the marks and type 2 is the remaining 20%. All three tasks are group tasks.

Presuming the tasks are in order, it seems that type 1 problems are more structured than types 2 and 3, which shows a good progression to independent working for the groups. The milestones in task 1 start out with some planning and initial simple problems and build up techniques to enable a solution to the problem to be achieved. Oral interviews are frequently used during milestones, which will improve communication and familiarity with the language of the problem ready for the final oral presentation. However, the milestones comprise a summative assessment as well with around 50% of the marks for the task and this combination of formative and summative assessment is not liked by Biggs and Tang (2007) who say this creates a conflict for students by asking them "to display and to hide error simultaneously" (p. 164). However, MacBean, Graham and Sangwin (2001) point out that students are less likely to participate in work that is not assessed (p. 7), so inclusion of summative milestones may be a necessary pragmatic decision. Following this, type 2 problems are less structured and overall require less work. Presumably the students are left more to their group management here and the lower workload reflects this. Finally, task 3 is more in depth than task 2 and culminates in a

written report, suggesting that independent group working practice from task 2 is incorporated in this larger exercise for task 3. This progression towards group independence seems very well orchestrated.

In task 1 the groups are led through the processes described in learning outcomes 1-4 and in later tasks these processes are less guided but still required, showing a development of those skills. The module contains several assessment types which seem well aligned to outcomes 5-9. However, outcome 10, on personal reflection, is not assessed by any of these three tasks. According to the module introduction this will be assessed by task 4, CV writing.

Each task brief has an outline mark scheme with details of the requirements for the presentation or report. This generally includes marks for covering background theory, formulation and illustration of solution, as well as marks for accuracy and presentation skills. However, there is no evidence of a mark for justifying the approach used or evaluating the solution given. These sorts of tasks, recommended by Lowndes and Berry (2003; p. 21), would allow the tasks to relate to outcome 10. There is an issue in group work of determining whether all students are contributing equally or whether the group is carrying, as MacBean, Graham and Sangwin (2001) put it, 'passengers' (p. 7). They highlight the tension of assessed group work with a quote from one student: "I think that's a bit unfair, every single mark that you get is dependent on other people" (p. 7). In this module, 80% of the marks are from group work. The module introduction claims that each individual's contribution to their group will be monitored in the timetabled sessions and the tutor reserves the right to reduce the marks of any group member "in the case of sub-standard contribution." An individual written reflective element such as that suggested by Challis, et al (2002), or some peer assessment of individual contributions as suggested by Hibberd (2002) might help evaluate the effect of dysfunctional group dynamics. Certainly, incorporating an individual project would have provided less reliance on the group for overall marks.

All three tasks are very similar in structure, with students gaining greater independence in each iteration through the problem solving cycle. This may provide a coherent structure and be useful in reinforcing the subject-specific outcomes 1-4 but more varied activities might have helped with the transferable skills outcomes 5-10.

Kahn (2002) suggests assessments must be "valid in that they actually test what whether students have achieved the outcomes of the course" and "reliable so that they measure student achievement on a consistent basis" (p. 102).

On validity, the assessment brief contains a breakdown of where the marks are available and a description of what the report or presentation should cover. In the case of the presentation it gives a description of the knowledge that can be assumed from the audience. However, there is limited information on how many marks will be gained by what level of attainment in each of these areas. In the module introduction there is a general outline of grades based on the amount of assistance the group required to complete the task but not for other areas. No marks are explicitly allocated for the management of the group as recommended by Hibberd (2002), even though these are listed as learning outcomes. Challis, et al (2002) suggest the importance of assigning marks on all of the transferable skills to show "the value attached to them by staff" (p. 90).

On reliability, it is not clear from the information in the module box how consistency or quality assurance were ensured. Certainly the sample work contains no evidence of a detailed mark scheme or second marker as may be useful to ensure consistency (Challis, et al, 2002) though this does not mean one was not used. Of course, resource limitations may not allow marking to be adjudicated; certainly no staff time has been suggested for this when I teach the module next semester. Beevers and Paterson (2002) regard Bloom's higher order learning objectives of analysis, synthesis and evaluation require learning outcomes that are "more complex and open to interpretation" than are standard mathematics questions (pp. 58-59). This subjective nature and likely difficulty

in consistency seem to indicate the need for a reliable marking process.

5. Feedback

Beevers and Paterson (2002) say "feedback is an essential part of any assessment" (p. 51) and Hibberd (2002) regards "detailed feedback" as "an important element in the enhancement of skills acquisition" (p. 169). Kahn (2002) says "feedback can target weakness in underlying skills so that these can be explicitly addressed, as well as addressing more immediate errors" (p. 102). Cook, Hornby and Scott (2001) say that "if students receive continuous sympathetic feedback their performance and satisfaction increases."

The module box contains some examples of feedback on presentations from task 1. The methodology used to formulate this feedback is not clear. The feedback is organised under four headings: "Overall structure of talk"; "Slides and use of slides in talk"; "Content"; and, "Presentation Skills". A statement of general comments is also included. Each of the four categories generally begins with a positive comment about that area and is followed by criticisms if present. The general comment is again positive in tone with criticisms worded as suggestions for improvement, such as "I am sure [student] will be able to give excellent presentations if [criticism] is addressed." This seems a good approach likely to encourage students to improve, considered by Beevers and Paterson (2002) to be one of the main purposes of assessment.

7. Other sources of evaluation

Kahn (2002) says it is challenging to design modules "that open up mathematics to students in ways that both attract them and serve their needs" (p. 92), making student feedback a potentially difficult area. However I believe Problem Solving has the potential to be such a module as students discover some of the ways of applying the mathematical knowledge they have acquired.

From the Module Leader Report Form for 2007-8, student feedback indicated the only adverse response related to the changeover of staff half way through the module. As the two parts are based around different subjects (mathematics and statistics) this is difficult to avoid. The student comments relating to the "best things about the module" include: "interesting work, real world situations"; "applied nature of work"; and, "self-supported study." Under "ideas for improvement" are "more worked examples" and "more notes," suggesting some students did not like the self-directed aspects of learning.

The Module Leader described the strengths of the module as "non-examined, student centred module where teamwork and inter- and intra-personal skills are encouraged." Further, under "fitness for purpose" the Module Leader said "module imparts important skills and generally provides useful training in areas of work not addressed in traditional modules."

8. Summary of evaluation

Problem Solving is a valuable module within the mathematics degree as it has the opportunity to deal with issues relating to employability that may not be effectively dealt with elsewhere until the placement or dissertation when it may be difficult to achieve acquisition of basic skills. The module is taught and assessed using methods that are suggested in the literature as addressing the module outcomes, namely group projects, oral presentations and written reports. The specific ways these methods have been applied is somewhat at odds with the advice from the literature, in particular through the inclusion of new mathematical content and the lack of a consistent reflective element. The assessment criteria do not explicitly cover all of the module objectives, so it is necessary to judge second-hand whether students have demonstrated some of the outcomes

related to group management. Formal feedback is not given against all outcomes and again this could be a problem for demonstrating the module enables students to achieve all outcomes.

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