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# Identifying Good Practice in Teaching and Learning in MSOR

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**Penny Bidgood**  
**Kingston University**

bidgood@kingston.ac.uk

**Bill Cox**  
**Aston University**

w.cox@aston.ac.uk



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The LTSN funded *Where Are We Now?* project, has the aims of identifying and disseminating good practice in HE Mathematics, Statistics and Operational Research (MSOR) provision. Initially six areas were identified as being of current importance and capable of dissemination [1]:-

- Access/widening participation and its implication for student support
- Innovative use of CAL/IT and other methods in teaching and learning
- Student mentoring and peer tutoring
- Student record systems that help in early identification of potential progression problems
- Effective and innovative assessment
- Transferable skills

A report on good practice in the first of these areas was given in the last Connections [2]; here the second is considered. Student mentoring and peer-tutoring as aids to learning can confer considerable benefits to all concerned; assessment, both formative and summative, can support and encourage student learning; effective delivery of transferable skills can promote students' personal development and learning skills. However although these areas have direct impact on students' learning they are not considered in detail here but will be the subjects of later articles.

Primarily, identification of learning and teaching good practice is through the QAA MSOR subject reports and the equivalent ones for Wales and Scotland. There are also clear connections with other LTSN-funded projects and activities, for example, *After the Diagnostic Test – what next? Evaluating and Enhancing the Effectiveness of Mathematics Support Centres* [2] and *Groupwork Reluctance in Mathematics Education* [3].

## ***Overall look at the aspect “Teaching, Learning and Assessment”(TLA)***

The 1998-2000 reviews of MSOR in England and Northern Ireland gave scores 1- 4 for each of the six aspects of provision. The subject review handbook lists four key features under the TLA aspect – *The teaching, learning and assessment strategy; Teaching; Learning and Assessment*. Under *Teaching* and *Learning* reviewers were looking for evidence of the clarity of the learning objectives, staff contribution including the impact of professional activities and research, materials provided, use of resources including IT, student engagement and participation and staff development activities [5]. In TLA 26 of the 71 providers were awarded grade 4, 44 grade 3 and 1 grade 2, indicating scope for improvement in 63% of the providers. The Colleges of Higher Education scored well with 4 of the 5 gaining grade 4[4]. MSOR fared badly in this aspect (and generally) compared with Physics and Astronomy, Psychology, Molecular and/or Organismal Biosciences that were also reviewed in the same period under the same conditions [6]. This would seem to indicate that there are problems in TLA in the MSOR provision. However in more than half of the providers, the review reports identify scope for improvement in assessment rather than teaching and learning practice. (Assessment will be the subject of a later article). Of the 45 institutions that lost points in TLA, only 12 did so through the teaching and learning part alone as evidenced by the report conclusions i.e. most points were lost through the “assessment” part of the aspect rather than the “teaching and learning” part. Major faults

were that assessment did not always measure the learning outcomes adequately, and there was not clear evidence of internal or external moderation.

In similar exercises carried out in Scotland (1992-94) and Wales (1995-96) the aspects were slightly different and no numerical scores were given. In Scotland the comparable area was "Teaching and Assessment"; again in the thirteen reports, most of the negative comments were about various aspects of assessment rather than teaching. The Welsh reports separate consideration of "Teaching and Learning" from "Assessment and Academic Support"; only one of the five institutions has negative statements about teaching and learning.

There were about 20,000 undergraduates studying MSOR in the QAA exercise and over 1200 teaching and learning sessions were observed. Reviewers reported that they were able to observe a range of levels, and activities from across the curricula. Examples of many different types of teaching and learning sessions were seen including activities such as team-teaching, project supervision, peer-assisted sessions and oral presentations. Comments on the teaching and learning sessions observed were generally positive with 52 of the 71 institutions praised for the high quality of their teaching and almost all for having staff who were committed, knowledgeable and accessible. Similar remarks are found in both the Welsh and Scottish reports.

There is much to be commended here - "Most of the teaching and learning observed is of high quality and some is excellent. The best sessions are characterised by careful planning so that the aims and objectives are fully met; clear delivery of topics at an appropriate level and by enthusiastic, knowledgeable and supportive staff" [4]. It was recognised in the overview report that "much greater prominence is currently being given to improving teaching and learning" [4]

There is considerable evidence of current good practice in learning and teaching in MSOR departments although not so much that was considered to be "innovative" by the reviewers. This good practice can be summarised under:

- Providing students with a wide range of teaching and learning activities
- Providing a range of learning support mechanisms
- Strategies that integrate different activities such as lectures, tutorials and practicals
- Student participation and engagement in the learning process
- Good use of learning resources

- Staff development that is effective in improving teaching and learning

In each case reviewers found much good practice, examples of which are given below.

### ***Providing students with a wide range of teaching and learning activities***

Reviewers observed that most contact teaching comprised formal lectures supported by tutorials and/or seminars, problems classes and practical sessions. Occasionally more innovative methods were used, including peer-assisted study sessions, team teaching and group work. In most cases the formal teaching was supplemented by ready access to staff on a more informal basis, sometimes even an "open-door" policy – staff were often praised for their accessibility and willingness to help students.

There is evidence that students have different ways of learning and hence that provision of a variety of teaching and learning experiences helps them to develop both subject-specific and transferable skills. This is good practice and there is evidence of this variety in the reports. For example Brighton was praised for its wide range of learning activities that enabled students to "learn by doing" and for its team-teaching approach to delivery. Birmingham was commended for its variety of teaching and learning opportunities in the first year, ensuring its students successful transition from school to university mathematics.

Teaching and learning methods that were particularly noted by reviewers as being innovative include the novel approach of using carefully designed workbooks in a problems based approach to teaching analysis at Warwick. This had been shown to improve student achievement in the module. Also the Polymath schemes at Bolton and Westminster were praised for giving students a rich and varied learning experience. Bristol was commended for innovative features in its provision such as a module that brought in outside speakers from industry and elsewhere thus broadening the student experience and also a unit on Mathematical Education that encouraged thinking about the learning process.

Many universities had peer-assistance schemes whereby students from a higher level help first years with subject-specific and/or learning skills. At their best these schemes confer benefits to all concerned; those at Kingston and UCL were considered to be examples of good practice. Similarly, reviewers report that at London Guildhall innovative peer support of high quality is provided at level 1.

The delivery of and learning achieved through key transferable skills were seen to be strengths at some universities although "The greatest weakness identified is in skills development. ...the provision for general transferable skills was found to be very uneven." [4]. Examples of good practice observed in this area include Westminster's mid-year poster session for third year students when they display their project work; reviewers noted that at Kent the key skills elements were particularly well delivered, including the oral presentation parts of project work. At Queen's, Belfast the Mathematical Investigations module at level 2 was noted as an example where innovative teaching and learning methods using group work, student presentations and assessment through written reports were highly valued by the students. Napier was praised for developing a number of innovative teaching methods including group work and oral presentations in mathematical modelling; at Bangor reviewers commended the "Ideas in Mathematics" module which gives students experience in writing reports, essays and in problem-solving.

### ***Providing a range of learning support mechanisms***

There are a number of examples of good practice in support mechanisms, including peer-assistance, supervised workbooks and individually-tailored programmes of "catch-up" work, to facilitate the transition to university level work and/or addressing the needs of students with low confidence in the subject.

At Loughborough the Mathematical Thinking module and Open Learning projects designed to ease the transition to university mathematics were commended in the subject report as being innovative. At Leeds reviewers noted an innovative arrangement that allows students to proceed at a pace commensurate with their mathematical backgrounds. At Manchester the consolidation modules and peer-assisted study sessions are regarded as innovative features. It was noted that at Sussex a successful innovation, much appreciated by students, was to appoint two research students as Student Support Assistants; they are available for several hours each week to provide informal help, particularly to first years.

Leicester and Loughborough were regarded as innovative in using personal tutors in small group teaching with first year students, thus developing presentation and communication skills as well as subject-specific skills. Other institutions noted as showing good practice by having small group tutorials include Durham and UMIST; Warwick was commended for the level of human resources devoted to first year student supervision.

Beyond the first year Warwick has a work-book based consolidation module at level 3 to help under achieving students to improve. Some institutions had mathematics support centres or facilities such as the level 2 learning clinics at Liverpool Hope. About half of all HE institutions now have such units and the LTSN-funded project *Diagnostic Test – what next? Evaluating and Enhancing the Effectiveness of Mathematics Support Centres* [2] has assembled useful information on best practice in this form of provision.

### ***Strategies that integrate different activities such as lectures, tutorials and practicals***

In the subject review handbook, one of the key features under TLA is the teaching, learning and assessment strategy and how it articulates with the aims and objectives of the provision; an explicit teaching and learning strategy that integrates lecture, tutorial and practical material is considered as good practice. Often, although this may be implicit, reviewers found a number of examples in which the strategy was well articulated and implemented by the majority of staff. For example Nottingham was reported to have a strategy that was well-matched to the curriculum and student profile – for mathematics students, subject specific and key skills were drawn together; for service students the strategy aimed to develop mathematical competence and confidence. The integration of material through a good learning and teaching strategy was regarded as a strength at Liverpool John Moores and that at Queen's Belfast was described as innovative. The Department at Edge Hill College was commended for its innovative teaching, learning, assessment and feedback programme involving carefully co-ordinated lectures, tutorials independent study, assessments, mini-projects and final examinations.

There were many examples seen of appropriate use of IT and software integrated into classroom activities, thereby providing opportunities for students to develop IT skills in context. At Portsmouth teaching included the use of CAL and TLTP software and technology was employed to advantage by encouraging students to expand their knowledge and experience through the web; here a number of courses were taught and assessed through the university's intranet. Good practice was observed at Middlesex in the use of computer-based simulations to illustrate points during sessions. The Test and Learn (TAL) package at Bristol with supervisions and tutorials were seen to be successful in supporting learning; reviewers were impressed by the range of Computer-Aided Teaching of All Mathematics (CATAM) projects available to second and third years at Cambridge. Active involvement of students in learning

was seen at Birmingham, particularly in computing sessions.

### ***Student participation and engagement in the learning process***

Student participation in the learning process is essential for success. Reviewers often commented on the lack of participation of students, particularly in large lectures, but they also testified to many examples in which students were actively involved. The best lectures, tutorials, problems classes and practical sessions engaged the students in the learning process, by various means. For example, at Liverpool students were seen to participate well in tutorials and computer workshops. The use of interactive notes i.e. notes with gaps, was commended at Glamorgan as a means of engaging students in the learning process. Glasgow was commended for its imaginative project and group work that encouraged the development of independent learning skills.

Further good practice noted by the reviewers includes opportunities for students to give oral presentations, to work co-operatively with peers and to develop as independent learners, the latter often through project work. At London Guildhall there is an Independent Study optional unit that gives students opportunities for independent study, under guidance, on topics that are of interest to them. Leicester has a number of innovative developments – project work in first year modules and group work in a number of second year modules. Particular innovations noted by the reviewers were the History of Mathematics and Communicating Mathematics modules that focus on developing skills required for presentation and independent reading. King's College aims to develop habits of independent study and progressively transfer responsibility for learning to the student – this is good practice. The modelling and problem-solving courses at Abertay Dundee encourage both independent learning and group activity and reviewers noted the considerable attention the department gives to the problems of assessing group work.

An increasing number of institutions offer the possibility of a placement year in industry and/or abroad; evidence from the reports indicates that this is a useful experience for students. In HE institutions, where it worked well, as an integral part of the student learning experience, the placement year was considered valuable in bringing together many opportunities within a practical setting. Institutions where the placement year was particularly commended include Surrey, Bath, Salford, UWE, Glamorgan and Glasgow Caledonian.

### ***Good use of learning resources***

The overview subject report states "Information Technology (IT) skills are well integrated into teaching and learning sessions, although the adoption of computer-aided learning (CAL) is still somewhat limited" and "Some providers are developing CAL activities as part of their teaching and learning strategy. Mostly this involves making lecture notes available on the www, although the more innovative use interactive worksheets, either developed in-house or adapted from commercially available software packages. The reviewers regard these activities as welcome enhancements to the students' learning experiences." [4]

Noted good practice in CAL includes emphasis on the use of web for teaching, administration and disseminating coursework at Ulster; examination papers and some course materials are on the web at City; QMW had some interactive worksheets, lecture notes and past papers on the web. The department at King's College was congratulated on its innovative use of e-mail and web facilities as teaching tools; also the gradual introduction of problem sheets and solutions on the web was a service appreciated by students. Staff at Surrey have introduced innovative web-based materials for student learning with well-structured interfaces to S-Plus and Maple worksheets.

Reviewers made particular note of the innovations in teaching and learning at Keele with regard to computer-based learning. The department has researched, designed and produced computer-based learning software. The innovative use of this resource in the first year, especially in relation to diagnostic testing and monitoring played a key role in helping the department achieve its aims and added a new dimension to a range of teaching techniques.

Middlesex was commended for excellent module handouts; these contained lecture notes, worked examples, exercises and problems and examples of past examination papers. There was also a dedicated resource-based learning room where students can direct their own learning and staff act as facilitators. Sheffield Hallam and Central Lancashire have developed innovative distance learning materials that impressed reviewers.

### ***Staff development that is effective in improving teaching and learning***

Generally there are good induction and mentoring arrangements for new staff and most institutions run a SEDA/ILT accredited Post-graduate Certificate course

for those new to teaching. Most providers undertake a peer review of teaching and 70% of these use it to inform staff development. For example, at City where an excellent programme of peer review was seen, sharing of good practice has led to teaching innovations such as the undergraduate seminar presentations in the second year module Actuarial Planning and Control.

In recent years most departments have co-ordinated and formalised their approach to teaching and learning by establishing teaching committees in some form. Reviewers found here a number of examples of good practice in which these committees were proactive and effective in promoting and implementing enhancements in teaching and learning. Of note were City's School Learning and Teaching Committee that identified good practice and internal workshops organised for dissemination of best practice in teaching and learning. Similarly at King's College innovations by individuals were encouraged and monitored through the Teaching Committee. Loughborough had a Teaching and Learning Committee with a focus on improving teaching and learning. Napier considered pedagogic development through its Mathematics Education group and Aberdeen had a Teaching Standards and Syllabus committee.

Reviewers noted that at Portsmouth staff activity in educational technology, writing text books and research has had a beneficial impact on teaching. The university has a development fund to promote innovations in teaching and learning which has been used extensively by the department. One member of the staff's teaching excellence had been recognised by promotion. City staff can take sabbaticals to update their teaching methods. Huddersfield instituted a teaching fellowship scheme to support innovation in teaching and learning; three of the eight fellowships are in the School, resulting in for example the successful mathematics bridging course for prospective students. At Leicester there were successful bids by some staff for university teaching initiative funds.

Staff research, consultancy and other professional activities can impact upon teaching and learning in terms of both content and delivery. "The reviewers welcome many examples of staff research and consultancy informing teaching" [4]. Some notable examples were the innovative and thoughtful approaches to teaching at Bath; Warwick with a research-led teaching philosophy; at Cambridge teaching drawing upon a rich base of research and scholarship and a marked influence of strong academic research on teaching and learning at all levels at QMW. At Reading there were a number of examples of innovation in teaching and learning including instances of staff research interests informing teaching.

### Conclusions

There is evidence from the subject reports that there is much to commend in teaching and learning in the HE MSOR departments. Teaching is generally good overall and some excellent; at its best student participation is high and students are engaged with the learning process. The summary above gives some instances where reviewers have commended particular institutions in specific areas, but there are many more examples that could have been included. For example, there were more cases where research and other scholarly activities including development of pedagogical methods informed teaching and learning and also where IT was generally well integrated.

Here some good practice in teaching and learning as identified in the subject reports has been described. However, the reports are at least a year old and some several years, so many instances of innovation may have taken place that were not reported or good practice may have been disseminated already. We would like to hear from anyone who can provide further examples in innovations in teaching and learning that they would like to share with the MSOR community.

### References

- [1] *MSOR Connections* 1, 3 August 2001
- [2] *MSOR Connections* 2, 1 February 2002
- [3] 'Guidelines for introducing Group Work in Undergraduate Mathematics' by J MacBean, E Graham, and C Sangwin *LTSN Occasional series 2/01 (2001)*.
- [4] *MSOR Overview Report*, QO7/2000, QAA
- [5] *Subject Review Handbook*, October 1998-2000, QAA
- [6] Davies N & Bidgood P *The 1998-2000 HE Subject Review of MSOR – What have we learned?*, Paper given at the RSS conference, Reading 2000