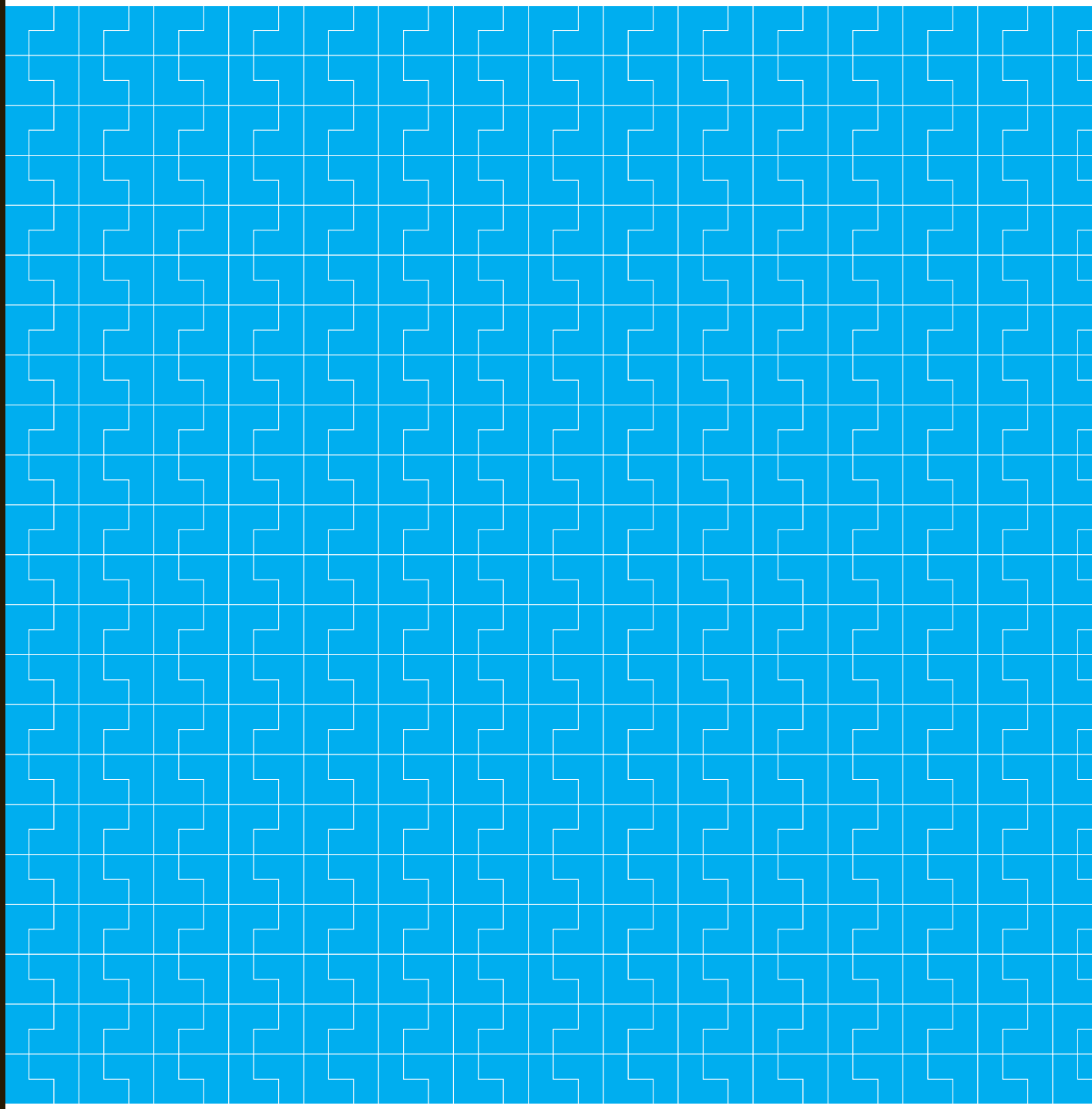
Mathematical Sciences HE Curriculum Innovation Project

Further Work Developing Graduate Skills in HE Mathematics Programmes



Edited by Peter Rowlett

The Higher Education Academy Maths, Stats & OR Network

National HE STEM Programme

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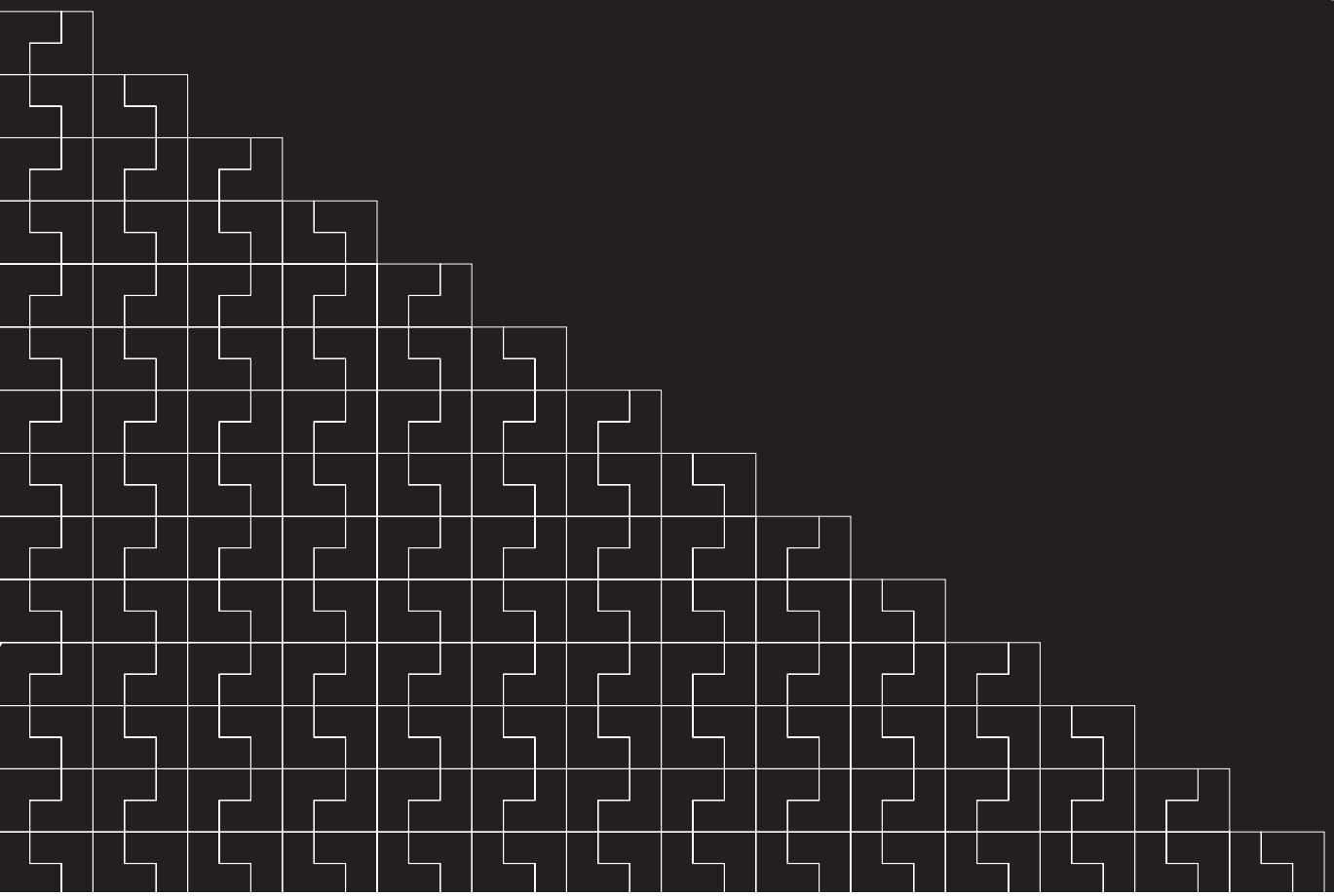
June 2012



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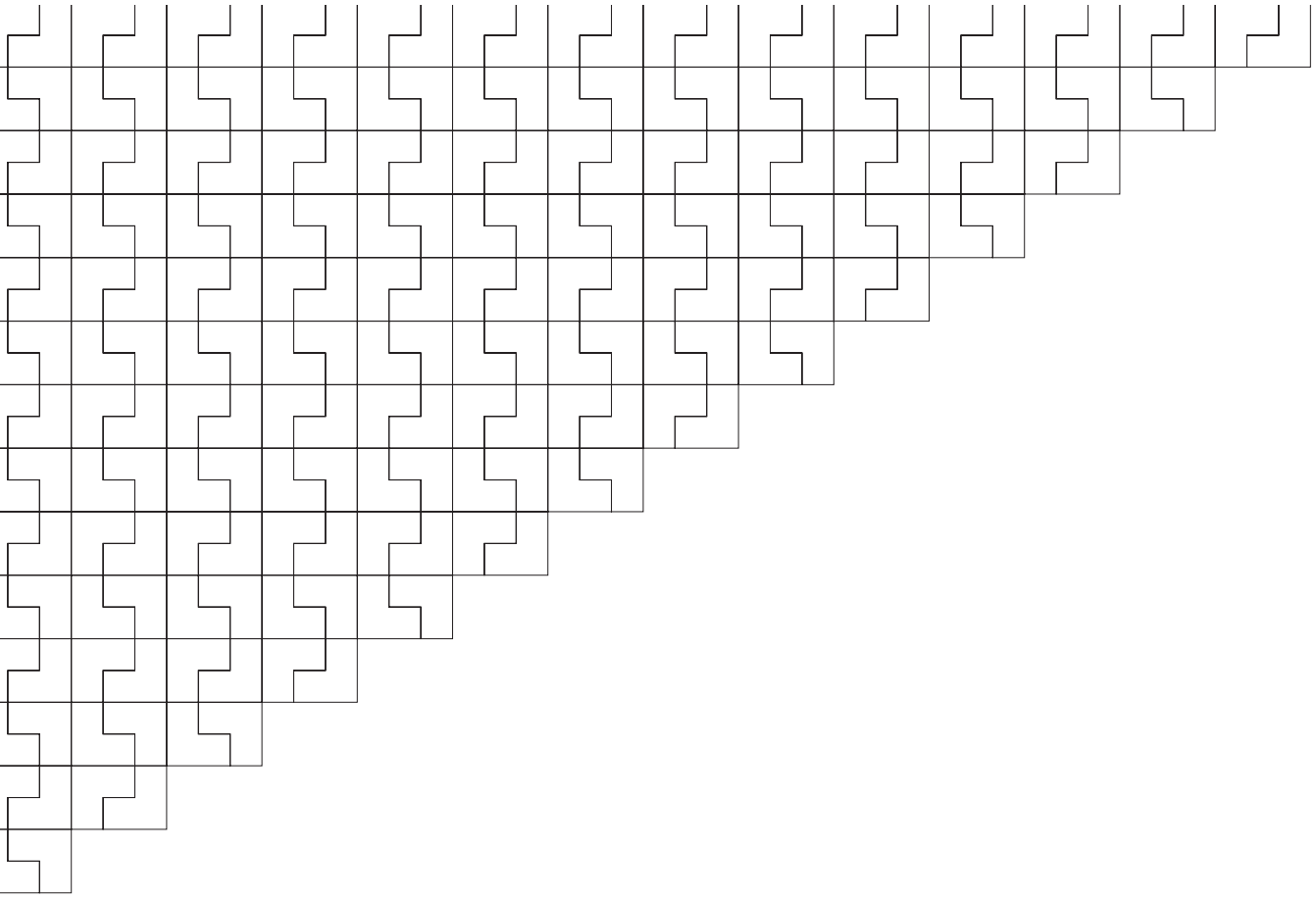
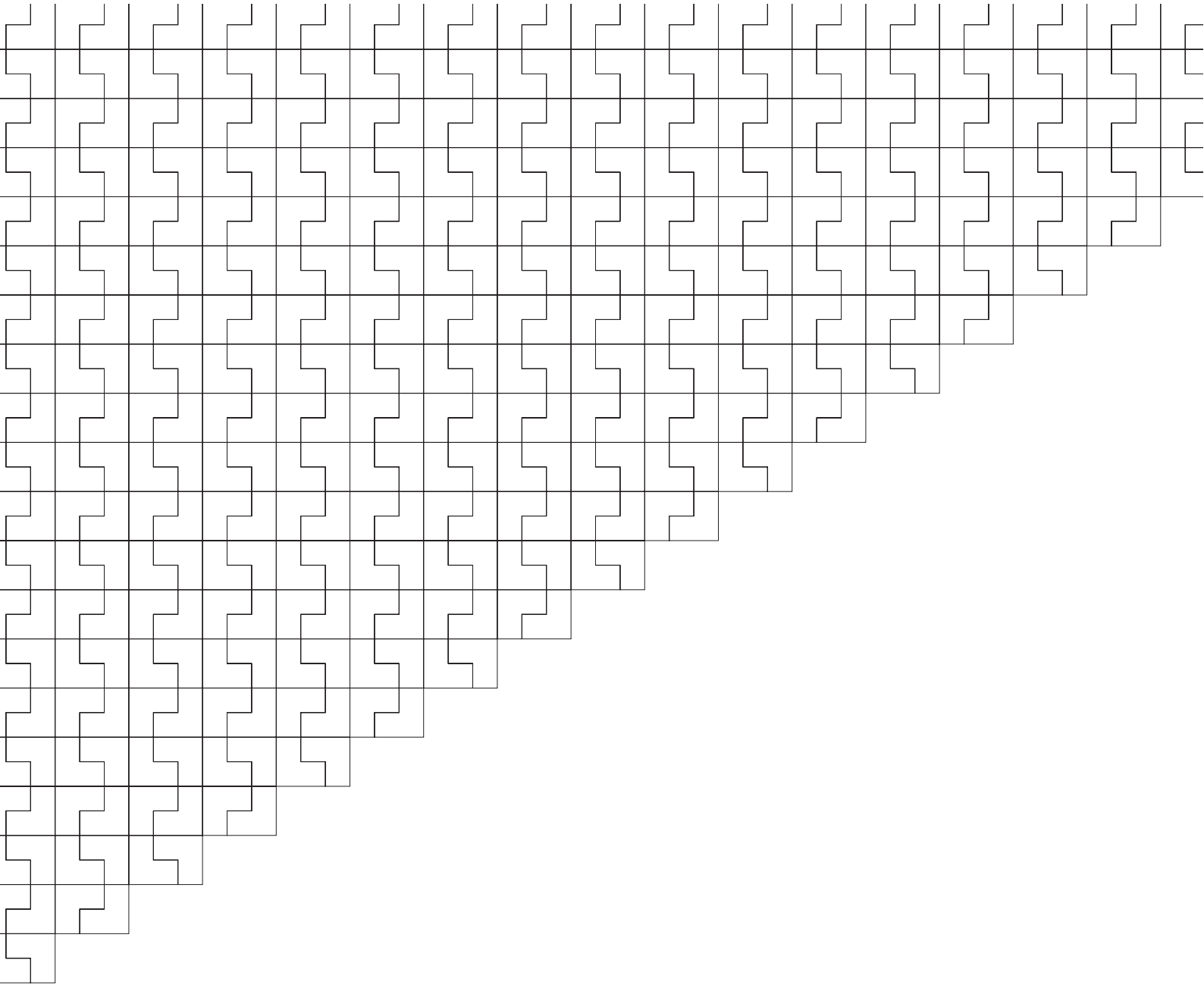


Contents



Introduction

In response to a Royal Society call for evidence in 2006, Stephen Hibberd and Michael Grove wrote that ([1], pp. 38-9)

> *increasingly students are looking for high employability prospects upon graduation. The areas of employment (careers) and employability skills are not sufficiently recognised or acknowledged, partly perhaps as many MSOR graduates move seamlessly into multi-disciplinary teams. There is an ongoing need for academic staff and employers to understand and integrate the skills that are, and could be, developed during the learning process for mathematics and statistics. This may involve more innovative individual or group based project activities, vocationally orientated experiences, interdisciplinary seminars and case studies. Personal attainment can be identified through peer-assessment, reflective logs and personal development portfolios. Such skills are also extremely beneficial and relevant to those going into advanced study or university-led research. A number of initiatives are underway and good practice does exist within the MSOR community in pedagogic development, innovation and implementation.*

As a result, they wrote, the Maths, Stats and OR (MSOR) Network established a working group on 'Graduate Skills' with Hibberd as chair to "identify and help coordinate" both "individual initiatives" and those from the newly established Centres for Excellence in Teaching and Learning (CETLs) (p. 39).

Among other activities, this working group took a workshop session to the CETL-MSOR Conference 2009 [2], which aimed to "promote and disseminate emerging innovative practice" and "explore and debate the potential for a greater role of graduate skills in the Maths curriculum and associated strategies and tools" (p. 48).

In 2010, Jeff Waldock contacted the speakers from this workshop to suggest collecting and publishing their good practice [3]. Waldock applied for funding from the MSOR Network and was awarded a small grant from the Mathematical Sciences HE Curriculum Innovation Fund, operated by the MSOR Network as part of the National HE STEM Programme. The result of this was the booklet '*Developing Graduate Skills in HE Mathematics Programmes – Case Studies of Successful Practice*', published in 2011 [4]. This presented seventeen case studies from fifteen universities seeking to develop graduate skills in a mathematical sciences context.

Also under the National HE STEM Programme in 2011, the MSOR Network organised the 'HE Mathematics Curriculum Summit' [5] to act as a high-level meeting considering the curriculum development priorities of the community. This made two recommendations around graduate skills which are directly relevant to this booklet:

9. "development of maths-focused resources equivalent to already published generic resources on improving students' communication skills" (p. 29);
10. "building on the case studies collected by Mathematical Sciences HE Curriculum Innovation Project funded mini-project 'Developing Graduate Skills in HE Mathematics Programmes' led by Sheffield Hallam University" (p. 30).

This booklet describes five projects which were supported by the Maths, Stats and OR Network as part of the Mathematical Sciences Strand of the National HE STEM Programme directly as a result of these two recommendations.

Part A follows recommendation 10, reporting on three small projects which took inspiration from the original set of case studies. Successful projects inspired by the original set encourage a view that at least some of the good practice given in that booklet is not simply a quirk of the

institution or colleague who presented the case study, but that it genuinely has the prospect of transfer to other circumstances.

Noel-Ann Bradshaw (University of Greenwich) drew inspiration from a case study by Louise Walker (University of Manchester), and from the spirit of the original booklet more broadly, bringing alumni back to the university to talk to current students, supported by employability material. Without prompting, recent graduates deliver the familiar messages about skills development, increasing awareness of the needs of employment, which students hear so much more clearly from the mouths of near-peers.

Andrew Neate and Kristian Evans (Swansea University) drew inspiration from original case studies by Kevin Houston (University of Leeds) and Peter Samuels (Birmingham City University), Gareth Williams (Open University) and David Bowers (University Campus Suffolk). They encouraged improvements of students' presentation of their written work through explicit formal advice backed up with an enhanced feedback regime.

Tony Mann and Steve Lakin (University of Greenwich) used the Progress Files system described in a case study by Jeff Waldock (Sheffield Hallam University) to improve their students' ability – and willingness – to record reflection on their studies.

Part B follows Summit recommendation 9, reporting on two projects which worked to develop curriculum resources and good practice advice specific to mathematical sciences in the areas of speaking and writing. James Groves (Lancaster University) developed and shared a mathematics-specific approach, based on a generic approach but grounded in the needs of the discipline, to developing speaking skills. Kevin Houston (University of Leeds), who presented a case study in the original collection, worked to collect and promote advice on teaching mathematical writing skills.

This booklet, published in 2012, can be linked to work going back for several years and still it looks to the future, providing good practice advice and curriculum resources for others to adopt similar approaches. All the new development projects found the experience sufficiently positive that these activities will continue in future years. The case studies presented here and the resources developed by the projects in Part B are available to inspire further development by others.

I outline the contents of this booklet here as a chronological narrative to set this activity into its broader pattern of development. The past work that led to this activity was driven by enthusiastic individuals under various different funding initiatives. So I am optimistic that this booklet will not be the end of this process despite the imminent ending of the funding for the National HE STEM Programme and the MSOR Network. The ideas discussed in these two booklets will continue as part of the learning, teaching and assessment practice of the individuals involved and, I am sure, of those inspired by what they read in these booklets.

Peter Rowlett, June 2012.

References

1. Hibberd, S. and Grove, M., 2006. A Response to the Royal Society paper: Science Higher Education in 2015 and beyond – call for evidence. *MSOR Connections*, 6(3), pp. 36-39.
2. Hibberd, S. et al., 2009. Integration of Graduate Skills into Maths Programmes. In: *CETL-MSOR Conference 2009 – Workshop Abstracts*, pp. 48-49.
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   [last accessed June 2012].
3. Waldock, J., 2010. 'Embedding skills in maths programmes - the continuing story...' [email]. (Personal communication, 12 January 2010).
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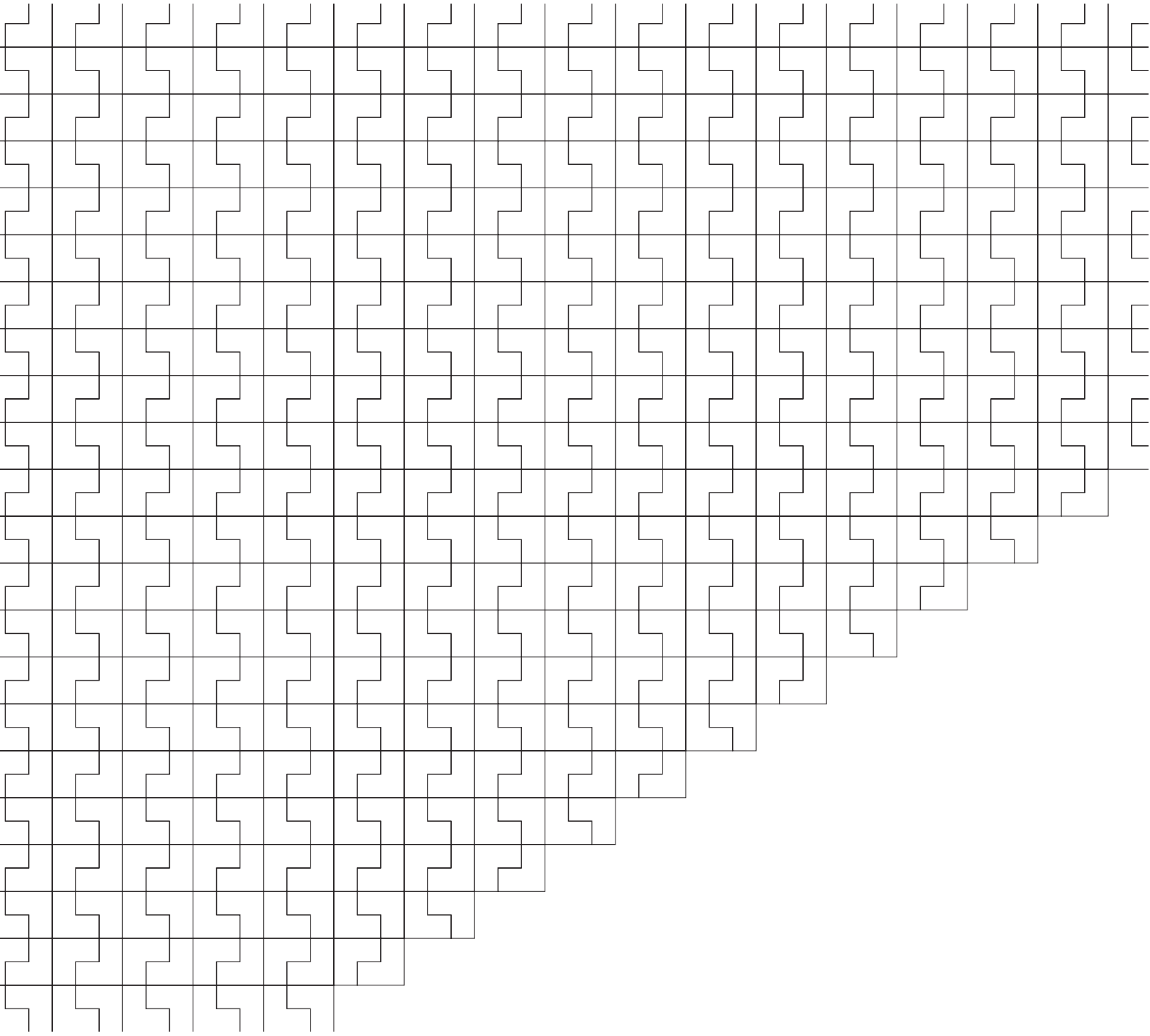

Part A: Building on the case studies on 'Developing Graduate Skills in HE Mathematics Programmes'

Three case studies which build on the original good practice guide 'Developing Graduate Skills in HE Mathematics Programmes – Case Studies of Successful Practice' [1]. The HE Mathematics Curriculum Summit [2] recommended as a curriculum development priority (p. 30):

> *Building on the case studies collected by Mathematical Sciences HE Curriculum Innovation Project funded mini-project 'Developing Graduate Skills in HE Mathematics Programmes' led by Sheffield Hallam University.*

References

1. Waldock, J. (ed.), 2011. *Developing Graduate Skills in HE Mathematics Programmes – Case Studies of Successful Practice*. MSOR Network.
2. Rowlett, P. (ed.), 2011. *HE Mathematics Curriculum Summit*. MSOR Network.

1. Maths Graduates: where are they now?

Skills Addressed:

Employment awareness • Self awareness and reflection

Noel-Ann Bradshaw

Department of Mathematical Sciences, University of Greenwich

Context

For several years the Mathematical Sciences department at the University of Greenwich has enlisted the help of the University's Guidance and Employability Team (GET) [1] to encourage students to apply early for jobs and to make the most of their experiences on their CV. However despite this many maths students at Greenwich remained unaware of the many and varied career choices on offer to them on graduation, did not understand how to respond to a competency style interview and were leaving job applications to the last minute.

Aware that our top graduates, having followed our advice, had successfully obtained positions with some of the county's top employers (Google, Hiscox, National Rail, Government Operational Research Service (GORS), etc.) we wanted to use their experience to enthuse our students.

This case study was inspired by 'Calculating Careers' initiated by Louise Walker at Manchester University [2].

Implementation (including barriers and enablers)

Using the Manchester case study as a model it was decided to hold an event in February that would be particularly convenient for second year students but also made available for first and final years as well.

Currently second year maths students undertake a core course in Operational Research which contains an element of Personal Development Planning (PDP). As part of this they learn how to write CVs and construct covering letters and personal statements. Traditionally an hour of this course has been given to GET to deliver information on graduate schemes. This year, however, this hour took the form of a training session for students to enable them to make the most of the forthcoming workshop in February.

Students were provided with an 'Employability Skills Guide' that we had compiled containing information and examples about the core competencies that employers are looking for. Students were encouraged to think about how they would answer competency based questions and consider suitable questions that they could ask the graduates.

Potential speakers were identified and contacted in October. Those who agreed to attend were: Petr Simecek (Civil Service); Justin Williams (Hiscox); Geoff Bunce (Rail consultant); Charlene Mliswa (PwC); Mike Wakeling (Bookatable.com); Alex Cole (applications for Google); Selvin Sunassee (Mindshare); Cordelia Osewa-Ediae (Adab Trust; on the value of Networking); Emma McEntee (on why to do a 2nd year placement); Sarah Bocus (teacher in Plumstead; was ill on the day and unable to attend).

Barriers

Despite being able to contact all these and other graduates on Facebook (without this it would have been very difficult to contact any of them) it was not easy to obtain their commitment to attend. Some found it hard to get their employer's agreement and others did not understand the importance of such an event and the need for advance planning.

Another problem was keeping the graduates' talks to time on the day. This meant that the session lasted much longer than it should have done and there was no opportunity for the panel discussion at the end.

Enablers

The graduates emphasised that the skills learned during the final year project course had been the most useful – this involved time management, report writing and presentation skills. They stressed the need to know how to use Excel and to do basic programming and they underlined the importance of attending extracurricular events and involvement in various projects to provide examples for answering the competency based questions. This was nothing new but the students appeared to hear it more effectively from people nearer themselves in age who had recently obtained their degrees.

Evidence and recommendations

This event had the largest audience of any event that the Maths department had previously hosted (academic and social), which suggested the value of holding it. It was attended by 70 in total including staff. Feedback was very positive but the following changes were suggested for next year:

- talks should be fewer or shorter or both;
- content should be less technical;
- the talk about 2nd year placements should have happened earlier in the year (we were aware of this but for various reasons this had not been possible to arrange).

There is a lack of evidence as to how much value the students placed on the Employability Skills Guide; this is something that will be addressed next year.

As a result of this project it has been suggested that we organise an employer mentoring scheme, which we will investigate. It was also suggested that one of the graduates (Justin Williams) should run a workshop on 'How to become an Actuary'; this took place at the end of March.

It is too early to tell what impact this event has had and will have on our graduate destinations but this is something that will be monitored. However the event was so successful and received such positive feedback that we are definitely planning to repeat it next year.

References / more information

1. *University of Greenwich Guidance and Employability Team*. Available via: www2.gre.ac.uk/current-students/emp/get [last accessed June 2012].
2. Walker, L., 2011. Calculating Careers. In: J. Waldock (ed.), *Developing Graduate Skills in HE Mathematics Programmes – Case Studies of Successful Practice*, MSOR Network, pp. 12-13.

2. Mathematical Presentation and Communication Skills within the Core Curriculum

Skills Addressed:

Written presentation • Thinking

Andrew Neate and Kristian Evans

Mathematics Department, College of Science, Swansea University

Context

Swansea University is a research-led university in south west Wales. It has a Mathematics Department consisting of 20 members of staff all of whom are engaged in research in pure mathematics. The department admits around 120 undergraduate students each year onto single and joint honours schemes.

First year mathematics students take four modules per semester, each of which gives a coursework assignment each week. Students receive themed support through fortnightly examples classes for each module as well as more general support through a weekly small group tutorial. The department has a Welsh language teaching fellow (Dr. K. Evans) and research student (N. Fry) who provide Welsh language support and tutorials for Welsh speaking undergraduate students. All such Welsh language provision is coordinated and overseen by Coleg Cymraeg Cenedlaethol which operates within the HE sector in Wales promoting teaching and research through the medium of Welsh [1].

As part of their education all mathematics students are expected to develop the ability to present a written argument precisely and succinctly. However it is difficult to find time within our mathematics curriculum to teach these writing skills in isolation. The traditional approach to this has been for students to absorb such skills from attending lectures and private reading. The department did not wish to reduce the mathematical content of our courses to make way for the isolated teaching of such skills so we have instead looked at ways to embed the acquisition of them within our traditional provision.

The importance of focusing on these study skills was highlighted in case studies 12 and 14 from 'Developing Graduate Skills in HE Mathematics Programmes' ([2] and [3], respectively). These had developed resources to help students with their writing and presentation skills but had also highlighted problems with getting students to engage with these activities. It was our intention to try and utilise these resources to get our students to start thinking about the importance of writing from the start of their time at university.

Implementation (including barriers and enablers)

We aimed to incorporate writing skills within the existing curriculum in three ways:

1. using examples classes during the first week of each semester to run workshop/lecture sessions focused on mathematical writing skills;
2. providing feedback on written presentation following each weekly coursework assignment;

3. providing access to existing resources via the university's VLE 'Blackboard' and providing translation of selected resources into Welsh.

The workshop/lecture sessions were structured to get students to complete selected activities from the study skills leaflets [4] and the leaflet '10 Ways To Think Like a Mathematician' [5]. One of the barriers highlighted in previous studies was trying to get students to engage with these activities. By providing a structured session in which students were expected to complete these tasks we could ensure greater participation. Emphasis was given to the importance of written presentation as a generic graduate skill that employers would value and as a way to help students improve their grades.

Another barrier identified previously was the reluctance of students to engage with activities that do not provide credit. To address this it was decided to provide a simple feedback on each coursework assignment. This was not used as part of summative assessment but was intended to provide an informal response and a continual reminder for students that they should be thinking about how they write. We did not wish for this feedback to provide a significant burden on staff time. As first year work is marked by postgraduate helpers working to ideal solutions, it was decided that they should provide the feedback. An additional section was added to our standard homework cover sheet giving a three point scale for written presentation (Poor, Good, Excellent).

Evidence and recommendations

The initial workshop sessions were very well received by our students. From the feedback they gave it was clear that many of them had never previously thought about how they presented their work. It was very useful to catch their attention with this at the start of their time at university. Many commented that they found the sessions very informative.

Feedback from staff running first year tutorials suggested that providing the presentation feedback was successful in focusing student attention on how they present their work and led to some students focusing on trying to improve their grades, even though these did not actually count for credit. However initial difficulties were experienced with consistency of the feedback. This was addressed by providing the postgraduate markers with additional training on what constituted good presentation.

Overall our approach has succeeded in raising student awareness of written presentation and we will repeat the exercise next year.

The Welsh language resources will be made widely available via 'Y Porth'; an e-learning resource available to Welsh medium students across Wales [6].

References / more information

1. *Coleg Cymraeg Cenedlaethol*. Available via: www.colegcymraeg.ac.uk [last accessed June 2012].
2. Houston, K., 2011. Writing Mathematics. In: J. Waldock (ed.), *Developing Graduate Skills in HE Mathematics Programmes – Case Studies of Successful Practice*, MSOR Network, pp. 34-35.
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4. sigma, 2009. *Maths Study Skills Leaflets*. Available via: http://www.sigma-cetl.ac.uk/index.php?section=102 [last accessed June 2012].
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6. *Y Porth*. Available via: www.porth.ac.uk [last accessed June 2012].

3. Progress Files — Greenwich Implementation

Skills Addressed:

Reflection • Organisation • Action-planning • Communication

Tony Mann and Steve Lakin

Department of Mathematical Sciences, University of Greenwich

Context

The proposer was impressed by the case study [1] and attended a workshop where the Progress Files system used at Sheffield Hallam University was demonstrated. This system allows students to record comments and reflections on their progress, to which tutors can respond by email using the simple interface built into the system. It was felt that this system would be of use at Greenwich to organise student logbook reflection and planning, since the Progress Files system presented a number of advantages over the more general system currently being used. It had the potential to be easier for students to use, to allow faster responses to students and to be much more convenient for staff in assessing student reflection on their studies.

Implementation (including barriers and enablers)

The implementation was delayed because of changed roles in the department at Greenwich. It had originally been intended to pilot the scheme in 2011/12 with final year students, but a change of personal tutor at a late stage meant that it was decided to introduce it for first year students instead, since that suited those staff who were familiar with the system. The plan was that first year students would use the Progress Files system for the Personal Development Planning (PDP) element of personal reflection and planning which is assessed as part of the core course 'Mathematical Technology and Thinking' [2].

The mechanics of implementing the system were straightforward for academic staff. However, because of the change of plan the system wasn't quite operational at the beginning of the academic year so the Progress Files system was presented to students as an essentially optional addition to the existing logbook.

Evidence and recommendations

A few students engaged whole-heartedly with the Progress Files, reflecting on almost every class every week. A significant number recorded a few reflections on each subject, and 66 (out of 120) recorded at least one comment, which, given that the activity was optional, exceeded our expectations. It was not only the strongest students who used the system.

Students showed considerable maturity in their reflections, making helpful suggestions and showing serious engagement with the content of their programme and willingness to share thoughts with their tutors. One student's mature and constructive critique of all our first year courses was particularly insightful. We have no doubt that the kind of reflection on their learning experiences that the Progress Files system encourages is of great benefit to students' learning.

Comments from students were largely favourable – not surprising since students knew that lecturers would be reading the comments and that they are not anonymous – but on occasion were very useful. For example, after one class where the lecturer felt those attending might have found the material difficult, the Progress File comments from a range of students were appreciative and showed a high level of understanding, reassuring the tutor.

The ability to respond quickly to student comments is particularly valuable. The speed with which this can be done means that tutors can engage with students and this facility helps engage students by providing quick feedback and encouragement. This helps students and staff get to know each other better. Since these are all factors which improve student engagement and retention, this aspect of the Progress Files system is particularly valuable.

Another major benefit of the Progress Files system, particularly compared with our previous systems, is that it makes it very easy for a tutor to read all the entries made by an individual student without having to open several different documents. Were this system to be used for assessing the PDP elements of our programmes, marking and delivering feedback could be much faster.

Students generally found the system easy to use and made comments like: “This makes me feel like my opinion is being heard”; “You can come back at a later time to see if you still think the same way”; and, “It helps me to reflect on what I’m doing and so I can improve on my understanding”. Some students were reluctant to engage because of bad experiences with reflective diaries at school or college and some had concerns about privacy. Others would have liked to see their fellow-students’ posts and one suggested a tagging facility for topics would be useful.

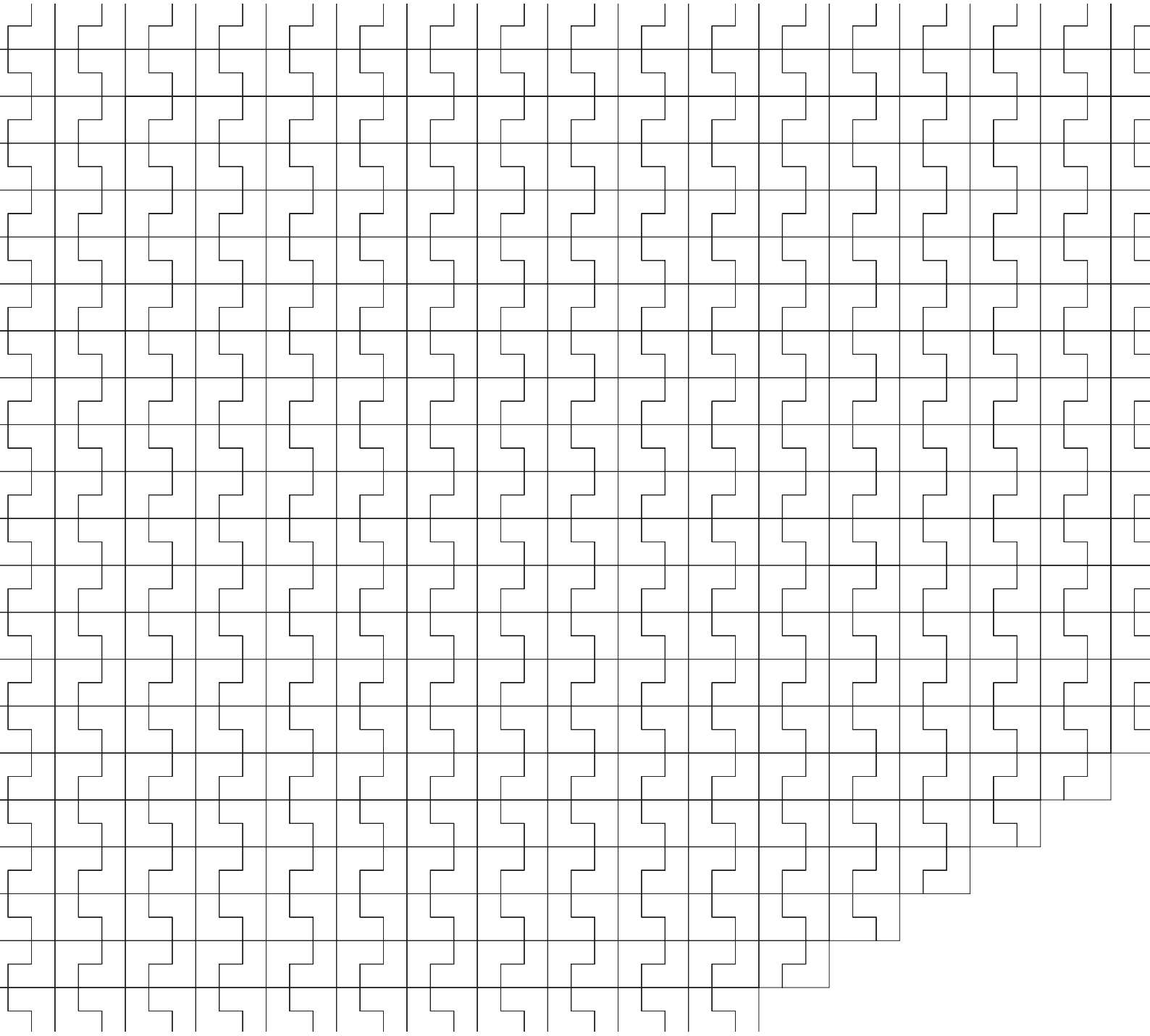
Because of the changes in staff roles, 2011/12 was treated as a pilot year for the Progress Files system at Greenwich. Our conclusion is that it has shown great potential, and we intend to use it more extensively from 2012/13, in particular making it the main channel for students to create their PDP logbooks. This will save staff time in marking and enable faster and more focused feedback, which will benefit both students and staff.

Our experience supports many of the comments by Waldock [1]: to be fully effective Progress Files must be embedded in the curriculum; there must be engagement from all staff; and there must be a tutor who champions the system. None of these three requirements were fully in place in our pilot implementation, with the consequence that the system did not fulfil its full potential. However our experience was sufficiently positive that we feel a fuller roll-out in the next session will derive even more benefits than achieved in the first year.

References / more information

1. Waldock, J., 2011. Progress Files. In: J. Waldock (ed.), *Developing Graduate Skills in HE Mathematics Programmes – Case Studies of Successful Practice*, MSOR Network, pp. 24-25.
2. Bradshaw, N., George, E., Lakin, S., Mann, T. and Ramesh, N.I., 2012. Breadth versus depth: a new first year module providing an introduction to the range of mathematics. In: D. Waller (ed.), *Proceedings of the CETL-MSOR Conference 2011, 5th-6th September 2011, Coventry University*, MSOR Network, pp. 28-32.

We are very grateful to Jeff Waldock for implementing his software for us and for his support, guidance and patience throughout. Peter Rowlett’s encouragement was also very valuable.



Part B: Maths-focused resources on improving students' communication skills

The HE Mathematics Curriculum Summit [1] recognised that (pp. 17-18)

> *the ability to deliver skills development may lie outside of the expertise of the mathematics specialists. However, the need to communicate is not a generic one; there is a need for students to communicate on mathematical subjects, especially to non-mathematicians.*

On the issue of how such skills might be developed, the Summit discussion reported that (p. 18)

> *there is a question of whether skills should be delivered through teaching or through the opportunity to practice. It is possible to allow the students to practice and provide feedback on the results, although if communication skills are so valued it may not be enough to let the students just try it without any extra training. If students are provided with regular opportunities to practice their skills, improvements should be observed, although such opportunities and associated feedback can be resource intensive to deliver.*

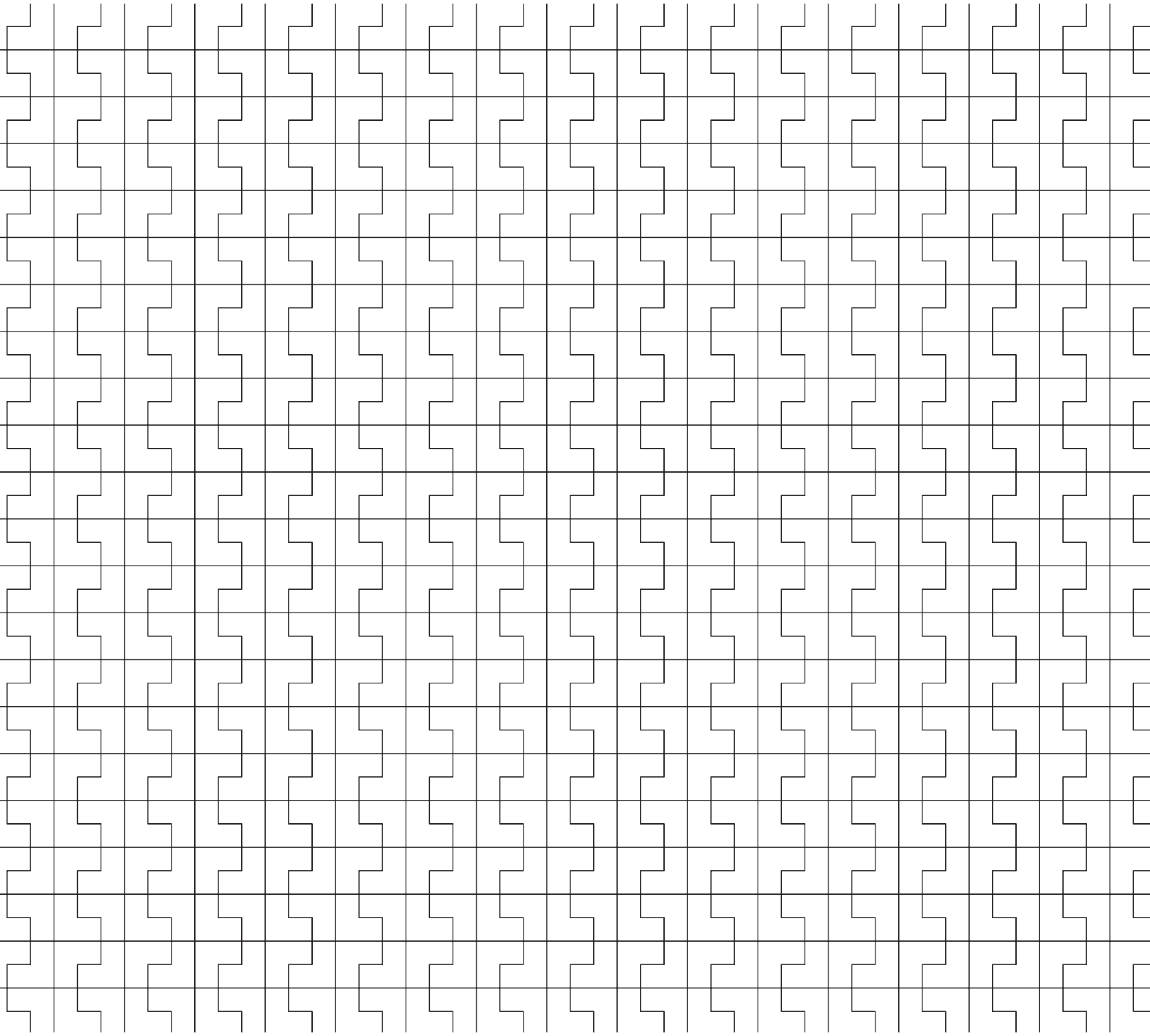
As a result, the Summit recommended as a curriculum development priority (p. 29):

> *Development of maths-focused resources equivalent to already published generic resources on improving students' communication skills.*

James Groves worked to develop an innovative approach to developing students' speaking skills and shared the resources his team developed. Kevin Houston builds on a case study from the original booklet [2] to collect good practice advice on writing mathematics.

References

1. Rowlett, P. (ed.), 2011. *HE Mathematics Curriculum Summit*. MSOR Network.
2. Waldock, J. (ed.), 2011. *Developing Graduate Skills in HE Mathematics Programmes – Case Studies of Successful Practice*. MSOR Network.



Enhancing the communication and speaking skills of mathematics undergraduates

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Background

The importance of developing the communication and presentation skills of mathematics undergraduates has long been recognised by both universities and graduate employers. The 2002 Roberts Review, commissioned by HM Treasury [1], observed that graduate employers value candidates' personal qualities and interpersonal skills; furthermore, "employers often regard SET graduates as being poor at applying and developing the knowledge and the skills that they have acquired" (p. 107). In the same year, Challis, Gretton, Houston and Neill [2] stressed that "professional mathematicians require good transferable skills, such as reading, writing, speaking and working with others, as well as subject-specific knowledge" (p. 79). They made a case study of the Common Skills Workshop offered to Mathematical Studies students at the University of Ulster, which focused specifically on developing oral and written communication skills through teamwork and the submission of a group project. Since 2002, considerable efforts have been made to enhance mathematics graduates' skills by the Maths, Stats and OR Network, part of the UK Higher Education Academy. The relatively high cost of delivering skills development courses has, however, tended to limit their reach.

The Department of Mathematics and Statistics at the University of Lancaster offers a credit-bearing module in skills development, MATH390 Project Skills, which is compulsory for undergraduate students on its major degree schemes. The majority of teaching for MATH390 takes place at the end of the students' second year of study; the students then research, write and make a presentation on a group project during the first term of their third year of study.

The results of the 2010 National Student Survey [3] were very positive for Lancaster's Mathematics and Statistics students, with the exception of the responses for communication and presentation skills. Only 55% of Mathematics and Statistics students agreed with Question 20, "My communication skills have improved," which was the lowest ranked question. The overall Question 20 result within the University was 80%. For Question 19, "The course has helped me to present myself with confidence," the result for the Mathematics and Statistics students was just 68%, which was lower than the overall Lancaster result of 78%.

The project

It was resolved to devise and deliver an enhanced course in communication and voice skills as an embedded element of MATH390. The course sought to develop five key skills in particular:

- the communication of ideas through speech;
- the vocal skills needed to speak effectively;
- the verbal description of quantitative data;
- the oral interpretation of diagrams and graphs; and,
- engagement with the audience.

The course was devised, written and delivered jointly by staff in the Department of Mathematics and Statistics and CETAD, the Centre for Training and Development at Lancaster. CETAD has experience of delivering courses on effective communication skills and presentation skills to a wide range of professional clients in the North West of England and is an Institute of Leadership

and Management (ILM) Approved Centre for corporate training. This was the first time that CETAD had worked with mathematics undergraduates.

The course

The course, titled Communication and Presentation Skills, sought to teach students how to present numerate information, at an appropriate level, to various kinds of audience. The sessions involved active participation by the students, with teamwork an essential element. Students were divided into four classes, with 27 in each class. Within each class, students formed themselves into six groups. Each class was taught by two tutors -- one from the Department of Mathematics and Statistics and one from CETAD. Each student participated in a sequence of learning sessions, taking place over three successive Fridays in June 2011, covering:

- What makes a good communicator?
- Formative assessment: given a previously-unseen article from a magazine, your group has two and a half hours to prepare and deliver a 5-minute presentation on the article. You may not use visual aids.
- What makes a good oral presentation?
- Summative assessment: your group has one week to prepare and deliver a 10-minute presentation on a mathematical result of your choice. You may use visual aids.
- What is teamwork?
- The learning cycle.
- Team exercise: coding and codebreaking.

This sequence of topics was designed by CETAD staff to provide a synthesis of the elements of Kolb's Experiential Learning Cycle [4] to support higher level learning. This process included maximising opportunities for peer and tutor small group discussions, both inside and outside of the classroom setting, recreating a basic version of T-groups [5].

Students had nine hours' contact time with tutors over the duration of the course -- three hours every Friday. The summative presentation marks contributed 10% of the students' overall marks for the MATH390 module. Feedback to groups on both their formative and summative assessments was given by a group of their peers (immediately following the presentations) and by their tutors (within a week of their presentations). Participants were encouraged to reflect on their performances and their feedback, identifying development points for them to work on. Participants were able to use their recently-acquired skills in mathematical typesetting using LaTeX, which they had been learning that month as another component of MATH390, to produce high quality slides for their summative presentations.

The team exercise on coding and codebreaking, devised by Department of Mathematics and Statistics staff, was created to highlight the benefits of collaborative work on mathematical problems. As the final part of the course it was designed to be an enjoyable -- but mathematically rigorous -- series of problems. In the task, each group used modular arithmetic and linear algebra to encode a short piece of poetry or prose. Each group had a different encoding key, represented by a three-by-three matrix with entries in the field of integers modulo 3. Encoded texts were passed to the group on the left, who were required to calculate the decoding key, represented by the inverse of the encoding key, and use this to decode the message.

Between June and November 2011 the students worked on their group projects. Each group made a 15-minute presentation on their project in November 2011, making use of the skills they had developed in the Communication and Presentation Skills course. The marks from the November presentations contributed a further 10% of the overall marks for MATH390.

Assessment methodology

CETAD staff devised detailed marking grids to assess both the formative and summative presentations. The marking process was designed to provide both group and individual rewards, and encourage group and individual responsibility, within the learning experience. This partly drove the need for group and individual practice, peer support, peer tutoring and peer feedback. Data provided by Glasser (cited by Biggs and Tang [6]) suggested that learning is more effective when you can apply it, and even more so when you apply what you have learnt in order to teach others.

Student feedback

Feedback from the participants on Communication and Presentation Skills was very encouraging. Of the 59 who completed a feedback form: 58 (98%) felt their presentation skills had improved; 43 (73%) rated the quality of the teaching "excellent", with a further 13 (22%) rating it "good"; and 34 (58%) rated the course overall as "excellent", with a further 21 (36%) rating it "good". Here is a sample of responses to the two free response questions:

- What were the most valuable aspects of the workshops?
  - *"Being forced to be confident";*
  - *"Showing how to work as a group";*
  - *"Preparing a presentation in a small amount of time";*
  - *"Receiving prompt feedback from assessments";*
  - *"Getting us to review what we had done";*
  - *"Having fun, light-hearted work".*
- How could the workshops be improved?
  - *"More information on what it is actually about beforehand";*
  - *"Be a bit more spread out over the year";*
  - *"More constructive feedback on presenting".*

One of the student representatives for the year group offered the following comments in February 2012:

> *"I found the presentation skills section of the module really helpful, but would have loved to have more than two weeks of my degree improving this skill, as I felt nerves and lack of support affected my final [group] project presentation. Maybe starting off in smaller groups, then moving to the larger groups for presentations, would have helped build confidence."*

Conclusions

Throughout the development of this project, emphasis was placed on the following as a basis for learning:

- the incremental development of communication skills;
- the importance of direct personal experience;
- regular peer and tutor feedback; and,
- opportunities for reflection.

The Communication and Presentation Skills course was felt to have been very successful and will be repeated – using the same staff – in June 2012. The Department of Mathematics and Statistics is now considering how the other component courses of MATH390 Project Skills could be enhanced.

Acknowledgements

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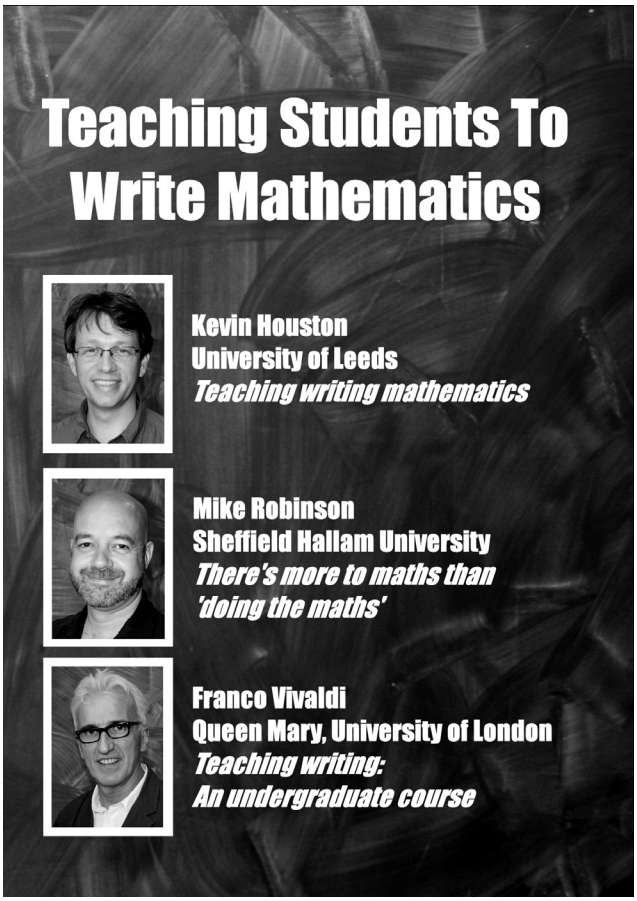
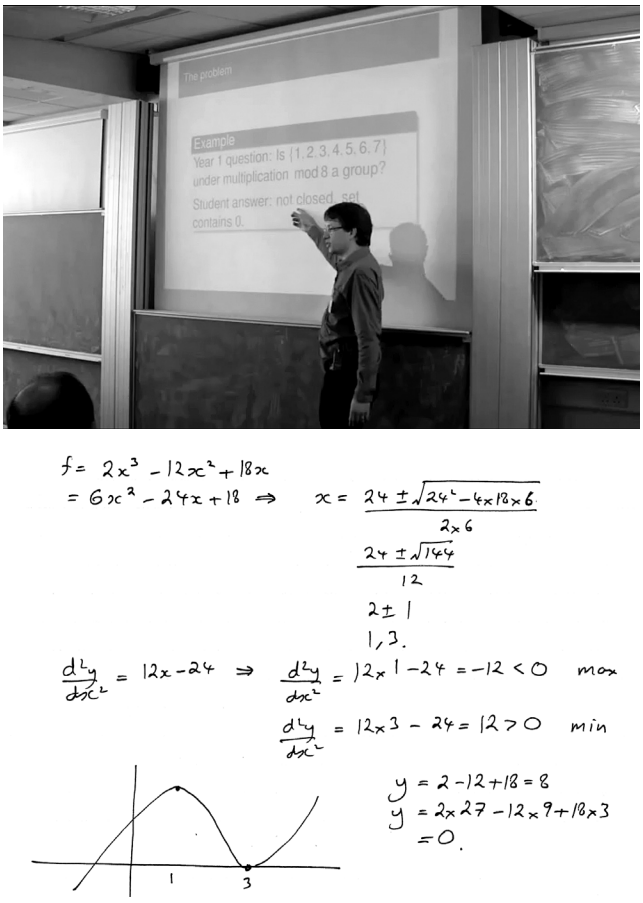
Teaching Students To Write Mathematics.

A DVD produced and edited by Kevin Houston.





Students don't write mathematics correctly. They throw down a mess of symbols with the answer underlined at the bottom and rely on the examiner's intelligence to get the marks. Teaching them to write in a more orderly and logical way has numerous advantages: it makes marking easier; allows students to demonstrate understanding (or not); and forces an improvement in their thinking skills. Expressing their ideas clearly and correctly is a valuable skill for graduates in further study, employment and life in general.

The original booklet, 'Developing Graduate Skills in HE Mathematics Programmes – case studies of successful practice', included a case study from Kevin Houston at the University of Leeds on mathematical writing and linking this to mathematical thinking. Kevin subsequently convened a workshop on this topic including talks by Kevin Houston (University of Leeds), Franco Vivaldi (Queen Mary, University of London) and Mike Robinson (Sheffield Hallam University). Sessions were recorded and made available with further reading and sample teaching resources via a DVD and online. The three recorded talks describe this important and current topic and feature a mix of practical advice and stimulating theory.

The DVD-ROM content contains the presentation slides, further reading and sample teaching resources. You can watch the videos and download the extra content, or download a copy of the DVD you can burn to disc yourself, from www.kevinhouston.net/dvds/writing-math.html

An original case study collection published in 2011, '*Developing Graduate Skills in HE Mathematics Programmes – Case Studies of Successful Practice*', offered exemplars of ways in which graduate skills had been successfully developed through curricular initiatives. Three projects reported here develop the earlier good practice – around employment awareness, presentation of written work and reflection and articulation of skills – and provide evidence that this can be transferred to new circumstances.

Even though the ability to deliver skills development may lie outside of the expertise of mathematics specialists, the need to communicate is not a generic one; there are specific issues in developing students' ability to communicate on mathematical subjects. Two projects develop maths-specific advice and curriculum resources around developing students' speaking and writing skills.

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