# Queen Mary ADEPT Fellowship Scheme

# The Account of Professional Practice

# Fellow Application

|  |  |
| --- | --- |
| Name | Professor Bill Jackson |
| School/Institute | School of Mathematical Sciences |
| Date | 5 September 2016 |

## Evidencing A1: Design and plan learning activities and/or programmes of study

|  |
| --- |
| I have been teaching mathematics at the University of London since 1980, first at Goldsmiths (1980-2002) then at Queen Mary (2003-present). During this time I have taught a wide range of undergraduate mathematics courses in such areas as algebra, combinatorics, operations research and probability. I have also taught post-graduate courses in combinatorics and algebra, and successfully supervised six PhD students. In addition, I have held several teaching related administrative roles: Chair of Mathematics Exam Board and person in charge of the department's TQA submission while at Goldsmiths; Chair of exam boards and course leader for courses in graph theory and operations research for the University of London External Degree Programmes in both Mathematics and Computing and Information Systems in the 1990's; Programme Director for both the Mathematics and Pure Mathematics degree programmes at Queen Mary.  My area of research is graph theory and I have designed and taught several modules in this area throughout my career. It is an ideal topic for a level 6 module in mathematics since it is both elementary (in the sense that it does not require a large amount of background knowledge) and challenging (since the techniques and ideas used to analyze graphs require mathematical sophistication). Graph theory studies mathematical structures which can be represented as figures consisting of points in the plane, some of which are joined by lines. (K1) Such figures can be used to give a very visual illustration of the concepts. I have used this to good effect in my teaching by including many figures in notes and lectures and encouraging students to work on problems by first drawing their own figures to get on understanding of the problem they are working on before translating this understanding into a reasoned solution. (K2,K3) This enabled me to make the graph theory modules more concrete and approachable than many other level 6 modules in mathematics. The last time the module was offered, it had an overall quality index rating of 98.8% on the student module evaluation forms, which was the fourth highest amongst the 23 level 6 modules offered by the school. Some specific comments from the evaluation forms are:  “In 3 years it is the best module I have done”; “Love the module, one of the best courses”; “Interesting module, easy to understand”; “I think this is my favourite module”.  (K4,V1,V2)  I also designed the modules to emphasize the fact that graph theory is a relatively new branch of mathematics which has expanded greatly since the 1950's because of its many applications in computer science and operational research. Many such applications are included in the modules: theoretical results are used to derive efficient algorithms for solving real life problems such as finding shortest paths between two locations in a road network or finding the maximum flow between two terminals in an electrical network. In addition estimates are obtained for the maximum amount of time a computer will take to solve any particular instance of these problems. (K1,V4) These applications made the modules more appealing to students who did not wish to become specialized mathematicians when they graduated. (K2, K3, V1)  I designed and taught my first module in this area 'Graph Theory' in the mid 1980's when I was at Goldsmiths College and it soon became a popular option in the BSc Mathematics and BSc Mathematics and Computer Science programmes. I designed a second module 'Algorithmic Graph Theory' for the University of London External BSc programmes in both Mathematics and Computing and Information Systems in the mid 1990's. I introduced a third module, also entitled 'Algorithmic Graph Theory' into the Mathematics programmes at Queen Mary in 2008 and it again became one of the most popular level 6 options run by the School of Mathematical Sciences. The last time the module was offered, it had the second highest number of students amongst the 23 level 6 modules offered by the school. A version of the online notes for this module when it was last taught at Queen Mary can be found at <http://www.maths.qmul.ac.uk/~whitty/MTH6105>.  The course I designed for the University of London External BSc programmes required me to prepare detailed course notes which could be understand independently from lectures. I used similar notes for the courses I taught at Goldsmiths and Queen Mary and students found these to be very helpful. The popularity of all of these courses, good exam results and positive feedback from the students evidenced the effectiveness of the course design.  In summary I believe that most, if not all, students find it very helpful to have a visual image to illustrate an abstract idea or argument. It is easy to do this in graph theory or geometry modules but we should also try to provide as many figures as possible in other more abstract modules. I also believe that giving examples of how the mathematics we teach is used in the real world can make the subject more interesting to many of our students. However, we need to keep in mind the following point made by Kaminski, Sloutsky and Heckler (2008, p.455):  “If a goal of teaching mathematics is to produce knowledge that students can apply to multiple situations, then presenting mathematical concepts through generic instantiations, such as traditional symbolic notation, may be more effective than a series of “good examples.” This is not to say that educational design should not incorporate contextualized examples. What we are suggesting is that grounding mathematics deeply in concrete contexts can potentially limit its applicability”  As a mathematician I agree wholeheartedly that the power and usefulness of modern mathematics is based on the fact that an abstract theory can be applied and used to solve many different problems (which become particular instances of the general theory). However to get most students to buy into the abstract approach, it is fundamentally important to give them sufficient examples of applications so that they can see the power of the abstract theory. |

## Evidencing A2: Teach and/or support learning

|  |
| --- |
| I have taught the level 4 module MTH4100 Calculus I at Queen Mary for the last three years. This is a large module with about 300 students. The teaching component consists of 3x11 one hour lectures to the whole group, and 1x10 one hour exercise classes to groups of about 30 students. In addition I have one scheduled office hour every week when students can ask me questions on a 1:1 basis. (K2, V1, V2)  I found it challenging to ensure that the students remained involved in the module until the end of the course. Many of the students had already seen a significant amount of the material in this module at A-level. The module aims to ensure that the whole cohort have the same background in basic calculus, and to reinforce this material by presenting it in a more rigorous way than at school. An associated danger is that students could resent the fact that the module makes them question ideas and concepts that they took for granted at school. (V4) I used a mathematical package called `MyMathLab' to help to get round this. (K2,V1) Students are required to purchase this software together with the course text book `Thomas Calculus' at the beginning of the module. They are given weekly online exercises to do using this software which revises basic school calculus and links it to the material covered in lectures. The software provides hints and/or links to the relevant section in an an online copy of the text book if they get stuck on a particular problem, and assesses their progress throughout the module. Most students find this very useful and it was frequently mentioned in the student module evaluation questionnaires as one of the best things about the module. One student remarked:  “Use of MyMathLab provides more practice for this module. Furthering our knowledge from what we learnt in A-level.”  (K3, K4, V2)  I have found that the best way for me to communicate in a lecture to such a large group is to present a skeleton of the lecture as slides shown on the digital projector and supplement this by writing supplementary material such as proofs or examples on the white board. (K2,K4) I make the slides for a particular week available online at the beginning of the week and then put full lecture notes online at the end of the week. When I first gave the module I tended to put too much material in the slides. As a result the students became too passive and lost interest. I now make the lectures more interactive by frequently asking them to tell me what to write on the white board at particular stages in a proof or example. (K3, K4,V1) As noted by Walker, Cotner, Baepler and Decker (2008, p.361) :  “Results demonstrate that students perform as well, if not better, in an active versus traditional environment.”  The activity of constructing proofs and examples in real time on the white board also shows the students that mathematics is something which can be created on the spot rather than having to be remembered off by heart from textbooks. (V1,V2) As Brown (2007a, p.26) states,  “Mathematics is a developing language for description, deduction, verification and calculation”  Online slides and lecture notes for MTH4100 can be accessed at <http://qmplus.qmul.ac.uk/course/view.php?id=3270>  Exercise classes are used to support the material presented in lectures. They consist of relatively small groups of 20-30 students and are run by a tutor who is either another member of staff, a postdoctoral research fellow or, most commonly, a PhD student. (K2,V1)  I used the standard departmental model for exercise classes in the first year that I taught the module. This entailed putting an exercise sheet online each week, the questions would be discussed in the exercise class of the following week and students would hand in their solutions to one specified question on the exercise sheet during the same class. (The marked coursework would be returned to the students with feedback in their next class and I would put model solutions to all the questions on the exercise sheet on the module web page in the same week.) I found that this approach to the exercise classes did not work. Attendance to the classes tailed off drastically during the semester. Many students would only look at the one specified question on each exercise sheet (comforted by the fact that they could read my online solutions to the other questions later) and ignore the rest. (K3,K5,K6) As a result they only gained a very superficial understanding of the material covered by the exercise sheets. This led to them loosing track of what was going on in lectures and then losing interest in the module (as was evidenced by falling attendance to lectures, responses to student questionnaires and final exam results). (K3, K5, K6, V3)  I have adopted a different system for the exercise classes for the last two years. I put an exercise sheet online once every two weeks, students attempt to solve all the problems on the sheet for themselves, but can ask their tutor for help in the exercise class of the following week. They are then tested on their solution to a randomly chosen question from the exercise sheet in the next exercise class. In addition, because the tests take place under exam conditions, I can give coursework marks for these solutions which count towards the overall mark for the module. This has greatly increased student involvement in the module and maintained a good attendance at both lectures and exercise classes right up until the end of the course. (K2, V1, V2, V3) As Walker et. al. (2008, pp 354, 365) note  "We attribute good attendance to the use of frequent (n=15) unannounced quizzes"  and  “Research shows that first-year students in particular are more receptive to active-learning techniques, so proper introduction of their value seems imperative to capture the enthusiasm of all students”  I believe the exercise classes and exercise sheets give important learning support for this course and it is vitally important that students use these to support their active learning experience. The system of mini-tests I introduced encouraged them to do this. Many students acknowledged this in conversations with myself and other tutors. |

## Evidencing A3: Assess and give feedback to learners

|  |
| --- |
| The module MTH4100 described in section A2 has both summative and formative assessment. The first year I taught the module the summative assessment consisted of a mid-semester test which students took online using the MyMathLab software which counted 10% towards the final mark and an end of year exam which counted 90%. The formative assessment was made up of 10 weekly written courseworks which consisted of one question from the weekly exercise sheets. These were marked by the tutor for each exercise class and returned to the students with feedback the following week. In addition I set a weekly online coursework using MyMathLab which students used to assess their progress and which gave them online feedback if they got stuck.  Unfortunately this system of assessment did not work as well as it sounds. Many of the students did not take the formative written coursework seriously. They handed in badly prepared solutions and disregarded the feedback given by their tutors. (K5) The fact that the mid-semester test counted towards the final mark and was conducted using MyMathLab encouraged the students to concentrate on the online MyMathLab coursework instead. (K3) As a result they did not develop the skill of expressing themselves clearly in writing and struggled when they were required to do this in the final exam. The fact that there was no summative assessment after the mid-semester test until the final exam (which took place 5 months after the module finished) meant that a significant number of students stopped making any serious attempt to be involved in the module after the mid-semester break. (K3)  I improved this situation by replacing the online mid-semester test component of the summative assessment by the five written mini-tests described in section A2. This completely changed the students’ perception of the written coursework. (K2) This made them appreciate that the written coursework is a fundamentally important part of the module. They paid much more attention to the feedback they got from their tutors so they could understand why they lost marks on a particular mini-test and do better on the next test. (K3,V1,V2) There was very little drop off in attendance at lectures and tutorial classes after the mid-semester break and students were much more involved throughout the module. (K4, V4)  In summary I believe that solving problems is essential for a student to understand the mathematics we teach and that both formative and summative assessment are valuable ways to encourage students to do this. Many of our students, however, particular those in the first year of their studies, are not mature enough to recognise this value if the assessment is purely formative. As Brinkworth, McCann, Matthews and Nordstrom (2009, p.168) note:  “Student responses in the study presented here indicates that a successful transition is not solely due to academic ability, but depends also on an ability to make a rapid adjustment to a learning environment that requires greater autonomy and individual responsibility than students expect upon commencement.”  For students struggling to cope with this transition, there also has to be an element of summative assessment associated to coursework for them to take it seriously. Gibbs and Habeshaw (1992) propose two key points to keep in mind when setting coursework:  “students are driven by assessment” and “students learn well by doing”.  I completely agree with this. It is impossible for students to understand mathematical concepts by purely passive learning. The have to be actively involved in solving problems for themselves to get a true understanding of what is going on. And I believe that for many students, especially those in the first year of their studies, summative assessment is an important tool in convincing them that they should do this. |

## Evidencing A4: Develop effective learning environments and approaches to student support and guidance

|  |
| --- |
| I use three different learning environments for the module MTH4100: lectures to 300 students in a large lecture theatre; exercise classes to 30 students run by a tutor; online self-learning using the MyMathLab software.  I described my use of a mixture of slides on the digital projector and written examples on the white board in lectures in section A2. The benefits of this are that the slides give a fixed clear structure to the lecture and the writing keeps the students involved and allows me to improvise depending on the student reaction. The disadvantage is that there is a danger that the written notes taken by the students from the white board may lose their connection to the relevant slide. I alert the students of this and tell them to take care to record the title of the slide each example refers to. If they forget to do this, they can reconstruct the link from my online lecture notes. (K2, K3, K4, V1, V2)  I use exercise classes as an opportunity for students to solve questions from the fortnightly exercise sheets and discuss these solutions with each other and with their tutor. I have a problem based view of mathematics: I believe that the *only* way students can understand a particular topic is by solving problems on this topic for themselves. Attending lectures and reading solutions to problems from my notes or a text book gives at best a very superficial understanding of what is going on. So I see it as essential that the students are encouraged to work on the problems on the exercise sheet. I do this by using 5 mini-tests based on the exercise sheets as described in section A3. (K2, K3, K4, V1, V2, V4)  I use the MyMathLab software as a support tool to help students revise their A-level mathematics and link it to the more rigorous approach adopted in this module. Its advantages are that it provides a vast number of online problems and exercises the students can work on and provides hints and links to the relevant sections in the online text book if they get stuck. A big disadvantage is that it can only assesses the final solution to a particular problem. It does not encourage students to express their ideas logically or to remember definitions or statements of results from the module, let alone write a proof. As such I think it is a useful tool especially for the weaker students, but it would be a mistake to put too much emphasis on its use and give students the impression they are doing well in the module just because they can solve the set exercises on MyMathLab. (K2, K3, K4, V1, V2, V4)  In addition to the above, I have one scheduled office hour every week when students who are struggling can ask me questions on a 1:1 basis. I am also available to answer questions by email, although I believe this is no replacement for a 1:1 discussion and my response to an email inquiry will often be that the student should come to my office hour or make a separate appointment to see me in person. I find these meeting to be useful not only for the student but also for myself as they influence both my choice of material and the way it is presented in future lectures and exercise sheets. For example it became clear from 1:1 meetings that many students struggled to draw graphs of functions. They relied on mathematical software on their i-phones or laptops to do this for them and did not develop the important skill of graph drawing and the resulting appreciation of how calculus can be used to give us a pictorial view of how a function behaves. I improved the situation by spending more time in lectures working out how to draw graphs in real time on the white board and making sure the students gave input into this process. I also put more emphasis on graph drawing in the exercise sheets and made it clear to the students that there would be a question on graph drawing in the final exam which would carry a significant number of marks (25%). Solutions to this question in the 2016 final exam were a big improvement on previous years. (K2, K3, K4, K5, V1, V2, V3) |

## Evidencing A5: Engage in continuing professional development in subjects/disciplines and their pedagogy, incorporating research, scholarship and the evaluation of professional practices

|  |
| --- |
| My professional development as a mathematics lecturer has evolved over the last forty years by observing good (and sometimes bad) practice used by other lecturers, and through discussions with colleagues, students and school teachers.  The first influence was my experience as an undergraduate student at Imperial College, London and a postgraduate student at Queen's University and the University of Waterloo in Canada in the 1970's. I learnt to appreciate how important it is to present material clearly and at a pace at which students can understand, and to communicate what is important and exciting about the material being presented. (K2,V1,V2)  My first teaching position was at Goldsmiths College, London. It was a small Mathematics department but contained several exceptional lecturers who had a strong influence on the way I teach. They taught me how important it is to make lectures an interactive experience. The idea of using mini-tests based on exercise sheets to increase student involvement in a course came out of discussions between colleagues in the department at Goldsmiths. I was in charge of the department's Teaching Quality Assessment (TQA) submission and subsequent TQA visit to Goldsmiths in the mid-1990's. This forced me to review the teaching and student support system used by the department both with colleagues in the department before the visit and with members of the TQA assessment team during the visit. The report from the visit was very positive about the teaching carried out in the department. One of the assessors remarked that the lectures he observed would have a very positive influence on the way did his own teaching. (K2,K3,K5,K6,V1,V2,V3)  I have continued to discuss teaching with colleagues at Queen Mary, both through frequent informal discussions and through the more formal peer review and appraisal systems. My teaching has also been informed by student feedback from the course questionnaires and the staff-student liaison committee. An example of this from the 2015/16 academic year is that students expressed a need for a more structured approach to the exercise classes in MTH4100. After discussion with the tutors, I decided to set an example question for each class. The tutor would go through this on the board with the help of the students at the beginning of the class, and the students would then be left to do the other questions themselves, asking for help from the tutor if they got stuck. I have attended several teaching related courses, on such topics as advising students and QM+, while at Queen Mary and participated in workshops designed to improve teaching quality within the School of Mathematical Sciences. I am currently part of a discussion group tasked with improving the progression rate of maths students between the first and second years of study. (K2,K3,K5,K6,V1,V3)  I have had the opportunity to discuss teaching and in particular the problems faced by students in the transition from school to university with several school teachers. My first PhD student was a school teacher who returned to university to do an undergraduate degree and then stayed on to do a PhD. I have been on several school visits while at Queen Mary and also gave talks to teachers as part of the Goldsmiths programme. I participated in a three week graph theory conference at Rutgers University in the 1990's which was attended by a mixture of university researchers and high school teachers and whose aim was to discuss ways of introducing elements of graph theory into high school maths classes. I am co-organiser for a similar meeting on distance geometry at Rutgers in July 2016 and will give one of four tutorial lectures to introduce the subject to the teachers. Discussions with teachers have reinforced my belief that the first semester a student spends at university is fundamentally important to their studies. We need to keep a close contact with new students through personal advisors/tutors to give them good study skills and to make sure they are coping. We should aim that students will become independent learners as they progress through their degree programme but we cannot expect them to be able to function independently when they first arrive. (K3,K6,V1,V2,V4)  **Bibliography**  Brown, R. (2007a). Promoting Mathematics, *MSOR Connections*, 7(2): 24-28.  Brinkworth, R., McCann, B., Matthews, C. & Nordstrom, K. (2009). First year expectations and experiences: student and teacher perspectives, *Higher Education,* 58(2): 157-173.  Freeman, S., Eddy, S., McDonough, M., Smith, M., Okoroafor, N., Jordt, H. & Wenderoth, M. (2014). Active learning increases student performance in science, engineering, and mathematics, *Proceedings of the national academy of science,* 111(23): 8410-8415.  Gibbs, G. & Habeshaw, T. (1992). *Preparing to teach: An introduction to effective teaching in higher education,* (2nd ed.), Technical & Educational Services.  Kaminski, J., Sloutsky, V. & Heckler, A. (2008). The advantage of abstract examples in learning math, *Science,* 320: 454-455.  Messineo, M., Gaither, G., Bolt, J., & Ritchey, K. (2007). Inexperience versus experienced students, expectations for active learning in large classes. *Coll. Teach.* 55: 125-133.  Walker, J., Cotner, S., Baepler, P. & Decker, M. (2008). A delicate balance: integrating active learning into a large lecture course, *CBE-life sciences education,* 7: 361-367. |

Appendix – the dimensions of the UKPSF

|  |  |  |
| --- | --- | --- |
| **Areas of Activity**  (A1) Design and plan learning activities and/or programmes of study  (A2) Teach and/or support learning  (A3) Assess and give feedback to learners  (A4) Develop effective learning environments and approaches to student support and guidance  (A5) Engage in continuing professional development in subjects/disciplines and their pedagogy, incorporating research, scholarship and the evaluation of professional practices | **Core Knowledge**  (K1) The subject material  (K2) Appropriate methods for teaching, learning and assessment in the subject area and at the level of the academic programme  (K3) How students learn, both generally and within their subject/disciplinary area(s)  (K4) The use and value of appropriate learning technologies  (K5) Methods for evaluating the effectiveness of teaching  (K6) The implications of quality assurance and quality enhancement for academic and professional practice with a particular focus on teaching | **Professional Values**  (V1) Respect individual learners and diverse learning communities  (V2) Promote participation in higher education and equality of opportunity for learners  (V3) Use evidence-informed approaches and the outcomes from research, scholarship and continuing professional development  (V4) Acknowledge the wider context in which higher education operates, recognising the implications for professional practice |