Mathematics and Statistics Support Centres: Resources for training postgraduates and others who work in them

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Abstract

This article provides a rationale for the focused training of postgraduates (and others) who work in mathematics and statistics support centres. It outlines a format for training that has been found to work well through workshop-style events run at universities around the country over the last five years. Within any form of training there are important topics for discussion and a wealth of resources freely available for those centre managers who wish to develop training for their own tutors. Tutors are in the front line of tackling the lack of confidence and skill deficits of students who arrive at support centres looking for help; tutors who are well-briefed in terms of the challenges they are likely to face and how they can best respond to students who are finding university mathematics and statistics particularly difficult will help to ensure that the services offered genuinely contribute to enhancing the student experience. While training for new mathematics support tutors is important, of equal, if not greater importance is identifying tutors with the right skills and abilities to work in mathematics and statistics support. We conclude by considering the recruitment of postgraduate tutors and by undertaking a brief discussion about the value of training to the tutors themselves including contribution to professional recognition that is gaining increased importance. Further sources of information can be found within Croft and Grove (2011) which forms a training resource pack, Croft *et al*. (2013) and in the resources section of the **sigma** network website (www.sigma-network.ac.uk)[1] which includes PowerPoint slides and training activities that can be used in, or adapted for, workshops.

The rationale for providing training

The majority of universities in the UK now offer some form of additional learning support to students (Perkin, Croft & Lawson, 2013), often through Mathematics and

[1] The **sigma** Network is a HEFCE-funded collaborative venture to build a community of practice for those working in mathematics and statistics support. Anyone working in the field is encouraged to get in touch and contribute to its activities.

Statistics Support Centres. These centres offer facilities and services to students to help them build confidence, address skills gaps and offer opportunities that complement students' traditional diet of lectures, tutorials, problems classes and personal tutorial sessions. This supplementary support is designed to be supportive, non-threatening and non-judgemental. It is a realistic response to the well-documented day-to-day reality in most universities of significant numbers of students who find themselves ill-prepared for the mathematical demands of their courses.

Many mathematics support centres make extensive use of postgraduate students working as tutors. Providing mathematics support is not the same as the routine tutorial support that many postgraduates undertake as part of their own programmes of study and for which training, typically at an institutional level, may have already been provided. Amongst the reasons for this difference are:

- Tutors are unlikely to know in advance who the students are, the departments they have come from, or the level they are studying at.
- Tutors are unlikely to know what, or indeed how, the students should have been taught and what they should have already learned.
- Students may be from departments that are not traditionally taught mathematics modules (for example geography and business studies) and may be alienated, intimidated and nervous.
- Some students are likely to present with statistical as opposed to mathematical problems and tutors need to be aware that offering statistics support differs in important ways from offering mathematics support.
- The students may be poorly prepared for what is expected of them due to mismatches between the mathematical or statistical demands of their courses and entry requirements.
- Some students may have additional needs that may or may not have been declared.
- A student's perception of the mathematics support service may be based on a single interaction with the tutor, as opposed to that which can be developed over time through weekly tutorial sessions.

When postgraduate students offer routine tutorials for specific modules:

- They will have contact with the lecturer who has taught the module and can discuss their expectations and requirements of them.
- They will usually have advanced sight of problem sheets, for which solutions are

likely to have been provided, and can prepare accordingly. Further they have access to lecture notes and indeed the lecturer should queries arise.

- The expectations on tutors are tightly constrained by the module, i.e. they will be aware of pre-requisite modules and may well be based in the same department as the students they tutor.
- Students and tutors can get to know each other in a tutorial group situation and develop a rapport. Building such a relationship is not as straightforward in a support centre environment when students might meet different tutors at different times.

With these differences in mind, support centre tutors will benefit from a training session that explores:

- The rationale for mathematics support and how it is implemented including awareness of the various models in use throughout UK universities.
- The ethos of their own centre and the importance of being excellent ambassadors for the service.
- The types of students who might use the centre, the courses they are studying, the level they are working at.
- An awareness of students' different learning styles and specific learning differences.
- Strategies to adopt when problem solving in the support centre, and in particular what to do in the event of being unable to solve a student's mathematical problem.
- The broad range of issues that might arise including welfare, plagiarism, students seeking help with coursework assignments, and ethical issues.
- To whom they should turn for help and advice.
- The extensive range of existing resources and materials that are available to help them in their role.
- How they might use their experience towards professional and career recognition.

A model for postgraduate tutor training

Through **sigma** a comprehensive range of freely available resources have been developed for centre managers (and others) to use as the basis for local training of postgraduates using a workshop format. Furthermore, a Guide (Croft & Grove, 2011) has been written specifically for postgraduates who tutor in mathematics support centres and is available for free download. The format of this Guide mirrors the

structure of the workshops that have been run successfully in the years since 2010 and has involved adapting a format first introduced very successfully by the Maths, Stats & OR Network in 2005 (Grove, Kyle & Cox, 2006) that was applied to postgraduate students who demonstrate mathematics. The format of a typical day-long workshop is shown in Figure 1.

1030-1045	Welcome and introductions
1045-1130	Mathematics support – what is it?
1130-1230	Problem solving
1230-1300	Principles of maths support – do's and don'ts
1300-1330	Lunch break and networking
1330-1400	Offering statistics support
1400-1430	Tutoring in the mathematics drop-in centre – awareness of individual differences and needs
1430-1530	Group activity – exploring various scenarios
1530-1600	Resources and networking with others
1600-1630	Question and answer session

Figure 1: Timings and structure for a typical postgraduate tutoring workshop

Figure 2: A typical postgraduate tutoring workshop in progress

Experience suggests that, ideally, the workshop should be delivered by at least two members of staff with experience of delivering mathematics support. Where possible, additional staff with specific expertise (for example a statistician or an additional needs tutor) can be engaged to run, or assist with, specific elements. It is also valuable to invite delegates from several different institutions so that they all learn from the experiences of their peers working in different environments and with different models of mathematics support. Experience suggests that a total group size of 20-30 is optimal; with too few tutors present the interactions and discussions will be hindered. Grouping delegates in sets of four or five has also been found to work well, particularly when asked to discuss the questions or scenarios posed.

Here we discuss briefly the key features of each of the sessions of Figure 1. This provides additional information based upon our experiences of delivering such sessions, but is naturally complemented by the additional detail that can be found within the Guide of Croft and Grove (2011).

Welcome and introductions

During this brief session delegates are asked to spend a few minutes considering what they want to learn/gain from the day, and at least one question they hope will be answered. They are invited to write these down on Post-it notes that they either retain for later reference or share with others straightaway on a communal board. Examples of questions noted at previous events include:

- *How can we backtrack, and un-confuse a student when a first attempt at an explanation is too complex?*
- *What do I do if I think a student has been told the wrong technique or something is just plain wrong in their notes?*
- *How do we advise students about presenting their answers well?*
- *What if I myself am not sure of the problem or I make mistakes?*
- *How do I divide up my time between all the students who need help?*
- *What is the best approach to helping the "here's my page of algebraic manipulation – where have I gone wrong?" type question – when pressed for time this is the hardest type of question!*
- *How do we approach helping with coursework?*

Here the purpose is not to answer these questions, but to use this session as a means of

generating interaction with the tutors that is critical for the success of the day. It is also particularly helpful for identifying any common issues that may be related to, for example, the specific model of support provided by a particular institution.

Mathematics support – what is it?

Again, to stimulate the necessary interaction with both the workshop leads and between tutors, the following questions have been posed for delegates to discuss in their small groups:

1. *What do you think mathematics support is and why might it be necessary now?*
2. *What is a 'mathematics (and/or statistics) support centre'?*
3. *What do you know about the nature of mathematics support in your institution? Who can access it? Where is the support offered and when? Are academic staff available for consultation where necessary?*
4. *What do you think is the role of you as a tutor in your mathematics support centre?*

The remainder of this session takes the form of interaction between the small groups and the whole and the workshop leads to share thoughts and ideas and build discussion. To aid the structure, a PowerPoint presentation is used to share the thoughts of the workshop leads in response to the above questions, however, this again is a basis for stimulating discussion and idea development rather than didactic presentation.

Mathematics support refers to activities and resources provided to support and enhance students' learning of mathematics and statistics, in any discipline, at any level of higher education and which are provided in addition to traditional lectures, tutorials, examples classes, personal tutorial sessions. Whether this definition is appropriate for the delegates when they are considering their own institution, and in particular whether the local support is available to students in any discipline and at any level, is usually a good starting point for discussion. We have met tutors who only work to support students in a management or business school for example, and others who work in centres where the support is only available to engineers. Experience can be very varied and it is useful for all present to hear about the range of models in use. Tutors usually recognise that this support is informal, not credit-bearing, voluntarily accessed, and should be supportive and non-threatening. Others have suggested that it provides alternative approaches to problem solving and helps develop independent learning

(through the discussion of strategies and techniques for problem solving as well as the range of resources available for independent study), and that this is a skill those working in support centres should aim to instil in students.

Discussion about why support is perhaps required more now than ever before enables the workshop leads to present information about:

- *"The mathematics problem*" in terms of insufficient numbers of students studying mathematics post-16 in the UK and the lack of preparedness for the demands of mathematics at university (Hodgen *et al*., 2010; Hawkes & Savage, 2000),
- The increasing quantification of disciplines such as the biosciences and the social sciences (ABPI,2008; British Academy, 2012).
- Widening access to higher education to increase participation amongst under-represented groups.
- Students arriving for higher education with increasingly diverse mathematical backgrounds.
- With the marketization of higher education come demands from students themselves for a high quality learning experience and appropriate academic support.
- Recognition within institutions of the importance of 'student satisfaction' and the National Student Survey.

Problem solving

In this session, delegates consider a variety of mathematical problems in their small groups. The aim is not necessarily to solve any of the problems but to discuss problem-solving strategies and how they would support a student arriving in their support centre with such problems. By providing problems that the delegates will be unfamiliar with also enables debate and discussion about how to deal with scenarios within a support centre where they do not know immediately how to tackle student's problem.

Subsequent discussion naturally leads to:

- An appreciation that it is not the role of tutors to 'tell the student the answer' and ideally the student should come to their own conclusion(s) with scaffolding provided through the tutor's questioning.
- An understanding that the tutors do not always need to know the answer, but at the same time ensure that the student leaves the centre having made some

progress.

A selection of problems that have been used in workshops can be found in the guide (Croft and Grove, 2011) and in the **sigma** resource pack on the **sigma** Network website. Further examples, and indeed an excellent discussion on what constitutes genuine problem solving, can be found within Hawkes (2015).

Principles of maths support – do's and don'ts

In this session the delegates, within their groups, are asked to think about what they might do (and what they should not do):

1. Prior to working in the centre.
2. During a drop-in session.
3. Afterwards.

Discussion about what tutors might do prior to working in the centre usually includes the following points: getting to know who is responsible for running the centre and who the tutor should contact if they have any concerns; understanding the purpose of their centre and which students can use it; the resources available both in the centre and through associated websites such as www.mathcentre.ac.uk. It is important that tutors know they can establish boundaries concerning what they have sufficient knowledge to tutor and what they don't (for example statistics, mechanics, research methods, etc.), and this forms a good opportunity for tutors to consider how they can make the most of the skills and expertise their colleagues possess. Finally, there is a need to ensure tutors are aware of emergency evacuation procedures and have information about who to call in case of emergency (for example local first aiders).

When discussing do's and don'ts whilst working in a drop-in session the following issues usually arise: the importance of welcoming students to the centre, introducing yourself as the tutor; asking about the course and level the student is studying before commencing the mathematics or statistics - knowledge of the students' course can be very important in determining the approach taken to tutoring the student; the importance of sharing your time equitably with all those waiting for help; not being embarrassed about letting the student know you don't necessarily understand how to solve a problem – but instead working together to try to understand by asking questions and referring to lecture notes and other resources; the importance of showing the student respect and not demeaning him or her, even inadvertently – remember the student may have needed a great deal of courage to enter the centre at all and the way

they feel treated will determine whether they persevere or not; encouraging the student to return, perhaps suggesting some additional work they should do in the meantime.

Offering statistics support

It is generally recognised that offering statistics support is very different from offering mathematics support. There are a number of reasons for this:

- Students may arrive seeking help with introductory exercises to calculate, for example, measures of central tendency or spread. They may be attempting routine exercises, for example using the normal, binomial or Poisson probability distributions. Tutoring these students in a support centre is akin to tutoring mathematical topics.
- However, students might equally arrive seeking help with a particular statistical software package that they are using to analyse data (SPSS, R and others). It is quite possible that the tutor will not have used these packages. The **stats**tutor website (see the section on Resources below) has a wealth resources that can help with these aspects and to which students can be referred.
- Some students may be seeking more complex advice and guidance on how to design and analyse a survey or an experiment. Often this is part of a final year project. Some students may seek to analyse data for a PhD thesis. In these cases assisting the student may demand more time than usual and a broader range of skills to help them.
- The interpretation of the output from statistical calculations is usually critical and might well require detailed knowledge of the context of the problem – knowledge that the tutor may not have.
- It is crucial that the tutor is aware of the level and discipline area of the student – sometimes a simple 'this is how you do it' might well be an appropriate response. For others, especially postgraduate students, it might be appropriate to recommend that the student spends time understanding the statistical requirements of the problem they are tackling and to develop the requisite knowledge for themselves.

For these reasons, and in an ideal situation, the statistics support tutor should be both a very experienced statistician and teacher. In a less than ideal situation, those responsible for running the centre need to be very clear about which students (courses and levels) can attend for help, and whether the tutors do indeed have the necessary

skills and experience. The **stats**tutor website has training videos concerned with statistics tutoring do's and don'ts.

An awareness of students learning styles, differences and needs

Crucial to the success of a support centre is the tutor's awareness that students present with a wide range of backgrounds, interests, and learning styles. Of course some are likely to have specific learning differences that have the potential to impact upon their learning. There is no expectation that tutors have specialist skills to deal with students presenting with neurodiversities such as dyslexia, asperger's syndrome, or dyscalculia, but it is possible that they will come across students like this and should know that a level of sensitivity is required. Croft and Grove (2011) contains specific subsections that discuss each of:

- Thinking styles.
- Learning styles.
- Maths anxiety.
- Specific learning differences (SpLD).
- Counselling.

Tutors should be warned that under no circumstance should they attempt a diagnosis nor suggest to a student that they may have a SpLD. If in doubt, they should refer to the centre manager or an appropriate academic such as a personal or welfare tutor.

Scenarios that might arise

Groups are given several wide-ranging scenarios that have arisen in real support centres and asked to discuss how they would respond. Scenarios provided include ones such as:

- *A first year student turns up at the centre with a copy of a diagnostic test that they have been given during the first week of term, and their marked attempt. They scored 23%. What might you do?*
- *A mature, first-year, overseas student comes into the centre. They have difficulty in explaining what their problem is, but show you a problem sheet from a module being studied in the Business School. The sheet has several questions, each of which has a scenario leading to a linear programming problem. It is clear that the linear programming problem must first be formulated, and then solved using either the simplex method or a*

spreadsheet (Excel, or a more specialist package). They seem to have little idea where to start. What might you do?

- *A student arrives and states: "I am doing a final year project and am very unsure of my statistics…My supervisor advised that I make an appointment with someone at the maths help centre and explain my project to them and then perhaps they would explain to me what tests I needed to use and why." What might you do?*

A number of other possible scenarios are available within the Guide (Croft & Grove, 2011) and also in the resources section of the **sigma** website. Of course, there are no simple answers to any of these questions but tutors have found it valuable to hear how others would respond and the suggestions they make.

Resources

Over the last decade a wealth of resources for use in mathematics support centres, by both students and staff, has been created by the community and through various funded projects. A good support centre should have access to these resources so that students can be directed and help themselves. The **math**centre website (www.mathcentre.ac.uk) focuses particularly on material that is known to be problematic at the transition to university. The **math**tutor website (www.mathtutor.ac.uk) contains much of the same material – videos, teach yourself booklets, diagnostic tests, etc. but arranged in a sensible order for self-study: arithmetic, algebra, functions & graphs, sequences and series, geometry, vectors, trigonometry, differentiation and integration. The **stats**tutor website (www.statstutor.ac.uk) contains a growing collection of statistical resources.

Delegate reflections on the training workshops

For each of the workshops that have been run, delegate feedback has been collected. This has not focused upon obtaining ranking scores, but obtaining specific comments that can be used to develop the events through a feedback loop. This has led to the workshop format, structure and content we describe here, and three key principles for delivering these: Practice sharing; an informal environment; and, interactivity.

A key feature of the feedback is that delegates welcome the opportunity to network and share ideas; something that is not always common even if tutors are based within the same institution. As such, this is something those running centres are encouraged to explore to aid the ongoing development of their tutors:

"Very easy to get external opinions on personal queries/dilemmas relating to the job. Also, set us thinking about aspects of our provision that we might not have thought about…"

[Delegate A]

"The brainstorming part of the event was important in terms of knowing each other's approach in dealing with different scenarios that may occur."

[Delegate B]

Another key feature is that to allow the sharing of ideas, an informal and relaxed environment needs to be established for the workshop sessions. Time and effort invested in this at the start of the workshop pays real dividends later and can help build confidence amongst the delegates:

"Very dynamic, interactive and easy going. Helped me get a bit more confidence as to my ability to be a good tutor."

[Delegate C]

But most importantly, it is essential that the sessions are very interactive and not consist solely of presentations by the workshop leads. The interactivity of the workshops is one of the most common comments cited in a section of the feedback form entitled 'what I liked most':

"…nice mixture of interactive sessions."

[Delegate D]

"Activities rather than presentations."

[Delegate E]

Recruiting postgraduate research students as mathematics and statistics support tutors

In a workshop held to discuss the training requirements of tutors (Croft *et al.*, 2013), discussion also took place regarding the *recruitment* of postgraduate research students, and in particular, how to find those with appropriate skills for working in a mathematics and statistics support environment. Advertisements for the post would better achieve their purpose if it they were transparent and specified the target audience for mathematics support and their possible level of need. Recruitment was also often undertaken through recommendations from peers, lecturers, supervisors and staff, with

an interview process of some kind. Tutor qualities or specifications could comprise of mathematics and statistics qualifications and teaching experience. Qualifications do not necessarily need to be discipline specific as a certain level of mathematics and statistics can be assumed from science based postgraduates. It is important however that learning and teaching skills are either present or that there is a potential for developing these skills with appropriate guidelines, nurturing and mentoring. Important skills are the ability to recognise students' needs, that is, to identify support needs beyond the need perceived by the student, helping students get to the actual need by unpicking the problem and by clever questioning.

Although teaching experience is desirable, tutoring in a support centre requires particular skills hence recruiting tutors with the potential for development as well as qualifications and experience is important. Working in a mathematics support centre is quite different to other forms of university teaching; not everyone possesses the necessary skills or abilities. Providing mathematics support is not about 'telling' the student the answer, but about encouraging them to identify their own mathematical problems, helping them tackle these for themselves with support and guidance, and providing suggestions and strategies for independent study. It requires individuals who are comfortable working on a one-to-one basis, who are patient, able to explain mathematical ideas in multiple ways, have excellent interpersonal skills, and are able to work with students of a range of abilities and from different disciplinary areas.

Recognition arising from mathematics support

Professional recognition for postgraduates for the time spent in training and the experience gained in a support centre is generally thought to be highly desirable. Not all postgraduate tutors will be interested but some, particularly those who have aspirations to work in university teaching might find formal recognition valuable. Certificates of attendance at training events can be produced easily, and in some institutions, training can contribute towards initial learning and teaching qualifications.

In one particular institution (Croft *et al*. 2013) a scheme has been established to enable postgraduate research students with teaching responsibilities to achieve associate status recognition from the Higher Education Academy. The scheme allowed selected postgraduates to be supported, by being paired with a mentor, in their submission of an individual application on the basis of their experiences in teaching and learning in higher education.

In some institutions there are examples of tutors going on to secure teaching roles upon

completion of their PhDs and working in a mathematics support centre can aid this. Tutors should be reminded of the fact that, for the reasons discussed earlier, they are undertaking one of the most challenging, but rewarding, forms of teaching in higher education. As such, they possess a wide range of skills, and should be encouraged to reflect upon these and cite their experience of working in mathematics support within their CVs and in any applications they might make. Former tutors who secure roles within their institutions can make an important contribution to mentoring and supporting new tutors as they commence their activities in a support centre.

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