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Understanding Evaluation of Learning Support in Mathematics and Statistics

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Understanding Evaluation of Learning Support in Mathematics and Statistics

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With rapid and continuing growth of learning support initiatives in mathematics and statistics found in many parts of the world, and with the likelihood this trend will continue, there is a need to ensure that robust and coherent measures are in place to evaluate the effectiveness of these initiatives. The nature of learning support brings challenges for measurement and analysis of its effects. After briefly reviewing the purpose, rationale for, and extent of current provision, this paper provides a framework for those working in learning support to think about how their efforts can be evaluated. It provides references and specific examples of how workers in this field are collecting, analysing and reporting their findings. The framework is used to structure evaluation in terms of usage of facilities, resources and services provided, and also in terms of improvements in performance of the students and staff who engage with them. Very recent developments have started to address the effects of learning support on the development of deeper approaches to learning, the affective domain, and the development of communities of practice of both learners and teachers. The paper intends to be a stimulus to those who work in mathematics and statistics support to gather even richer, more valuable, forms of data. It provides a “toolkit” for those interested in evaluation of learning support and closes by referring to an on-line resource being developed to archive the growing body of evidence.

Keywords: Mathematics support, statistics support, learning support, evaluation, progression, retention.

1. Introduction

1.1 What is learning support in mathematics and statistics?

Learning support in mathematics and statistics in universities is any extra, optional, non-compulsory programme or facility that assists students in developing mathematical and/or statistical confidence and skills during their enrolled study in a degree course, whether undergraduate or postgraduate, but with no credit associated with the learning support programme. Sometimes such learning support may be aligned with specific components of the degree course, but its assistance is optional and supplementary to the designated activities of the programme attaining credit towards a degree. Such support, which is increasingly offered from a dedicated mathematics and statistics support unit or centre, may include any or all of:

- drop-in assistance
- sessions or classes on specific topics or supporting specific courses
- appointments for 1-1 assistance

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• support facilities in paper or electronic form
• diagnostic testing with associated support assistance on specific topics
• designated space for support
• enabling or remedial programmes
• support for postgraduates
• programmes with no associated credit towards the student’s course

This is support for students who have been granted entry to a university course, and are, by and large, considered by the university to meet the formal entry requirements for the course, even if teaching staff may require or assume levels of knowledge and skills beyond these, or if the university sector places the responsibility for assumed knowledge on students.

This definition of learning support in mathematics and statistics (here abbreviated to MSLS) distinguishes it from preparatory programmes, often called bridging programmes, that enable a student to obtain prerequisite or assumed knowledge before entry to a course. There is also a distinction between MSLS and fostering citizenship numeracy as a graduate capability embedded in the curriculum, because the mathematical and statistical skills of MSLS are needed for and during students’ study for their degree. Naturally, MSLS overlaps with both these, and indeed, MSLS may often be needed for bridging programmes and for the development of graduate skills embedded in the curriculum. Like language, the totality of development in mathematics and statistics comes from formal and informal learning; MSLS is part of the overall spectrum of this development. The focus of MSLS tends to be on building mathematical and statistical fitness, confidence and transferability, all with reference to specific courses being taken by the students.

1.2 Why has learning support in mathematics and statistics grown?

What is special about mathematics and statistics that has led to the emergence, development and ongoing provision of learning support systems? Such systems are responding to needs of students beyond those that are met by the normal support provided within the learning and teaching of a course. A vital contribution of such systems is the message to students that it is both important and acceptable to identify mathematical weaknesses, and to seek and accept help. But, as reported in Pell and Croft [1] and MacGillivray [2], the use of MSLS systems is not restricted to those with the weakest skills. MSLS facilities play a significant role in the provision of sufficient systematic support to facilitate the development of confidence in mathematical and statistical skills to the level perceived by individual students to be necessary for their success in their tertiary studies.

There has probably always been a need for MSLS as a component of the totality of tertiary learning and teaching in mathematics and statistics. The many changes over the past three decades in the higher education sector, in attitudes within education, and in the increasingly quantitative needs of a modern society, have brought this need forward with increasing acceleration over the past decade. Widening pathways to university study and diversity of students (including international students), greater attention to attrition, movement in other disciplines to implicit rather than explicit reliance on mathematics, more flexible prerequisites and assumed knowledge have all contributed to the need for MSLS. These factors are as relevant as curriculum changes at school level, shortages of well-qualified
mathematics teachers in many schools, and a general lack of understanding or acknowledgement of how mathematical and statistical thinking underpin other disciplines and how such thinking is learnt.

1.3 The need for data collection and analysis

Audits of MSLS centres have been carried out in the UK, Australia and the Republic of Ireland ([3-9]). One of the points that comes out in these audits is lack of security of MSLS centres. This emphasises the importance of collecting and analysing information to provide evidence of the contribution of MSLS to improving student achievement and reducing attrition. A recurring theme is the importance of data being collected and analysed, but an acknowledgement that few MSLS facilities currently have sufficient resources or expertise to analyse data – data that would also be of significant value to universities in their strategic planning. Because MSLS centres have developed in response to student needs, scarce resources are almost completely oriented to meeting these needs. It requires a cultural shift in the views held of MSLS centres by universities and by the centres themselves, as playing a vital role in the overall learning fabric for the academic health and fulfilment of students and hence of the whole university.

To understand how the process of evaluating mathematics support centres is evolving, it is important to recognise their origins. Most centres started in response to local needs and were usually small scale operations or a small part of broader central learning support. There would tend to be little or no attempt to gather data except perhaps to record which students attended and, maybe, the departments from which they came. At the next level, some institutions recruited former school teachers, or retired lecturers, or young lecturers on their ways to other careers, to offer a greater level of support. Whatever their background, these staff were recruited because of their interest in teaching and their longing to work with students. They were often part-time, often worked term time only, and their focus and time was on helping students. Their work was, and is, supplemented by casual (paid) or volunteer work by undergraduate and graduate students. Anecdotal evidence would suggest that their efforts have been invaluable in developing the confidence and competence of individual students and in enhancing students’ experience of mathematics at university. However, such evidence is rarely sufficient to convince those who allocate funding, nor to satisfy those who seek more rigorous ways to measure efficacy and thereby develop provision from an evidence-informed base. With such extensive and rapid growth of MSLS activity, as clearly laid out in the aforementioned audits, it is now right and proper to ask about its role in student learning and in universities in general, not just to secure ongoing funding, but also to ensure that MSLS centres play their full role in universities. This leads to questions such as ‘What data is it possible to collect?’ and ‘How can we analyse and interpret what we do collect?’.

This paper examines these questions to provide a framework and guide for evaluation of learning support in mathematics and statistics. Because the fundamental importance of collecting and analysing data is to understand what is being accomplished, and what can further be accomplished, we outline in Section 2 the extent of prevalence of MSLS centres and a range of their aims. In Section 3 we present a framework of types of evaluations, sources of evidence and forms of analyses. In Section 4 we review several examples of
current evaluation practice. The paper concludes with a discussion of why there will always be a need for learning support in mathematics and statistics, the role of data and analysis in its ongoing work, and references an on-line resource being developed to archive evidence.

2. Extent of provision, aims of learning support, and growth of a community

2.1 Extent of provision

For mathematics and statistics departments world-wide, it is not unusual to have some form of drop-in provision for courses to cater for individual assistance on work within the curriculum of courses given by the department. This is part and parcel of their normal operations and is often an extension of, or supplement to, ‘office hours’ by staff for student consultation. Other types of programmes used in many disciplines are the PASS programmes (Peer Assisted Study Support programmes) in which past students of a particular course act as mentors to current students in the same course. Such provisions have some common elements with MSLS, but are confined within courses and depend on students who have recently completed the same course. In this paper we focus on centres providing general learning support in mathematics and statistics, across courses and disciplines, with at least some autonomy, and with focus on the general development of students’ mathematical and statistical skills, whether students’ questions arise from specific courses or not.

There are similarities in the development of centres of MSLS in the UK, Ireland and Australia, but little literature exists on this topic from other countries or in general. Amongst the earliest surveys of such provision in the UK was that of Beveridge and Bhanot in 1993 [3]. Working from Luton University, Beveridge established the Mathematics Support Association in a first attempt in the UK to draw together those interested in and practising mathematics support. The Association produced the Mathematics Support Association Newsletter from 1994 -1999, copies of which have been archived on the sigma website1 http://www.sigma-cetl.ac.uk. In that survey, a questionnaire was sent to 800 further and higher education institutions to ascertain current practice in mathematics support, with 42 replies from higher education institutions and 100 from colleges of further education. All responding institutions had at least one form of mathematics support; he found the support to be more readily available in colleges of further education. No distinction was made between extra optional assistance (such as drop-in) within a course and support provided by a centre in MSLS. In a follow-up survey in 1996 [4], Beveridge gained additional information concerning which skills (e.g. algebra) were deemed to be better/worse but his paper gives very little detail. Unfortunately the nascent work of Beveridge to establish a community was shortlived despite his best efforts, probably because it was ahead of its time in the UK.

A more substantial survey of the situation in higher education was carried out by Lawson et al in 2001 [5,6] which revealed that of the 95 UK higher education institutions replying 46 (48%) had some kind of mathematics support centre provision. Since 2001 a number of projects (e.g. the LTSN MathsTEAM project [10], and mathcentre [11]) have raised

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1 sigma is one of the UK’s Centres for Excellence in Teaching and Learning (http://www.sigma-cetl.ac.uk)
awareness of the role of mathematics support centres and have made resources available for those interested in establishing them. In 2004, Perkin and Croft [7] updated the information with a thorough survey to 106 UK universities, achieving a response rate of 95%, with 62% stating that they offered some form of mathematics support provision over and above that normally provided. What was particularly interesting was that support centres were by then to be found in the full range of institutions including some of the most prestigious “Russell Group” institutions. Since the 2004 survey new UK centres have been opened at other universities, such as Sheffield, Bath and Leeds Universities as part of the sigma dissemination programme.

In Australia, a counsellor in mathematics was appointed at the Australian National University as long ago as 1973. In 1984 mathematics learning centres were established at two very different universities: the University of Sydney and Central Queensland University. In the past fifteen years, in almost every university in Australia, at least some form of learning support in mathematics and statistics has been set up at some stage. Over the years some of this activity has been discontinued or evolved. During 2007, as part of a project funded by the Australian Learning and Teaching Council’s (ALTC) Leadership for Excellence in Learning and Teaching Program, the nature and extent of learning support in mathematics and statistics (MSLS) in Australian universities was investigated by MacGillivray, [8]. By 2007, she found that 32 of Australia’s 39 universities had at least some form of support. In some universities, the support is associated with a central service, in others it is provided by a mathematics/statistics department, and in others by a combination. In respect of their data collection efforts she wrote:

Mathematics Learning Support needs sufficient security to attract, train and retain staff, and to play its part in the ongoing and longitudinal data collection and analysis that should be an integral part of its contribution to the university. All universities should ensure that such data collection and analysis are undertaken and performed correctly to provide vital information for university academic management. However, as reported, few of the facilities currently have the resources to undertake this important work.

In the Republic of Ireland, 13 institutions with mathematics support provision are reported in the 2008 audit of Gill, O’Donoghue & Johnson [9], with most provision established since 2000. Web searches can locate centres in MSLS in Canada, US, Switzerland and New Zealand, but other national audits of provision do not appear to be available yet. In many other countries drop-in assistance or duty tutors are provided within mathematics and statistics departments for students taking courses with the department. So there is no doubt that throughout much of the world support centres are being developed. Whilst many of these are isolated initiatives, increasingly there are attempts to bring these together for mutual support as we describe in Section 2.3.

### 2.2 Aims of learning support in mathematics and statistics

The evaluation of traditional university programmes needs to be carried out with respect to the programmes’ aims and objectives. Hence for a MSLS centre to evaluate its work, it needs to articulate its purpose. We strongly recommend, as did Lawson et al in their Good Practice Guide [12], that centres give time and thought to articulating their individual purpose – why have a centre?, what problems are you seeking to solve?, what changes are
you intending to bring about? who can use it? and so on. Having clearly defined aims is a prerequisite for evaluation so that appropriate measures can be devised and aligned with the aims. The audits of [3-9] found that many MSLS centres expressed their purpose to at least some degree, and although the wording and extent of articulation varies, commonalities are used to express the following suggested general form for aims and objectives of a MSLS centre. Our suggested general overall aim for a MSLS centre is to help students attain the level of mathematical and statistical confidence they need to achieve their potential in their degree, whatever that level might be, and whatever the discipline of their degree. Objectives of MSLS centres could be all or a subset of the following:

- to help consolidate and extend students’ understanding of their mathematical and statistical knowledge
- to help students achieve their potential in mathematical and statistical skills and capabilities
- to be responsive to the particular needs of individual students, including when these students have special needs, e.g. due to specific learning differences
- to help students become self-learners
- to overcome deficiencies in prior learning
- to engender a more positive view about mathematics and statistics
- to engender a more positive view about a student’s ability to at least cope and to aim to succeed in the mathematical or statistical elements of their course
- to improve student satisfaction
- to improve retention of individuals and cohorts
- to improve levels of achievement
- to help staff across disciplines in understanding what the mathematical and statistical demands are in what they teach – to articulate precisely what they are asking of their students
- to make staff more aware of the backgrounds of their student cohorts and to respond accordingly
- to contribute to the professional development of staff and student tutors who work in the centre
- to be a catalyst for change and development within the university
- to help staff understand where students are positioned at various stages in their study
- to keep abreast of developments and to network with other MSLS centres and relevant professional bodies
- to contribute to the development and network of resources, and to student access to resources
- to collect and analyse data relevant to learning support, students backgrounds and progression, and of value to the university’s mission and performance
- to contribute to faculties and university planning and strategies
- to collaborate with other forms of learning and student support within the university
- to represent the cause of MSLS for students
- to increase awareness of, and provide support where possible for, mathematical and statistical foundations for postgraduate students
- to position the learning support within a scholarly framework contributing to the scholarship of learning and teaching
to develop and foster programmes of relevant research or scholarship

2.3 Scholarship in mathematics and statistics support and the development of a community of practice

The recent rapid growth in the number of MSLS centres has been accompanied, albeit with some lag, by the development of communities of practice of those who work in the field. In the UK four annual conferences, known as the CETL-MSOR Conferences, have taken place between 2006 and 2009 and these are concerned with striving for excellence in teaching, learning and support of mathematics and statistics within higher education. Within these a significant number of presentations have been on the topic of learning support in mathematics and statistics (for conference proceedings see [13]). In the southwest of England, a network of mathematics support professionals has been established to share information, coordinate views, and raise the profile of mathematics support in the region [14]. A similar network has been established in Scotland [15], and others are planned. The growth of MSLS centres at Irish institutions has prompted similar gatherings. Mac an Bhaird & O’Shea [16] describe the rationale behind the establishment of regular workshops in Ireland on mathematics learning and support centres, the first being held in 2006 at the Dublin Institute of Technology, and the second at the University of Limerick in 2007. In 2008, the third workshop, at the National University of Ireland, Maynooth, focused explicitly on trying to answer the question “Is mathematics support worthwhile?” Papers from that workshop are available from [17].

Samuels and Patel [18], with reference to theories of scholarship, provide evidence that the community is maturing and that scholarly practice within this community is now much more prevalent. They cite a number of examples of how evidence is being gathered, evaluated and communicated already but argue that the many isolated initiatives should be developed to bring about a culture shift within the community to further increase scholarship in learning and teaching. Perhaps at last, the 1994 vision of Beveridge is being realised.

Because learning support in mathematics and statistics interacts or interfaces with an enormous variety of courses, levels, students and concerns, papers on it appear in a range of conferences organised by an array of professional groups. The Australian Bridging Mathematics Network (BMN) was established in 1991 to provide a support group for those teaching bridging mathematics courses. Increasingly, much of the focus of the BMN was on preparatory and bridging programmes for mature age students. The paper of Taylor and Galligan [19] in 2005 gives an overview of the contributions of the BMN to adult learning in mathematics. The International Conference of Adults Learning Mathematics (ALM) is an international research forum bringing together researchers and practitioners in adult mathematics/numeracy teaching and learning in order to promote the learning of mathematics by adults. ALM has become a Company and has also obtained the status of a National and Overseas Worldwide Charity by English and Welsh Law since the beginning of 2000. Its website www.alm-online.net has conference proceedings dating back to 1994, with many papers referring to the use of MSLS-type activities to prepare adults for higher education.
Papers on learning support in mathematics and statistics appear at the International Congress on Mathematics Education (ICME) and the International Conference on Teaching Statistics (ICOTs). In Australia, they appear at the conferences of the Mathematics Education Research Group of Australasia (MERGA), Australasian Engineering Education (AaeE), Australian Mathematics Society (AustMS), and Australian Association of Mathematics Teachers (AAMT), to name some. Even the Association for Academic Language and Learning has been increasingly interested in numeracy since its 2005 conference.

In the past decade, the conference in Australia’s region with the most interest in learning support in mathematics and statistics, has been Delta, the Southern Hemisphere Symposium on Teaching Undergraduate Mathematics and Statistics. Delta is a biennial conference specifically on the teaching and learning of mathematics at university level. It started in 1997 and statistics was included in the titles from 2003. Delta is a community rather than an organization, and there is no formal society. There is an international committee and the convener of each symposium forms a local organizing committee. The name, Delta, came from the concept of change in university mathematics. Each conference has a different theme and location.

As part of the ALTC Leadership Project “Quantitative diversity: disciplinary and cross-disciplinary mathematics and statistics support in Australian universities”, [8], a symposium specifically on learning support in mathematics and statistics was held in July 2007. Information about the symposium, including abstracts and presentations can be found at http://sky.scitech.qut.edu.au/~macgilli/carrick/. Many delegates expressed a desire to hold such symposia on a regular basis. However it was agreed at one of the forums of the symposium, that participating in, and organising satellites to, conferences such as Delta and others described above, would be of greatest benefit and effectiveness.

3. A framework for evaluation of learning support in mathematics and statistics

The essence of learning support is that it is not formal. It enables students to try to engage with mathematics or statistics in an environment with no formal expectations of them other than that they are there to try. Whilst this is a strength in providing an environment for students to face their fears, conquer weaknesses and develop confidence and self-knowledge, it also brings challenges for measurement and analysis of its effects. In this Section we provide a framework for those working in learning support to think about how their efforts can be evaluated and what data can be collected. Section 4 describes briefly some aspects of how findings can be presented, analysed and reported. It cites a variety of exemplars of work being undertaken by others to capture the sort of evidence required and gives details of a website which has been established to archive developing practice in evaluation.

As reported in MacGillivray [2], information on the value and effectiveness of learning support comes in the form of both usage by the students and their subsequent performance. Whereas the former can be ascertained from within a centre, collecting data on student performance and progression requires resources and collaboration with staff from the students’ home departments – departments with which centre staff may have little regular contact. For data analysis there is also a need for expertise and staff time.
It is thus helpful to think about the fruits of learning support effort in terms of both usage of the facilities, resources and services provided, and also effect on or improvements in performance of the students and staff who engage with them. In both of these categories it is possible and appropriate to collect, explore, analyse and report qualitative and quantitative data.

3.1 Usage

Because MSLS programmes are optional extras for students, measures of demand are measures of meeting needs. Usage data are important because they give a measure of demand for facilities, resources and services. They provide evidence that students and staff value what is on offer. They confirm the extent of student and staff need. The fact they come or seek advice is a measure of the extent of their needs and their perception that the learning support can help them. When students continue to make use of learning support it is clear that they perceive it to be of assistance to them, and thus can contribute to greater levels of student satisfaction. Students’ use of learning support, even if only marginal, signifies engagement on their part. Learning support thus provides an outward and visible sign of student engagement at a time when many higher education institutions around the world are challenged to maintain student participation in traditional ways of teaching and are widely reporting falling lecture attendance [20].

3.1.1 Qualitative data on usage

Qualitative data can take the form of comments on student feedback forms, findings from interviews and focus groups, and observation. Other forms of qualitative data include results from student surveys when students choose to make specific comments about the learning support they have received, comments from other staff and external audits of universities. Qualitative data from student users of MSLS tend to be a mixture of comments on how it made them feel, on how it helped them and on the teaching performance of their assistants, but may include comments on usage such as “used this service regularly”. Because selections of comments appearing in reports are always open to the accusation of selective bias, it can be effective to record all comments in a separate document or appendix to the report, so that the claim of representative comments can be checked. Another source of qualitative data on awareness of MSLS facilities and programmes may be obtained in cooperation with lecturing staff through a question or two included on a survey of the whole class. Questions such as “rate your knowledge of the MSLS facility and its programmes” and “describe your usage of the MSLS facility” with response categories ranging from “not at all” to “very substantial”, can provide interesting and sometimes unexpected information. For example, a comment such as “it was good to know it was there even though I didn’t use it”, or “I meant to go there but never got round to it” are also indicators of the value of the existence of the centre and its programmes. Generally speaking, comments or extracts from them should be reported verbatim, including spelling and grammatical mistakes.

In the exemplars to follow in Section 4 there is evidence of how the use of the MSLS facilities has encouraged the development of student communities through provision of space within which students can work together. Thus observational data on the behaviour of student groups can supplement focus group data and can be very illuminating, as we shall see.
3.1.2 Quantitative data on usage

There are many possibilities for quantitative data on usage although which data can be collected depends on the nature of a centre’s programmes and its physical and staffing structure. For student usage of drop-in space, assistance, group support tutorials, workshops, resources etc, it is important to be clear about the difference between numbers of individual students and of numbers of visits, assistance events, attendees etc. Both types of numbers are valuable but the distinction must be clear. Another aspect that requires a consistent approach is any recording of course or degree, particularly as this may be dependent on information provided by the student, and there can be amazing variety in the way students provide this information.

There appears to be little impediment to keeping attendance records at course or topic specific support sessions or workshops, with students voluntarily recording or ticking their names or identities and their courses, provided it is clearly explained in writing that MSLS programmes do not contribute to assessment or any other aspect of formal courses (apart from providing support for students). Explaining to students that records of usage are essential to enable the MSLS programmes to continue usually results in full and enthusiastic assistance from students. Such records give the number of individuals who use these components of a programme and the frequency of usage per user as well as per session. Students’ cooperation in maintaining such records is very high; the most common cause of missing records in such sessions tends to be forgetfulness on the part of the staff member taking them as described in [2].

The extent of recording usage of drop-in space may depend on both the infrastructure and ethical considerations. Centres with spaces which require student id entry, either by physical or human means, have ready access to accurate data, but lack of these does not prevent the collection of useful data. Students can be requested to help the survival of the drop-in facility by recording their entry and how long they spend in the facility and their course or degree. Ethical considerations may mean such records are anonymous, but their value is not diminished except that later, longitudinal studies of performance of individuals using the centre is then not possible – one of the reasons evaluative work is so challenging. Again, reported experience is that students’ cooperation is very high as they quickly identify strongly and positively with the drop-in space as being “theirs” in at least some sense. An estimate or check of the accuracy of such records, usually of the degree of under-reporting, could be carried out by randomly chosen periods of observation carried out unobtrusively. The means of recording must be quick, simple, prominently displayed near the entrance, clear (especially with respect to course or degree if requested) and frequently collected. Care must be taken in reporting such anonymous data in terms of numbers of visits.

Consideration should be given to recording the nature of the assistance given in the drop-in facility. Again, ethical considerations may require the students to be anonymous but the value of this is significant. This recording requires cooperation from the drop-in helpers so a quick and simple method is needed to facilitate good data collection without too much disturbance of their work. Number of students in a group requesting assistance (frequently but not always 1), course or degree are quickly recorded and can be done at the beginning of the interaction. Recording a brief word or two after the interaction on duration (approximate) and the nature of the assistance provides very valuable evidence to backup anecdotal reports,
and can be made easier for drop-in helpers by prior agreement amongst them on categories and terms to be used. In a centre which is staffed by many different tutors over the course of a week, a prominent whiteboard in the centre can be used by staff to record the types of problem being presented on any particular day or week and may be even hints or references to assist other tutors when facing similar problems. This has the effect of increasing communication between those involved, improving their efficiency, and the board can be photographed when full as a record of events.

Data that can be collected on usage of resources are highly dependent on the form of the facility, and what is regarded as usage worth recording. For example, browsing a book or leaflet within the facility is probably not worth the trouble of recording and it is likely that such data would be significantly inaccurate. Visits to websites are not necessarily usage, but do represent interest and visibility. If information or worksheets are available on copies that can be retained by students, an inventory monitoring process on these can reveal useful information about topics and times of demand during a teaching semester.

Although advice to staff may not seem to lend itself to quantitative data, brief records of dates, times and nature of interaction, no matter how short, may prove useful. A general principle in collecting data is to plan beforehand, collect all data that can be collected consistently and accurately, and maintain databases whose structure has been designed with input from centre staff.

3.2 Effect
Because MSLS is optional and extra, usage data are important and very helpful in providing information on demand and engagement, to be fed into planning and strategies as well as evaluation of the overall performance of a MSLS centre. MSLS centres need to constantly emphasize how usage data contribute significantly to evaluation because of the optional extra nature of MSLS. However it is data on effect or improved performance that often has greater impact. Such data enable links to be made between MSLS usage and students’ confidence, performance, and prevention of avoidable attrition. Information on how students have been helped to achieve their potential, to become more positive about mathematics, to overcome deficiencies in prior knowledge, to achieve a sufficient standard to remain in the system, and to improve their course marks, is highly desirable. As noted earlier though, should students wish to remain anonymous, gathering performance data is then problematic.

3.2.1 Qualitative data
Most qualitative data from students and staff are on effectiveness and performance of MSLS staff. These can come from students reporting improvements to their confidence or levels of achievement in interviews, focus groups, questionnaires or feedback forms. Where it is possible, staff comments on improvements of individuals or cohorts can be collected.

When staff spend time giving one-to-one help with students or help in student-driven sessions, it should come as no surprise that students appreciate this and say so on feedback forms. It is rare to find negative feedback from students regarding the provision of MSLS (except perhaps to say that it should be even more available!). However, because it is optional and extra, students would not continue to use the services nor take time to fill in feedback forms if they did not feel more confident, more positive and improved in their
academic performance. This is why verbatim comments should be reported as they provide insight into how and why the students feel as they do.

Qualitative data gathered externally provides evidence of a different type. In the UK, universities are subject to quality audits by the Quality Assurance Agency (QAA). Institutional and national audit teams not only evaluate overall performance but often receive unsolicited information from interviews with students and staff. Such information can find its way into published reports from the QAA and other public documents and should be treasured. Where departments have courses which are accredited by professional bodies and are subject to course validation, it is often the case that the MSLS facilities are cited as good practice – again this information is valuable and should be recorded, e.g. in annual reports. Also in the UK, the National Student Survey [21] is carried out annually, and independently of the each university. Results from such surveys should be trawled through for reference to effect of MSLS services.

3.2.2 Quantitative data

Quantitative data to demonstrate effects or improvements in performance are often comparative (e.g. showing improvements over the years, showing differences in performance between users and non-users) and as such require collaboration with, or assistance from, university administration or lecturing staff in the students’ home departments. Certainly cooperation is necessary if data on students’ prior qualifications and current performance is required. As noted, the identities of students using mathematics support need to be known for this to take place.

For student performance, the essential concept is to compare performance relative to a base measure for those who used MSLS with the same relative performance for those who did not, using the same measures of performance and base for each group. For all students, level of mathematics studied at school as well as results in it, is valuable data and sometimes can be obtained only by surveying the students directly. Although the prime aims of diagnostic testing are self-assessment for the students and information for planning and strategies by MSLS and teaching staff, it can be used as a base measure provided it is done by the whole cohort – or most of the cohort. Sometimes the base measure can be performance on a first piece of assessment. For students who have been at university for at least one semester, their grade point average could be used although it can be a poor base measure for these purposes for students in degrees without very substantial mathematics content. In some situations a follow-up diagnostic test may be appropriate, for example, for nurses in dosage calculations, but in many situations final results in courses for the whole cohort are necessary to permit quantitative comparisons to be made. It is best if the measures involved in investigating performance can be treated as continuous – such as marks, percentages – rather than categorical such as grades, because the latter are generally too coarse to yield information about comparisons.

Attrition data do not require a base measure and also can sometimes be obtained more readily from university administrations, but they can be quite challenging to work with, particularly in non-professional degrees, because of defining attrition amongst the many transferences in degrees by students and the many changes in degree structures (and associated codes or names) by universities. The response variable in attrition is also binary –
either yes or no – which can require care in analysis. However, the binary nature makes presentation easier (in tables of charts) and attrition data are very powerful forces in universities.

One point that must be emphasized and appears again in Section 4, is that causality cannot be inferred in this situation because the students are not randomly assigned to use or not use MSLS facilities; they choose to do so, and choose the extent of their use. Claiming causality in this situation invites the counter-argument that those who choose to use MSLS facilities are engaged and it this that “causes” improvements rather than the MSLS. This argument has even less quantitative validity because there is no measure of engagement for both groups (users and non-users) and no concept of how students could be randomly allocated to be “engaged” or “not engaged”. Many of those who would argue this, also point out that students who do not “need” MSLS still use the services.

Causality does not need to be claimed for improvement in performance data to have impact, particularly as readers will tend to infer causality based on the context, even when the results are presented in neutral ways, using words such as “related” or “linked”. If those who use MSLS services perform better relative to a base measure, or are present in smaller proportions in attrition, then this is quantitative evidence of the value of the MSLS. Similarly, MSLS aims to help students achieve their potential, no matter what level that may be or in which degree. If able students choose to use MSLS services then these are fulfilling a need. In both [1] and [2] it is commented that MSLS provision is used by both students who are seeking excellence and the less able looking to avoid failure. These findings suggest that the provision of mathematics support is more wide ranging in its level than traditionally conceived and that mathematics support has moved from one of remedial support to one of enhancement for all. This is in line with recommendations made in the UK’s National Audit Office report [22] on retention. It states that a university’s approach to retention should be a positive one and that it should provide students with opportunities to improve their grades rather than just addressing gaps within their knowledge.

4. Presentation, analysis and reporting on data – what is happening in the field?

In this Section we review several examples of how evidence is being gathered, analysed and reported by workers in the field. We intend this to add substance to the evaluation framework of Section 3 and encourage others to develop evaluation mechanisms within their own centres.

4.1 Usage (qualitative)

Qualitative usage data comes in the form of what is said and written about whether students use mathematics support, which aspects they use, and why they choose to use it.

As stated above, data in the form of feedback and comments should be quoted verbatim, with a full collection of comments available for evidence if the choice of selected comments is challenged. Centre managers should find ways of recording and presenting such data, for example in the form of annual reports, or reports to university Learning and Teaching Committees, or websites. Doing this raises the profile of the centre and, especially when the
data is externally provided, gives substance to assertions about effectiveness. For example, the QAA Institutional Audit Report of Loughborough University in 2008 records:

sigma CETL has its origins in the Mathematics Education Centre but has widened its concern from the teaching of mathematics to engineers to include support for mathematics education across the University. The ready accessibility of useful help was praised by both undergraduate and postgraduate students that met the audit team. Other students described the benefits of the support rooms and associated equipment. Postgraduate students were appreciative of the one-to-one help and individual study programmes provided for them by the Centre.

The full report is available publicly at [23]. The report of 2004 [24] records:

The audit team identified the following areas as being good practice in the context of the University: the work of the Mathematics Education Centre...” “Having discussed the work of the MEC with members of staff across the University, the team came to the view that [its] contributions to the University's resources for staff development, and their work more generally, constituted a feature of good practice.

The Centre ensures that good use is made of this data which provides external evidence that students use and value the facilities provided.

Gill and O’Donoghue in [25] describe qualitative data gathered independently of their Centre by staff from the Office of the Dean of Teaching & Learning and presented in a report. That report noted:

…the large majority of students questioned were extremely positive in the feedback provided about the Maths Learning Centre. They fall into two categories – those who rely on the MLC for backup and those who rely on the centre as a fundamental part of the maths learning curriculum.

So we see evidence of students using mathematics support both for survival, and for enhancement – a message which recurs in several publications. The authors go on to describe how comments in an external quality review urged that the University would guarantee continued existence of the centre.

Qualitative feedback on usage from students themselves is essential. There are now many examples of reports describing this. For example the work of Ni Fhloinn on measuring the effectiveness of mathematics support through student feedback is described in [26] and includes usage comments such as “one to one teaching very helpful, and I wasn’t afraid to ask questions as I would be in lecture”. MacGillivray [2] cites feedback from students on usage: “excellent support provided – used this service regularly”, and “helpful staff, very approachable worth coming to”.

To summarise, be alert for opportunities to gather qualitative data from a variety of sources, record it, and report it. If the Centre doesn’t already publish an Annual Report, and report its findings to, for example, a University Teaching & Learning Committee, then find a mechanism for doing so. Websites can be used to encourage other students to use the centre and can be used to archive (anonymous) feedback. Conferences and other fora are also invaluable for recording and making public statements about what has been found to work.
4.2 Usage (quantitative)

Quantitative usage data which are amongst the most obvious and readily collected are of numbers and categories. Tables provide exact numbers but an accompanying graph or chart can often impart crucial information more readily and make comparisons clearer. For example, Figure 1 below taken from [27] shows the cumulative number of student visits to a learning centre over the two 15-week semesters in each year from 2002/03, when the Mathematics Education Centre at Loughborough University was established, until 2007/08. The growth in demand over the six year period is evidence that sustained efforts to raise awareness of the learning centre have been worthwhile. A table in [27] shows the actual number of students and the number of visits they made together with the departments from which they came, in the year 2007/8. The detailed information in this table is valuable but a chart showing number of students and number of visits by department would provide an even more accessible view to a reader of a report or paper. The percentage of a cohort who use MSLS services would be another item of usage data, one which would allow comparison across departments (or even universities) with greatly differing sizes.

[Insert Fig 1 here]

Figure 1. Cumulative student visits of support facilities over each of six academic years demonstrating year-on-year growth in demand (provided courtesy of Dr Carol Robinson).

O’Sullivan [28] reports on work he has undertaken to evaluate mathematics support initiatives at the Institute of Technology, Tallaght, Dublin. In addition to reporting quantitative data via usual measures such as numbers of students using mathematics support, he also records the number of email contacts. The importance of record keeping is emphasised here, and interestingly he notes that data is now gathered on how many students using learning support are first in their family to attend third level education. Such quantitative data are useful for showing the importance of mathematics support to widening participation and inclusion activities.

4.3 Effect (qualitative)

Qualitative comments from students can be strongly indicative of the ways in which MSLS are bringing about change in students’ perceptions of themselves as mathematics learners. Often their comments also refer to improvements in grades. For example, comments such as the following from MacGillivray [2] reveal different reasons for the students’ positive feelings and provide evidence of meeting some of the more subtle but vital MSLS objectives:

I have avoided this stuff for the last 20 years, but it really is easy and fun

The MAC [maths access sessions] sessions have been excellent and have improved my understanding and my marks

I arrived being “scared of numbers” and left the session feeling empowered.
Parsons [29] writing about the effects of mathematics support provision and accompanying changes to the engineering student learning experience via diagnostic testing and changes to lectures, provides details from students of improvements to their grades and perceptions:

Maths Support was useful and without it I don’t believe I would have passed this module – now I’m getting A grades in my exams (1st year BSc Engineering student)

Solomon et al [30] in analysing data from focus groups of students who had made use of two universities’ support centres highlights unintended, yet positive consequences of establishing mathematics support. The students she reports had ‘colonised’ the centre, and used it to develop a strong community identity. She writes:

Although there were limits to how much help from tutors they could receive in the learning support centres … the undergraduate mathematics students … had continued to use these as spaces for group study.

Quoting one particular student, Roz:

Towards the end of the first year … I used it a lot because a group of us who tend to get fairly good marks used it a lot. Other people sort of came in to work with us and got the help and so on and so … we got … we feel that we kind of established it in some way by using it a lot and encouraging other people to say ‘well we'll meet in the Maths Support Centre and we'll work together’ sort of thing. And then … and it developed a real upspin, it was really kind of in a sense the place to be, and there was a lot of people, there was a lot of use.

Solomon goes on:

a related and equally important effect of the support centres is on the students’ general approach to learning, and their positioning of each other as engaged participants in their local community of practice.

So the qualitative evidence emerging is that there are positive effects from MSLS far deeper than those of retention and improvement first envisioned, and that centres can help develop learner identities significantly. In terms of fostering better relationships with tutors and empowering students, Solomon et al [30] quotes from the focus groups:

When they are in maths support, you know they’re there to help people and you’re not bothering them. If you go to their office, you’ve got your stuff in your bag, there’s nowhere to get it out to show them, you know there’s a queue of people behind you, they were doing something before you arrived if there wasn’t anyone in the queue ahead of you so you feel like you’re bothering them, it’s their space as well and you’re going into their office, whereas maths support is neutral ground for everybody … it doesn’t belong to anybody, you’ve got your stuff out and they will work their way round the table to come to you, you have your work out ready even if you’ve put it to one side so you can flip back to it and say ‘can you just help me with this’.

4.4 Effect (quantitative)

Quantitative studies on the effect of mathematics support are now beginning to emerge. Often these involve more extensive data collection and analysis. For example, the Maths Learning Centre at Dublin City University, Ireland, has a remit in respect of retention. Dowling and Nolan [31] have compared the pass rates of those “at risk” students who visited
their centre with those who did not. [31] gives data over two academic years, and a subset of this is reproduced in Table 1. The number of “at risk” students increased in 2005/6 because the diagnostic test threshold defining “at risk” was raised. They go on to argue that by applying the pass rate of those who did not visit the centre but who were “at risk”, to those “at risk” attendees, that around 22 students over the two years went on to pass when they might otherwise not have done. Clearly, as mentioned in Section 3.2.2, it would be erroneous to argue causality, but this linking of performance with attendance at the support centre is quantitative evidence of the value of the centre.

Table 1. Taken from Table 6 in Dowling & Nolan [31].

<table>
<thead>
<tr>
<th></th>
<th>2004/5</th>
<th>2005/6</th>
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</thead>
<tbody>
<tr>
<td>Number at risk</td>
<td>80</td>
<td>161</td>
</tr>
<tr>
<td>Number at risk who visited MLSC</td>
<td>41</td>
<td>95</td>
</tr>
<tr>
<td>Pass rate at risk who visited</td>
<td>53%</td>
<td>60%</td>
</tr>
<tr>
<td>Pass rate at risk who did not visit</td>
<td>25%</td>
<td>49</td>
</tr>
</tbody>
</table>

The information of Table 1 could also have been presented in two-way tables (illustrated with stacked or split bar charts) as shown in Table 2 below.

Table 2. Numbers of at risk students who visited/did not visit MSLS and passed/failed with data derived from [31].

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td></td>
<td>Pass</td>
<td>Fail</td>
</tr>
<tr>
<td>Visit</td>
<td>22</td>
<td>19</td>
</tr>
<tr>
<td>No visit</td>
<td>10</td>
<td>29</td>
</tr>
</tbody>
</table>

The statistical test of whether there is a relationship or not between visiting and passing gives a p-value of approximately 0.01 for 2004/2005 and less than 0.01 for 2005/2006. That is, there was approximately 1% chance for 2004/2005 and less than a 1% chance for 2005/2006 of getting these data or more extreme if passing and visiting the MSLS centre are independent.

Quantitative performance data can also be summarized as in Table 3 which is adapted from data collected by Cuthbert and MacGillivray [32]. They were interested to know how students that used their support sessions or examination workshops compared to those who did not. Their study considered students who commenced engineering degree programmes in 2002 and were offered optional additional mathematics support through Queensland University of Technology Maths Access Centre (QUTMAC). By 2006 many of these students had either graduated or discontinued study. Table 3 shows the number enrolled and the numbers who had either graduated or discontinued by 2006. The corresponding numbers
for those who used the QUTMAC are also shown. The authors argue that those who use QUTMAC are nearly twice as likely to complete the course as the whole cohort and half as likely to discontinue studying engineering. Again, causality cannot be inferred but this is evidence of value. Furthermore, when universities are under increasing scrutiny to explain how they are dealing with wastage, this sort of evidence points crucially to the fact that a university with an MSLS facility is being proactive and successful with students who are willing to engage with what is on offer.

Table 3. Showing the link between MSLS use and completion or discontinuation (adapted from Cuthbert & MacGillivray [32]).

<table>
<thead>
<tr>
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<th>Completed by end of 2006</th>
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<td>Total enrolled in 2002</td>
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<td>Used MAC programmes</td>
<td>171</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>(49.71%)</td>
<td>(49.71%)</td>
</tr>
</tbody>
</table>

For quantitative performance data such as marks or percentages, relationships are often of interest and are presented in scatter plots. For example, Figure 5 and 6 of [27] are scatter plots of students’ overall result in the mathematics course against the result of an initial diagnostic test, with different symbols for students who used or did not use MSLS services after failing the diagnostic test. In fact this data shows the value of linking diagnostic test results with targeted support. Evidence in [27] shows that, in the main, those who were offered and accessed additional support succeeded. On the other hand, most of those who did not respond to offers of intervention went on to fail. In related work by Bamforth et al., [33], plots of final marks against diagnostic test marks are given, again with different symbols for users/non-users for two years. The paper comments that the beneficial results seen in the first year were not repeated in the second year, but when numbers of visits were considered, the indications were that differences in these may explain the different graphs for the two years with only regular centre users succeeding. The number of visits by particular students in this example, often called a confounder in statistics, is clearly linked to levels of engagement, and is a variable which needs to be considered to obtain a true understanding of what is going on.

For investigating relationships between quantitative variables such as overall result, result in diagnostic test, number of visits, and including other variables such as level of school maths or results in a prerequisite course, multiple regression or, more generally, general linear models are used. In [34], such techniques were used to investigate whether and how use of MSLS, number of attendances, and level of school mathematics affect overall result, with the mark in the first assignment being included in the possible predictors to provide the reference “base” measure. An interesting aspect of these results was that in comparing students with the same mark for their first assignment, attendance at least once was significant for students with advanced maths at school but the number of attendances was not. For students with the lower level of school maths, the number of attendances was
significant. This is consistent with the findings of Bamforth et al [33] because her students entered with poor levels of school mathematical attainment. Analysis of the following semester’s results, using both first semester and the result in the first assignment, showed that the effect of the level of school maths lasted beyond first semester and was very substantial, as was whether or not the student used the MSLS. Investigating a number of quantitative performance variables like these requires the techniques of general linear models. If estimates of average marks are given for groups, interval estimates should be used to incorporate both variability and number of observations, as in [2].

Unlike marks and percentages, attrition data is binary, so in investigating relationships with use/non-use of MSLS, data can be presented in a two-way table as in Table 2 above, with a test of independence as in [2]. If it is desired to investigate the effect of variables such as number of visits, mark in a prior course or assessment item or level of school mathematics, logistic regression could be used.

In a more recent attempt to measure the effectiveness of their centre Mac an Bhaird, Morgan & O’Shea [35] also analysed the end of year grades of students who attended and compared them with those that did not. Because so many unknown factors affect performance (the authors refer particularly to not knowing how hard students work, and how much time they spend studying, and note that perhaps only the best students used the centre), they also tried to take into account performance in past (school level) examinations. The students in the study had all taken the Irish Leaving Certificate at either Ordinary Level or Higher Level. They found that, breaking attendance down by Leaving Certificate Grade, the mean mark of students who attended the centre was always higher than the mean mark of those who did not. Furthermore, for those less well-qualified mathematically on entry, the pass rate of the group of attendees was higher than the pass rate of the group that did not attend. Their study also looked at whether using the centre helped students who had performed poorly on a diagnostic entry test and found evidence of a positive effect.

Patel & Little [36] in a study of engineering students counted the number of mathematics related module passes associated with use or non-use of their centre. Their data shows a greater proportion of mathematics related module passes are associated with centre use than with non-use.

Finally, Patel & Samuels [37] describe an attempt to add a new dimension by measuring the relationship between mathematics support effectiveness and students’ approaches to studying. In addition to diagnostic testing on entry, they have developed an existing ‘approaches to study’ inventory designed to draw out information on the students’ learning styles. They intend to combine this with information about which mathematics support methods students avail themselves of: one-to-one help, on-line resources, diagnostic test and remediation, workshops and examination revision. They hypothesise that some modes of mathematics support work better for some types of students, and their study intends to learn more about this. Preliminary results will be available in due course.

**4.3 Other indicators of effectiveness**
In addition to the measures of success outlined above, there are publications which refer to other indicators of the value of mathematics support efforts. For example, Gill and O’Donoghue [25] in a paper concerned with justifying the existence of mathematics learning support note that their centre is a key selling point by the university in the recruitment of mature students – a university strategic goal. Many such students have been out of formal education for “anything from 2-30 years and find themselves falling into a learning gap”. They draw attention to the fact that almost all of the degree programmes in their university require students to study mathematics, so most of these mature learners will need to study mathematics or statistics at some point. They have specially targeted support provision for mature students, and have witnessed very significant growth in numbers between 1999 and 2005.

Gill and O’Donoghue [25] also cite the following as other measures of success: the number of departments in the university whose students make use of MSLS; the number and value of externally funded projects which are attracted by the presence of the centre; the collaborative links they have been able to establish with centres elsewhere; research outputs on transition from secondary to university mathematics and understanding adults’ approaches to learning and doing mathematics, including higher degrees awarded in these areas.

5. Ongoing need for learning support in mathematics and statistics

The reasons for ongoing need for MSLS lie in the nature of mathematics and statistics, in the manner in which they underpin or are an important component of (the vast majority of) other disciplines, in the ways they are called on at tertiary level, and in the widespread lack of recognition or acknowledgement of the many dimensions and roles of mathematical and statistical thinking in the higher order processes demanded at tertiary levels.

Considerations of similarities and contrasts with language and physical prowess can also help in understanding why and how mathematical and statistical skills and confidence are of such significance. Mathematics is a natural human activity, as fundamental and important as language. Like language, mathematical skills and thinking underpin much in other areas, and tertiary study asks for them to be accessed and used confidently and promptly in new and sometimes taxing contexts. Like language, mathematical confidence and thinking need time to develop; they need to become a part of the person; and, if specific skills are needed in a fully usable, transferable way, then both mathematics and language need to be studied significantly beyond the level of those specific skills. There are also similarities between mathematics and sport. Physical activity is natural to humans and physical health is important for both success in, and quality of, life. The “having” of physical skills is not a dichotomy across individuals. Natural capabilities in physical and sporting skills are a multi-dimensional and multi-faceted complex continuum across individuals, but everyone can develop their inherent skills, often extensively. And it is increasingly recognised that general fitness is necessary to develop sport-specific skills – just as general mathematical fitness is needed to develop discipline-specific quantitative skills. Unfortunately the level of acceptance and accolades given by society to the rigorous development of sporting skills through regular training, is not extended to the development of mathematical skills.
At the same time as mathematical and statistical skills are increasingly demanded at tertiary level, there are other factors which inhibit the adequate prior acquisition of basic skills. In many parts of the developed world young people are alienated from the study of mathematics and the widespread availability of alternatives to rigorous mathematical study mean that students can and do vote with their feet. Furthermore, as access to tertiary level education has widened, and governments such as that in the UK have ambitious targets to raise participation levels, it is often the case that these “additional” students embarking on higher education courses have less highly developed mathematical foundations than would traditionally have been the case. The problem is compounded when there are insufficient numbers of mathematically qualified teachers in schools – a situation recognised in the report from the Post-14 Mathematics Inquiry under Professor Adrian Smith [38] who wrote:

In the short term, the Inquiry believes that Higher Education has little option but to accommodate to the students emerging from the current GCE process. Many are, of course, already doing this through, for example, the provision of first year enhancement course.

The totality of mathematics support in the above broad sense in a university comes from mathematics and statistics departments, relevant staff in other disciplines, and learning support in mathematics and statistics in the way in which this term is now generally used and described here. The components and their mutual arrangements within this totality depend on the university, its courses and structures. The focus of learning support tends to be on building mathematical fitness, confidence and transferability, all with reference to the specific courses being taken by the students. It is relevant to note that Thomas [39] discusses measures to improve retention more generally, particularly in respect of widening participation, and recommends that these are carried out as a formal institution-wide activity and not just the responsibility of a few people ‘who care’. We would argue that the same recommendation can be made of mathematics support particularly because the need will be ongoing and widespread.

6. Conclusions

This paper has described how mathematics and statistics support initiatives within universities, in a variety of manifestations, have now become widely established. The comprehensive audits which have taken place in the UK, Ireland and Australia give credence to this assertion, though data gathered formally from other parts of the world would add further valuable evidence. Samuels and Patel [18] provide evidence that the community is maturing and that scholarly practice within this community is now much more prevalent. Whilst practitioners in the field feel in their hearts that the work they are doing is valuable, and know from first hand experience how their work has changed individuals’ lives, there is a professional impetus to move from the anecdotal to the formal, research-based acquisition of data on effectiveness of our collective efforts. This requires a culture shift by practitioners and institutions, given that many workers are much more interested, naturally, in the face-to-face, day-to-day work with students, than in data collection and analysis. Furthermore, as the audits show, resources (and sometimes the expertise) to undertake this parallel work are scarce. Nevertheless, a shift is occurring and we have witnessed a growing body of literature describing not just implementation of initiatives but also ways in which they are being evaluated. This paper has set out a framework to help those thinking about embarking upon
evaluation of mathematics and statistics support to start to shape up their ideas. It has described how this can be done qualitatively and quantitatively for both usage and performance data. Some of the ways other workers are already doing this have been cited by way of example. More recent attempts to match support to learning styles and to understand more about ways in which students’ mathematical identities are influenced by mathematics support have been described. The mathcentre site, (www.mathcentre.ac.uk), contains a growing archive of research papers which set out to evaluate mathematics support centres, and readers are encouraged to contribute their own published papers (or Abstracts where the full paper cannot be archived for copyright reasons).

7. Acknowledgements

The authors would like to thank the many practitioners in MSLS centres with whom they have had fruitful discussions about ways in which effectiveness can be measured. In particular, thanks go to Dr Carol Robinson for permission to reproduce her data on support centre usage.

8. References.


# TABLES

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<tr>
<td></td>
<td>Pass</td>
<td>Fail</td>
<td>Total</td>
<td>Pass</td>
</tr>
<tr>
<td>Visit</td>
<td>22</td>
<td>19</td>
<td>41</td>
<td>Visit</td>
</tr>
<tr>
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<td>157 (29.24%)</td>
<td></td>
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<tr>
<td>Used MAC programmes</td>
<td>171</td>
<td>85 (49.71%)</td>
</tr>
<tr>
<td></td>
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<td>43 (25.15%)</td>
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</tbody>
</table>
Figure captions:

Figure 1. Cumulative student visits of support facilities over each of six academic years demonstrating year-on-year growth in demand (provided courtesy of Dr Carol Robinson).