Section 8:

Individual differences and needs in mathematics support

This section of the Guide aims to provide you with an awareness of some of the implications of the non-academic differences between students in the context of tutoring in the mathematics support centre. Included are some activities, focused around scenarios, which you may wish to ask the lead of your Centre to use within a training session for those new to providing mathematics support.

These non-academic differences are important because they can affect students' ability to gain from the way we try to help them – especially if we adopt the same approach to every student based only on their presented academic, as opposed to non-academic, needs. As members of staff we also have a duty of care towards students, so awareness of individual differences or needs might mean we are better informed to refer a student to another university professional who can assist them better.

The five areas of differences and needs that are covered in this section are:

- Thinking styles;
- Learning styles;
- Maths anxiety;
- Specific learning differences;
- Counselling.

Thinking Styles

We start this Section with an Activity to get you thinking about the way you and others think!

Activity (3 minutes)
On a blank sheet of A4 paper, using four differently-coloured pens, copy Figure 8.1, changing pens in sequence approximately every 45 seconds. When you have finished, provide a key of the order you used the pens, e.g. 1. red, 2. green, etc.

This activity will help demonstrate how people have different thinking styles: if several people independently attempt this task, some will work from the outline to the detail whilst others will work through different areas of detail in turn. Sharma (1989) applied this idea to simple mathematical thinking and has characterised these two opposite thinking styles as 'grasshoppers' and 'inchworms' which can be differentiated as shown in Table 8.1.

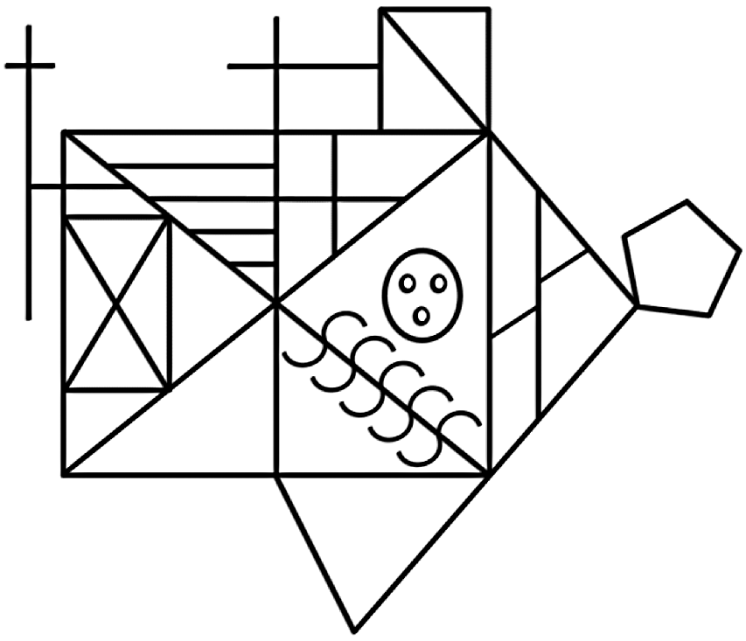

Figure 8.1: Diagram adapted from Rey-Osterrieth Complex Figure

	Inchworm	Grasshopper
I. Analysing and identifying the problem	1. Focuses on the parts and details; separates 2. Looks at the numbers and facts to select a relevant formula or procedure	1. Tends to overview; holistic; puts together 2. Looks at the numbers and facts to estimate an answer or restrict the range of the answer; controlled exploration
II. Solving the problem	3. Formula, procedure orientated 4. Constrained focus; uses a single method 5. Works in serially ordered steps, usually forward ('rifle') 6. Uses numbers exactly as given 7. More comfortable with paper and pen; documents the method	3. Answer orientated 4. Flexible focusing; methods change 5. Often works back from a trial answer; multi-method ('shot gun') 6. Adjusts, breaks down/builds up numbers to make an easier calculation 7. Rarely documents the method; performs calculation mentally
III. Checking and evaluating	8. Unlikely to check or evaluate the answer; if check is done, uses the same procedure or method 9. Often does not understand procedure or values of numbers; works mechanically	8. Likely to appraise and evaluate answer against original estimate; checks by an alternate method 9. Has good understanding of the numbers, methods and relationships

Table 8.1: Cognitive styles of the inchworm and grasshopper *(Chinn, S. and Ashcroft, R. (2007) Mathematics for Dyslexics, 3rd Edition, Chichester: John Wiley & Sons)*

An example of its application to more advanced mathematical thinking is the solution of ordinary differential equations (ODEs), such as:

$$\frac{dy}{dx} = 3x + 2y, \quad y(0) = 1$$

A characterisation of their possible approaches is given in Table 8.2. Whilst the inchworm may get more questions correct more quickly they may not have as good a holistic understanding as the grasshopper.

Another consequence of this theory is that students may not have the same cognitive style as their tutors. Tutors need to be careful that they do not judge students' work incorrectly by only seeing it from their own preferred thinking style.

Inchworm	Grasshopper
Recognises the equation as a coming from particular class of ODE	Plays around with the equation, e.g. tries differentiating e^{2x} and ye^{2x}
Rearranges the equation into standard form	Eventually realises that the terms involving y must be considered as the derivative of the product ye^{-2x}
Finds for the integrating factor	Rearranges the equation appropriately and multiplies both sides by e^{-2x}
Writes the solution down using the standard form without really understanding the process	Integrates both sides and applies the boundary condition to obtain the solution

Table 8.2 Characterisation of the approaches of inchworms and grasshoppers

Learning Styles

Students adopt different learning styles when studying mathematics. A summary of current research into learning styles in mathematics and numerate subjects is shown in Table 8.3:

One implication of these styles is that the proportion of students with different styles attending the drop-in centre will change at different times in the academic year. For example, additional drop-in centre hours close to examination periods would be more suitable for strategic and procedural surface learners.

Approach to studying	Strategy	Intention
Deep	To transform knowledge and integrate ideas	To understand and integrate to prior knowledge
Surface	To reproduce information	To simply reproduce contents
Strategic	To combine approaches to suit need	To pass assessments
Procedural deep	To relate knowledge to other knowledge	To understand through problem solving procedures
Procedural surface	To memorise processes	To pass assessments

Table 8.3: Learning styles in mathematics and numerate subjects (Patel & Samuels, 2009)

Maths Anxiety

We introduce maths anxiety by asking you first to consider and discuss the following scenario:

Scenario 1

Two female final year nursing students come to the drop-in centre. They appear nervous and defensive. When it's their turn they tell you that they have failed their nursing numeracy test twice and if they fail it once more they will be thrown off their course.

Discuss:

- *Their possible mathematical needs*
- *Their possible other needs*
- *How would you change your approach?*

Maths anxiety is tension, apprehension or fear that interferes with maths performance. It is a 'non-intellectual' factor that nonetheless interferes with educational and career choices. It is only weakly related to general intelligence. It can also result in physical signs, such as sweating, rashes or an increased heart rate. It is reliably elicited by asking the simple question: *"On a scale from 1 to 10 how maths anxious are you?"*

Maths anxiety is particularly relevant to subjects such as nursing as nursing students may have a weaker maths background, have spent many years without doing maths, be less confident and less interested in maths, and feel socially intimidated by the drop-in centre environment. Nevertheless, they are forced to pass a maths test in order to become professionally qualified.

Maths anxiety may also create a vicious circle of short-term memory overload as shown in Figure 8.2. Given a mathematical problem, a student will approach it with a certain level of knowledge. However, at the same time that they identify the problem they may also trigger a negative emotional reaction to it (for example, simply thinking about the word 'fractions' can cause anxiety in some students). Then instead of thinking about how to solve the problem they are distracted by these negative thoughts and their performance may not be as successful at it could be. This poor performance then strengthens their negative attitude towards the subject (for example, "I can never do fractions") making a vicious circle. This can then lead to a sudden drop in performance above a certain level of difficulty as their working memory simply cannot cope with both the complexity of the problem and the anxiety reaction to the problem at the same time.

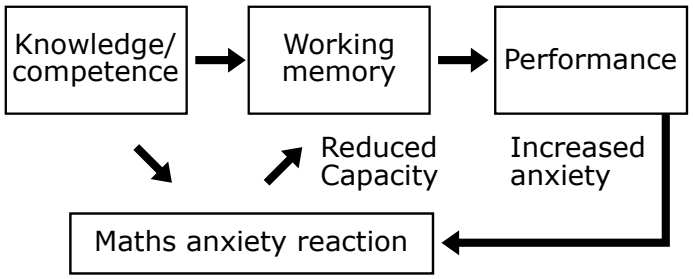

Figure 8.2: The maths anxiety reaction cycle

Tips for Overcoming Maths Anxiety

The following are some suggestions of ways in which you can help a student to overcome their maths anxiety:

- Concentrate on small successes in order to build confidence and self-belief;
- Fill knowledge gaps;
- Consider using physical techniques, such as breathing exercises;
- Consider receiving counselling for negative past experiences of learning or doing mathematics;
- Encourage the student to improve their test-taking strategies:
- There's no need to be a perfectionist – use a strategic approach based on your strengths, not anxiety about your weaknesses;
- Practice without a clock and slowly build up to timed practice;
- Try making learning enjoyable, for example use maths gaming sites[14];
- Don't over prepare the night before a test.

Sources: (Arem, 2009; Hembree, 1990; Sabin, 2002).

Specific Learning Differences

We introduce specific learning differences by asking you first to consider and discuss the following scenario:

Scenario 2

A male first year student comes to the drop-in centre and asks for help with matrix multiplication. His work is untidy and disorganised. You try to help him but he finds it hard to follow your written explanation. He also appears distracted by the noise in the centre and doesn't give you eye contact. He eventually leaves complaining of a headache from the bright lights.

Discuss:

- *What do you think is going on?*
- *How might you change your approach?*

Specific learning differences (SpLDs) are different ways of processing information. They are not a sign of a lack of intelligence but they can interfere with higher level academic tasks. They cover a spectrum of inter-related difficulties. Individuals with SpLDs may have an associated identity problem (e.g. they may 'feel' stupid). Common examples are:

Dyslexia – Difficulty in processing the mechanical aspects of language; also related to visual stress[15].

Dyscalculia – An inability to connect with numbers and basic maths concepts[16].

Dyspraxia – Difficulty with motor skills and sequencing multiple step tasks[17].

Autism (including Asperger's syndrome) – Difficulty relating to the physical word socially, in communicating and behaviour – appears like 'watching a film'[18].

Tips for tutoring students with Specific Learning Differences

- Treat all students normally, with warmth and respect;
- If a student tells you that they have a SpLD:
  - If they've been identified by an educational psychologist they may be able to receive free equipment and extra support from a specialist under Disability Support Allowance funding;
  - If they haven't you could refer them to your Disabilities Office for screening.
- Consider changing the environment:
  - Adjust the light and reduce background noise (if they are a problem);
  - Offer to use coloured paper;
  - Cover up distracting information;
  - Leave gaps between lines / use short sentences (dyslexics).
- Don't be over offended by students' body language – they may not be aware of normal social rules (autistics).
- Finally, if you suspect that a student may have a specific learning difference but they have not disclosed this to you, DO NOT suggest to them that they may have one. Identification of specific learning difficulties can be a sensitive process requiring the professional expertise of educational psychologists, SpLD advisors and counsellors. However, it may be possible to gently refer a student to a SpLD advisor without offending them or causing unnecessary anxiety. If in doubt, seek the advice of your Centre Manager.

Source: (Pollak, 2009)

[14] See for example: www.mangahigh.com
[15] See http://ddig.lboro.ac.uk/self_check_list.html for a checklist
[16] See http://www.sussexpatoss.org/documents/Helen_Arkell/CawseGillian_DyscalculiaChecklist.doc for a checklist
[17] See http://www.civilservice.gov.uk/about/resources/diversity/toolkits/dyspraxia.aspx for a checklist
[18] See http://www.educational-psychologist.co.uk/autismcklist.htm for a checklist

Counselling

We introduce counselling by asking you first to consider and discuss the following scenario:

Scenario 3

A female postgraduate student comes to the drop-in centre in a quiet period asking for help with her quantitative analysis.

When you begin to explain a statistical technique to her she suddenly bursts into tears and explains that she has just split up with her long standing boyfriend, has only 2 weeks to finish her dissertations and has major financial problems.

Discuss:

- *What would you do?*
- *What issues do you need to be aware of?*

McGahey and Szumko (2006) promote Rogers' (1979) Person-Centered Approach (PCA) to counselling in the context of personal tutoring. PCA has three basic elements (adapted from Rogers, 1979):

- **Congruence** – Genuineness, realness, authenticity: The more the tutor is him or herself in the relationship, putting up no professional front or personal facade, the greater is the likelihood that the tutee will change and grow in a constructive manner. It means that the tutor is openly being the feelings and attitudes that are flowing within at the moment. The term transparent catches the flavour of this condition – the tutor makes himself or herself transparent to the tutee; the tutee can see right through what the tutor is in the relationship; the tutee experiences no holding back on the part of the tutor.
- **Unconditional Positive Regard** – An attitude of accepting, caring or prizing: When the tutor is experiencing a positive, acceptant attitude toward whatever the tutee is at that moment, therapeutic movement or change is more likely. It involves the tutor's willingness for the tutee to be whatever immediate feeling is going on – confusion, resentment, fear, anger, courage, love, or pride. It is a non-possessive caring. The tutor prizes the tutee in a total rather than a conditional way.
- **Empathy** – Understanding the person from their internal 'frame of reference': This means that the tutor senses accurately the feelings and personal meanings that are being experienced by the tutee and communicates this understanding to the tutee. When functioning best the tutor is so much inside the private world of the other that he or she can clarify not only the meanings of which the tutee is aware but even those just below the level of awareness. This kind of sensitive, active listening is exceedingly rare: very rarely do we listen with real understanding, true empathy.

McGahey and Szumko (2006) assert that the use of these techniques in tutoring can lead to effective learning as they break down the power relationship between the tutor and the tutee and enable the tutee to be treated more as a whole person whilst still maintaining a professional relationship.

Consider your attitude and approach towards students in your drop-in centre: how might they be improved by adopting these principles?

Counselling techniques are also relevant to tutoring in the drop-in centre in other ways:

- It is important to be aware of your own safety and professional boundaries in a drop-in centre;
- It may sometimes be appropriate for your Centre Manager to refer a student to another professional service, such as counselling, finance or mental health (most commonly for anxiety and depression). If in doubt, discuss this with your Manager.

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Section 9:

Scenarios You Might Encounter

Providing Mathematics support in Higher Education is potentially a very challenging experience. A range of student motivational factors and learning styles are constantly observed and this should not be underestimated. Given the range of approaches to learning adopted by students, it is vitally important for tutors to consider how they might respond to the variety of situations that occur. Support which would be excellent for one student might be futile for another.

To this end four typical student profiles have been created to help tutors reflect upon the range of strategies that might be employed when dealing with students. Following each profile described below there are some additional questions and comments to provoke further debate and self-reflection. There will not necessarily be a correct way of dealing with any of these scenarios.

Note that this is not an exhaustive list of scenarios and questions. Indeed you are encouraged to raise further questions and explore a wider variety of situations with your colleagues in the Support Centre.

Scenario A: "I can't do maths"

David is currently on a Chemistry degree scheme with a high numeracy content. As the main focus of the degree scheme is Chemistry, and not numeracy, the numeric part of the course is taught very quickly with multiple question sheets set. He has never felt particularly confident with maths, and the high turnover of work that he has to do makes him feel less and less secure about his ability.

David attends a mathematics support centre with a file full of jumbled notes, half attempted question sheets and an uncompleted coursework that is due in the next few days. When he is approached by a support tutor, and asked what the problem is, he replies "I can't do maths".

Question A-1: How can a tutor encourage a student to engage with mathematics if they have already convinced themselves that they 'can't do it'?

Phrases such as "I can't do maths" or "I'm not mathematically minded" are heard all too often when providing Mathematics Support. In these cases reassurance that the student is not 'just stupid' is vital. It is very likely that it has taken the student a great deal of deliberation to simply attend the support session and therefore it is important to try and establish what the student can do and build on those experiences. It can help to take time to discuss what the student enjoys studying, the level of their mathematical background, how they tend to approach mathematics. Creating the right environment for the individual is essential before diving in to any technical problems.

Question A-2: How can a tutor be expected to assist a student who himself doesn't know where to start?

This question is not meant to imply that the students query should simply be dismissed until he sorts himself out. Moreover it is about establishing clear student/tutor expectations to emphasise the process of support as a two-way experience with input required from both student and tutor. For example, it could be suggested that before discussing any mathematical problems the student is given the responsibility of organising and reviewing his work to determine where the problem areas might be. The tutor can then make suggestions on how appropriate (and realistic) assistance might be provided in relation to the specific topics raised by the student. All the time, it is important to maintain a positive atmosphere during such discussions.

Scenario B: – "Here is my data, what statistical test do I use?"

Afia is a postgraduate student in Optometry, and has been collecting data for her thesis over the past three years. She has little experience of statistics, and has only picked up some key terms and concepts from browsing the internet. When it comes to finally analyse the data, her supervisor, who knows very little about statistics, recommends that she attends the Maths Support Service.

Afia attends Maths Support, with a laptop and a spreadsheet full of data. After explaining to a tutor the story behind the data, she asks "What statistical test do I use?"

Question B-1: What exactly is the research trying to show? i.e. Is there a clearly defined hypothesis?

The first point to note is that queries of this nature can be very time consuming, but it is vitally important before even looking at the data, to get the student to clearly explain what they are trying to establish. It may be that no consideration to the statistical testing has been given until after all the data has been collected, and as a result the recommendation of a specific statistical technique may be difficult without some additional analysis of the data. It is very important to be clear to manage expectations during the session. It is not the responsibility of the tutor to carry out the analysis, but merely steer the student to the appropriate resources so they may carry out the analyses themselves.

Question B-2: Is it appropriate for a postgraduate tutor to be responsible for advice given to another postgraduate research student?

This is possibly more of a strategic consideration for those coordinating the support service. However, in particularly busy support sessions, a tutor can very easily get involved in a query before establishing the level of the work under

consideration. In all such cases (not just when considering statistical work) it can be difficult to inform a student that you are not the most appropriate tutor to discuss such queries. Nevertheless if at any point a tutor is not comfortable dealing with a particular query (for any reason) it should be referred to a more experienced tutor.

Scenario C: "How do I integrate – my exam is later this afternoon"

Sachin has an exam later this afternoon and so runs into Maths Support with just a few pens and pencils. He always leaves things until the last minute, and is still unsure how to integrate some simple functions, but he wants to be quickly taught the basics so that he might do better in the exam this afternoon. He can stay for twenty minutes only, and so asks a tutor "How do I integrate?"

Question C-1: Should support actually be offered to the student in this situation?

It might be argued that providing support in this situation would be unproductive given the lack of time available for the student to reflect on the ideas discussed. However, if it is possible to provide support to students (within any time/resource constraints) then support should be made available. Simply reviewing techniques that the student may/may not know will help reinforce ideas and hopefully provide the student with enough confidence to at least attempt similar problems. It is important in such circumstances for the tutor to remain calm and positive so as not to further agitate the student. It may also be helpful to enquire if the student has all the necessary equipment for the examination.

Question C-2: Is it the responsibility of a Maths Support Tutor to try and avoid this situation from happening in the future?

Ultimately it is the responsibility of the student to be prepared for an examination. However, as well as informing students on specific mathematical queries, tutors should be constantly encouraging generic study skills such as time-management, reading mathematical texts, mathematical writing, problem solving etc. In this situation, it would be appropriate to discuss honestly the importance of exam preparation, so that the support available can be fully utilised in the future to discuss any queries that may arise well in advance of the actual exam.

Scenario D:"How do I do question 4?"

Poppy is a Maths student, who has been working on a coursework assignment in the library. She manages questions 1 to 3 fine, but comes to a halt as soon as she sees question 4. She looks at the time, and notices that a Maths Support session is happening down the corridor.

Poppy walks into Maths Support with the coursework sheet, and asks the tutor "How do I do question 4?" Afterwards, she calls into Maths Support again, and asks "Is my answer correct for question 2?"

Question D-1: Should a tutor encourage a student to consider more generic ideas instead of focussing on the answer to a specific question? If so, how might this be achieved?

It should be noted that a tutor is not expected to know the answer to all the problems posed in a support session. Indeed it can be a positive situation not to know the answer as it allows the tutor to demonstrate the problem solving techniques they would adopt to attempt to solve the problem. This might include some simple ideas such as exploring resources for more information (texts, internet etc.), or solving a simplified but similar problem. Again, emphasis on such skills will hopefully encourage the student to become more independent when faced with similar barriers in the future.

Even if the required method is known, instead of demonstrating the solution, a tutor could encourage the student to engage with the problem by posing suitably related questions. For example, a tutor might ask the student, "What techniques do you think are appropriate for this example, and why", "Have you seen/attempted any similar or related examples? What techniques were used there?" Students should also be encouraged to check their own work and reflect upon the answers they obtain; this should also include a discussion about methods students can use to check their answer. For example, could the answer be checked numerically? Could it be checked using a computer package?

Question D-2: Given their mathematical background, should a Mathematics Undergraduate be treated differently to a student from another discipline?

All students should be treated as individuals, and just because a student studies a particular degree scheme it does not mean that they should receive a different level of support or understanding. However, if through discussions it is established that a student has a more detailed mathematical background and has more confidence with their mathematical ability, then some of the techniques outlined above could be further emphasised. For example, asking the student to search for additional information, asking the student to attempt the problem before discussing it further, maybe asking the student to join a group of her peers to discuss the problem, would all be valuable techniques that would benefit the student's learning.

Clearly, many of the suggestions above have applications to a number of scenarios. All can and should be adjusted according to the individual query and student. Having the mathematical knowledge is important, but it could be argued that it is equally important to be able to clearly communicate with students in order to develop an environment where students can feel relaxed and are suitably encouraged to discuss and explore ideas. Care must always be taken to not over-burden a student but at the same time get the student involved and engaged in their own learning journey.

All this makes assisting in mathematics support a challenging, yet extremely rewarding experience.

Appendix 2:

Handout: Individual Student Differences in Mathematics Support

Activity 1

On a blank sheet of A4 paper, using four differently-coloured pens, copy the figure shown, changing pens in sequence approximately every 45 seconds. When you have finished, provide a key of the order you used the pens, for example:
1. red, 2. green, etc.

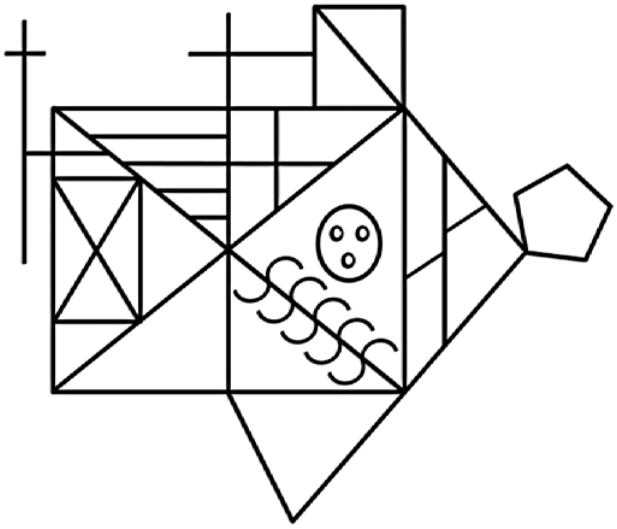

Diagram adapted from Rey-Osterrieth Complex Figure.

Activity 2

Consider the scenarios below. The leader of the workshop will identify which scenario(s) you should consider and discuss within your group. Don't forget to identify someone who will report back to the larger group.

Scenario 1

Two female final year nursing students come to the drop-in centre. They appear nervous and defensive. When it's their turn they tell you that they have failed their nursing numeracy test twice and if they fail it once more they will be thrown off their course.

Discuss:

- *Their possible mathematical needs*
- *Their possible other needs*
- *How would you change your approach?*

Scenario 2

A male first year student comes to the drop-in centre and asks for help with matrix multiplication. His work is untidy and disorganised. You try to help him but he finds it hard to follow your written explanation. He also appears distracted by the noise in the centre and doesn't give you eye contact. He eventually leaves complaining of a headache from the bright lights.

Discuss:

- *What do you think is going on?*
- *How might you change your approach?*

Scenario 3

A female postgraduate student comes to the drop-in centre in a quiet period asking for help with her quantitative analysis.

When you begin to explain a statistical technique to her she suddenly bursts into tears and explains that she has just split up with her long standing boyfriend, has only 2 weeks to finish her dissertations and has major financial problems.

Discuss:

- *What would you do?*
- *What issues do you need to be aware of?*

Appendix 3:

Handout: Scenarios You Might Encounter When Providing Mathematics Support

Consider the scenarios below. The leader of the workshop will identify which scenario(s) you should consider and discuss within your group. In each case you should identify what you would do to support the student and agree as a group on what your actions would be.

Don't forget to identify someone who will report back to the larger group.

Scenario A: "I can't do maths"

David is currently on a Chemistry degree scheme with a high numeracy content. As the main focus of the degree scheme is Chemistry, and not numeracy, the numeric part of the course is taught very quickly with multiple question sheets set. He has never felt particularly confident with maths, and the high turnover of work that he has to do makes him feel less and less secure about his ability.

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Scenario B: "Here is my data, what statistical test do I use?"

Afia is a postgraduate student in Optometry, and has been collecting data for her thesis over the past three years. She has little experience of statistics, and has only picked up some key terms and concepts from browsing the internet. When it comes to finally analyse the data, her supervisor, who knows very little about statistics, recommends that she attends the Maths Support Service.

Afia attends Maths Support, with a laptop and a spreadsheet full of data. After explaining to a tutor the story behind the data, she asks "What statistical test do I use?"

Scenario C: "How do I integrate – my exam is later this afternoon"

Sachin has an exam later this afternoon and so runs into Maths Support with just a few pens and pencils. He always leaves things until the last minute, and is still unsure how to integrate some simple functions, but he wants to be quickly taught the basics so that he might do better in the exam this afternoon. He can stay for twenty minutes only, and so asks a tutor "How do I integrate?"

Scenario D: "How do I do question 4?"

Poppy is a Maths student, who has been working on a coursework assignment in the library. She manages questions 1 to 3 fine, but comes to a halt as soon as she sees question 4. She looks at the time, and notices that a Maths Support session is happening down the corridor.

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