

Project Report

**Maths Intervention Programme at Uxbridge College
supported by the West London Lifelong Learning Network**

9-10th February 2009

“Slow & Easy Maths – Differentiation”

1. Rationale:

Differentiation (calculus) is a difficult topic for students. It is important that students enjoy this important topic as it is widely used in Engineering.

The aim was to plan and deliver 2 sessions of 2.5 hours each, to make learning enjoyable, fun and make a difficult topic easy. Hence two sessions were carefully planned and delivered over 2 consecutive days.

Sessions were aimed at BTEC, HNC, and HND learners in Electrical/Electronic engineering. They were held from 6 pm-8.45 pm to enable those at work to attend.

The objectives of this project were to ensure students are offered tutoring using an ‘active learning’ approach to achieve particular learning outcomes for differential calculus. It was hoped that this approach would also act as an exemplar of good practice to other staff at the College, widely discussed at staff meetings and disseminated to other interested parties who may wish to duplicate this model of delivery. Commitment from Senior Managers was secured before embarking on the project.

2. Method of delivery:

The programme aimed to provide some interesting activities on Day 1 to build confidence and ensure learners understand the importance of differentiation, become familiar with key words, to appreciate links with gradient and basic applications in real life and in engineering. A number of examples were discussed to add to this context and help make learning points more memorable through practical and functional examples.

Day 2 involved calculation of turning points; further practical applications; differentiation of trigonometric functions; differentiation of function of function.

Two experienced and student centric tutors were present during both workshop sessions. They ensured the sessions were informal and relaxed.

The learning outcomes for Day 1 were:

- Describe what is meant by differentiation
- Calculate gradient of a tangent, $\tan \theta$ and differentiation
- Differentiate simple and polynomial functions
- State two applications of differentiation
- Calculate second differentiation

The learning outcomes for Day 2 were:

- Calculate turning points (maxima, minima, inflexion)
- Apply differentiation formulae to practical applications
- Calculate differentiation of trigonometric functions
- Calculate differentiation of function of function

3. Preparation and planning for agreed outcomes:

The WL LLN arranged collaboration between Uxbridge College and another local college provider (Southall and West London College), to share the expertise of one of their Subject Learning Coaches in Mathematics.

Two meetings were planned (2x3 hours each) between these colleagues. One of the Uxbridge tutors was also qualified as a Subject Learning Coach (SLC) in Mathematics. The aim was to share expertise, to plan the learning outcomes and activities.

Planning these sessions was hindered by finding the time to get together with competing timetables and having enough time to plan. The team ended up meeting twice for a total of 5 or 6 hours, but Graeme Moran, the consultant SLC advised they still hadn't quite finished. He commented that 'it was quite tricky to make sure we planned something different. At each stage we had to ask 'how do we normally do it? Okay, how can we make it different? More interactive?' The Uxbridge tutors spent further time fine-tuning the programme and powerpoint presentations.

Key aims were to facilitate learning in Mathematics, make it enjoyable and to actively engage learners. It was also agreed that the learners needed to work collaboratively, carry out discussions, enjoy problem solving and use differentiation in an engineering context. Agreement that the project would target small groups meant that weight was to be given to quality of outcomes, rather than quantity of outputs.

The learning offer needed to be notably different to other remedial maths classes, as per the recommendations of the Brunel Maths Conference in October 2008 for 'avoiding more of the same'.

It was therefore agreed that refreshments and snacks would be offered. As many attendees would be coming straight from work they would need sustenance. This would also act as an aid to having the sessions delivered with some informality and encourage a friendly collegiate atmosphere.

Independent activity, pair work and group work were planned. It was important to encourage a community of learning and develop a culture so that the learners can be good at mathematics. This was also to attempt to dispel the culture of it being acceptable to claim '*I was never any good at maths*'.

As Geoff Petty (2004) states, "Note that just any activity will not do. We need to set activities that require the learner to make constructs of important concepts, and then connections between these constructs. This requires the learner to reason as well as have direct experience. Many students do not bother to make constructs when they are just listening because of this lack of reasoning."

Petty also reminds us that relevant activity is not enough. "We also we need to get our students to think about this experience so they really do learn from it. We need to get them to explain it to themselves, to each other, and to you. This reflection is the active meaning-making process in action; it gets the students to form concepts, to improve them, and to create those long red explaining links that make the subject 'make sense'."

4. Delivery

Day 1:

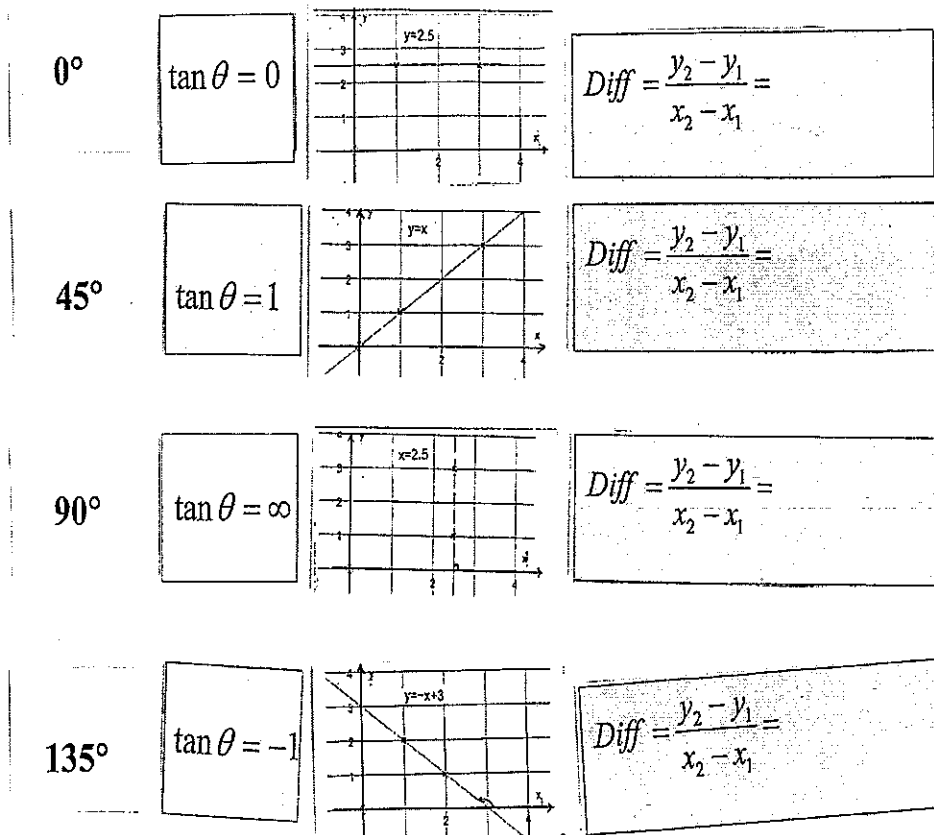
After introducing the topic, aims and outcomes were made known to learners. The session started with 5 minutes of brainstorm to explore the meaning of differentiation in Maths, followed by feedback from different pairs.

The next activity involved word search for key terms in differentiation. This was independent activity to introduce some key words in differentiation. The learners who finished early checked spellings of their peers. This helped ESOL learners with their spelling and understanding.

Petty's research further reminded us "not confuse the delivery of content with it's arrival. Or good explaining with good learning. In the end it is perhaps no surprise that students only get good at doing it --- by doing it!"

The next activity involved matching cards (see Figure 1 below). There were 4 sets of cards involving θ , $\tan\theta$, line graphs with gradients and differentiation. On the differentiation cards learners had to calculate differentiation by looking at points on the graphs. Linking the cards with geometry during this activity, learners concluded that $\tan\theta$, gradient of a line and differentiation has the same meaning.

Figure 1 – Matching Cards



The next activity was differentiation of function x^n where formula was introduced and an example was discussed. Learners were then paired up to carry out tasks and helped each other in problem solving.

Following this activity, learners discussed applications of differentiation viz. velocity and acceleration. The concept of second order differentiation was then introduced and learners carried out tasks on 2nd order differentiation, again helping each other and learning from their peers.

Finally the session was summarised, linking what has been learned already (eg gradient of graph). All the learners agreed that all the learning outcomes were achieved.

Day 2:

The workshop started with recap for 10 minutes followed by the feedback. Then aims and learning outcomes were introduced. There was a big jump in the work and it proved challenging.

The new activity started with turning points for the curve and introduction of maxima, minima and point of inflexion. Learners worked in pairs and those pairs who finished early helped others.

We then introduced problems on further practical applications of differentiation in Engineering which were solved by the learners. Students acted as Maths advocates (refer Section 5 below). This worked well, particularly as we found that A-level maths students from abroad still had difficulty and couldn't link through to practical application.

Following this, differentiation formulae of trigonometric functions were introduced. Finally differentiation of function of function was carried out.

During the sessions, the tutors were not shy of using mathematical language. It was felt that repetition of maths language was essential, continually linking to examples (eg time/distance; acceleration/velocity; depth of sea/river and how it changes; production volume; min/max capacity of some materials etc).

All learners filled in the evaluation forms and the tutors distributed USB sticks, learning material and engineering career brochures provided by West London Lifelong Learning Network. Finally the session was summarised and again learning outcomes were achieved.

The learners were provided with all the resources including power point presentations on both days. They were actively involved in learning new mathematical concepts and took part in collaborative learning with their peers. There was constant support available from the 2 facilitating tutors.

5. Maths Advocates and Maths PALs

Part of the project aims were to involve learners as maths advocates and involve them in peer assisted learning (ie Maths PALs) to test the effect on their levels of confidence.

4 learners were selected for this role, but as these learners were not confident in all aspects, they were changed at appropriate and practical times for different topics, depending on their understanding of those topics.

Peer learning went very well as the students learned from each other. Explaining tasks to other learners clarified the advocates' doubts and made them more confident in those topics. The longer term results of this are that most of the students attending these sessions are now able to lead in the class and the maths advocates in particular have become experts in the topic.

6. Embedding and Sustaining

A similar strategy using cards has also been introduced into the lesson plans at Level 2 and 3 at Uxbridge College. The tutors used some easier tasks with less complexity and have had good success with this method.

In addition, they feel there is scope for inviting other lecturers to participate and to observe the delivery of these learning sessions, thereby spreading the use of more innovative techniques, being flexible and responsive in teaching and learning mathematics and fostering a culture of creativity and innovation.

The programme can be repeated but both tutors felt the programme needed more time, to enable further repetition, particularly to practice changing co-ordinates x and y and linking back to the cards to test and link to knowledge of geometry. An additional hour was suggested; however this would not be a best fit with learners coming in from the workplace.

The tutors enjoyed the interaction with their colleague from Southall College and are now demonstrably transferring their experience into other lessons. They are both giving further consideration to assisting the West London Lifelong Learning Network with other maths intervention workshops aimed at Apprenticeship progression. Although both are very experienced maths tutors, this additional activity and experience would contribute favourably to their further professional development.

Measurable results are not available in terms of students completing their tests, exams or passing the differentiation questions compared to past years. However, three months later, it has been evident that students who attended the course are leading other students in the classroom and providing support. 'Maths PALs' and Maths Advocates have been recognised within the group and these individuals have since grown to become experts in the topic.

Each participant of this programme was issued with a certificate of completion for the workshops (see Appendix II). This was signed by the principal of the College and the Executive Director of the Lifelong Learning Network and presented to the learners by their tutors.

7. Cost of provision – WL LLN Project No 0809017

Total project budget:	£1,240
Funding requested from WL LLN:	£750
Match funding agreed: List sources	£490 approved for preparing estate facilities; food and drinks; materials; photocopying; general admin support and any additional staff time to successfully deliver this project
Outline of how the total project budget will be spent: Include staff time, resources, stationery, travel, etc	£250 payable to Maths Subject Learning Coach as a separate consultancy payment £250 x 2 = £500 for 2 staff members at Uxbridge College to collaborate and prepare material and to facilitate and deliver 2 workshops on consecutive days at the College.

8. Conclusions

Most students found the sessions demanding. Some found it a little stressful, as evidenced by those who had worked until 5pm and were becoming tired. The refreshments, snacks and relaxed humour during the break were therefore very welcome and considered part of the key success factors of this project. An additional hour would have removed the stress of delivery, but would not have been a good fit for students in work.

The project was well planned, managed and delivered, and these are considered key success factors for duplicating the programme. Utilising an 'active learning approach', the learners learned difficult mathematical concepts in differentiation with relative ease and enjoyed the sessions. Hence, if any difficult topic is carefully planned, delivered and managed, it can be made interesting, enjoyable and challenging. Aims and objectives of the project were therefore met.

Identifying key staff for student centric tutoring was essential. A slow and steady pace and building in repetition was also key to success. This ensured that new learning was understood and connected to existing knowledge, concepts and experience.

9. Acknowledgements

Our thanks to the programme delivery team Muhammad Maruf Tunekar & Dr Mansour Mohammad at Uxbridge College for their dedication to delivering a successful intervention project and their constructive follow up for this evaluation.

Further thanks to Mr Graeme Moran, Mathematics Subject Learning Coach at Southall College, West London College.

**Kerry Schutz - Sector Manager
Science, Technology, Engineering & Mathematics
West London Lifelong Learning Network**

10th June 2009

References

Petty (2004) Teaching Today: a practical guide 3rd Ed. Nelson Thornes: Cheltenham (Research as a word doc is available from this weblink: <http://www.geoffpetty.com/downloads/WORD/ActiveLearningWorks.doc>)

Appendix I - Evaluation (Learner feedback summary)

12 learners attended and all filled in the evaluation forms, the summary of which is given below.

Questions	Strongly agree	Agree	Disagree	Strongly disagree
1. The learning outcomes were clear	9	3	0	0
2. The structure of the topic was good	10	2	0	0
3. The tutors were sufficiently prepared	12	0	0	0
4. The tutors had good subject knowledge	12	0	0	0
5. The learning activities were useful	6	6	0	0
6. The learning resources were helpful	7	5	0	0
7. Presentation and delivery of good standards	10	2	0	0
8. The tutors encouraged interaction with other students	10	2	0	0
9. The tutors provided adequate support	10	2	0	0
10. I found the activities interesting	8	4	0	0
11. I found the activities challenging	8	4	0	0
12. I learnt a lot on differentiation in Maths and now I fully understand it	7	4	1	0

13. Which activities you enjoyed most and why?

- Solving problems and understanding
- Differentiation formulae to practical applications
- Using colour cards; discussing about θ and graph was really interesting
- Presentation and learning outcomes were quite clear
- Discussion using cards and word search
- Most of them because the teachers explained things properly (trigonometric functions, practical application of differentiation)

- Day 1 was fine, I found I understood differentiation a lot better than second day. This may have something to do with the lack of sleep I had.
 - I enjoyed turning points because I found it challenging and interesting
 - All of them, maths was made enjoyable (trigonometric functions, practical application of differentiation)
 - Differentiation of trigonometric function
 - Representing using cards. It makes understanding much more easier like graphs
14. Which activities you enjoyed least and why?
- Practical application of differentiation
 - Very few questions
 - Some handouts were difficult to start with but once explained and discussed with other students became easier
 - Differentiation of trigonometric function was not very much enjoyable as it was bit confusing
 - Solving more problems. There are some problems which are long.
15. Any other comments?
- I hope college will continue to do these activities every month
 - Tutors provided full support and practical applications quite interesting & I would like to join again soon
 - More time, more questions and exercises
 - Would help having more sessions with different topics
 - More lessons
 - The two extra classes were very good and I am glad I came. I just found it hard to juggle long hours of work and late college lessons. Overall very happy and I will try my best to understand differentiation in my own time with problems given to us by teachers
 - Can we have more!
 - This programme should be repeated once a month
 - It has been a very good time.

Appendix II – Certificate of attendance

This certifies that

Name

successfully completed the

**Level 4 workshop sessions
on 'differential calculus'
9th - 10th February 2009**



Laraine Smith
Principal, Uxbridge College

Graeme Hall, Executive Director
West London Lifelong Learning Network

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