

Enabling peer teaching
Mathematics Department Farnborough Sixth Form College

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To teach is to learn twice. ~Joseph Joubert, *Pensées*, 1842

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INTRODUCTION

I wanted to create a classroom where the students would learn from each other in a formal manner. Effectively I wanted to create ten teachers each having teaching one student in my classroom of twenty students. So everyone was either providing or receiving individual tuition.

I had initially thought it might be possible for students to learn different pieces of a topic, and then pair to share their learning experiences. This approach troubled me as term began in September and I began to get to know my classes. One concern was what would happen if the students didn't understand the topic, would they then teach it poorly? I was overly concerned by this, as I believed that with mixed ability pairing the roles will naturally revert. Each pairing will gravitate towards sound knowledge. My real concern was the class not being together as a whole. The thought of having different students learning different things in class would make whole class discussion very awkward. Effective whole class teaching is one of the most successful teaching methods we have (Hattie, 2008).

So the approach I decided upon was I would introduce a new topic. We would have 30 minutes of whole class teaching. Then I would hand over to the class to teach each other the 'details' and nuances of the topic. To enable this transition I decided I would try to produce a set of resources that might encapsulate much of the teaching that might typically occur at this point. Fully aware that one cannot encapsulate on pen and paper the essence of teaching, I nevertheless set myself the goal of recording what examples might be used at that point: Which questions students would attempt? What might be said by a teacher to encourage and guide a student through those questions? I decided to brand these resources 'You teach' – 'You do', so that students would be familiar with their style as I introduced them throughout the term.

Why use peer teaching?

In any classroom students will automatically seek help from their peers, we only have to hear snippets of their conversations to realise how much informal peer teaching is going on: "How do you do that?" - "Did you get the answer..." - "Do you get this?", etc. So the question becomes why formalise a process that is already been done informally in the classroom. Three reasons for this:-

- I wanted to make peer learning centre stage in my classroom. Give all students the opportunity to teach a peer and be taught by a peer in a formal manner should aid future informal interactions and make these more widespread both inside and outside the classroom.
- I see this as a very effective way of teaching, especially in large class sizes where providing personalised learning and differentiation on a new topic can present challenges to whole class teaching. It also allows the 'teacher' to survey the whole class and work with isolated pairing when required. (Typically, once you hand over to the

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students to teach they tend to do good job and enjoy this. So much so that getting them back' to whole class teaching becomes much more the issue).

- Peer teaching scores highly on effect size (0.5^1) for overall learning (Hattie, 2008). The students would have benefited from practising skills that go beyond the mathematical classroom:
- They would have the opportunity to work with others
- To communicate and articulate complex concepts
- Develop skills in both peer and self assessment.

Finally, regardless of the end grade goal, students enjoy the social interaction of peer teaching which models most closely how they learn outside a classroom.

Literature survey

A literature survey on peer learning surprisingly gave fewer resources than might initially have been expected. I was particularly interested in finding examples of resources (work sheets / activities) that had explicitly been designed for peer teaching. There are many activities that involve pair/group work, for example Jigsaw activities when students match questions and answers. But I was really interested in finding resources that targeted giving a student the ability 'teach' another student. One can argue that any text book could allow this, yet they I would maintain they are generally presented from the perspective of one student doing the learning/ work. I could not find one education resource (activity) book for students that had been explicitly designed for use in a peer learning environment in mathematics.

In Peer learning in Higher Education (Boud, etal 2001) a great deal of description is given to advantages of peer learning. One interesting finding is the cost reduction - here they are mainly looking at higher education within degree courses, and state the student lecturer ratio can be greatly increases without effecting learning outcomes. This is very relevant to college teaching, with the increasing class sizes. Much of the case studies concern the motivation and management of getting students to assist effectively in workshops and tutorials and fostering buddy schemes with faculty departments. My action research project is classroom focused. I expect peer teaching in the classroom did continue outside the classroom, but offer no evidence on this.

A detailed analysis of the different knowledge levels that might exist in peer teaching (Whitman, 1988) classifies the classroom based peer learning as co-peer teaching. So for another example

¹ An effective size of 0.5 is indicative of a grade increase at GCSE when applied over one academic year. Effective whole class teaching has the highest effect, 1.13.

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'Near peer' teaching is where one of the peers has either just completed the course or module. So in the mathematics workshop where A2 students help mainly AS students, this would be classified as near peer teaching. When the teaching is being done with by students at the same level, this is termed co-peer teaching, and is what this action research project is focused on. Once again this book is primarily focused on undergraduate (higher) education. The main method for enabling peer teaching with co-peers was to give open ended discussion style question on the board and then split the class into groups to discuss. A general feedback and share session was held at the end of these sessions. This think-pair-share type of approach is well documented (Petty 2009) and is one highly regarded method to encourage peer teaching. It concludes by stating that in all cases of peer teaching the benefits are mutual; both the teacher and learner gain a greater understanding.

Overall, as previously stated, I found little literature on producing resources explicitly for peer teaching. There are many studies on peer teaching, classification of, different models, etc but few examples where resources are provide to facilitate this approach. Jigsaw and matching activities are known good resources for enabling group work, and extensively used in the mathematics department at Farnborough. Teachers can utilise these resources to encourage peer teaching in the classroom – but they are not target resources for this aim.

Based upon a literature review of peer teaching, and with consultation with fellow mathematical teachers at Farnborough, I set myself an initial goal with this action research project to create the template design for these 'You teach' – 'You do' resources; resources which explicitly target peer teaching.

METHODS USED

This action research project was focused entirely on a single idea: what could happen if the students in my three AS maths classes were put into pairs and asked to teach each other. The obvious dilemma was how can teach what you don't already know. Having briefly considered giving different subtopics to each pair in the pairing and rejected this approach, (on the grounds I wanted to have a single class room focus in lessons), I focused on the single idea of having targeted resources that enabled peer teaching after a topic had been introduced.

Using this approach, I would produce a set of 'You teach' – 'You do' resources for each of the major topics, and then let the class work from these in their set pairings.

The style of the 'You teach' – 'You do' resources was very important:

- They had to be hand written; I wanted the students to be exposed to good mathematical grammar throughout the activity.
- The solutions had to be thorough; they had to ensure a weaker student would be fully empowered to assist a more able student.

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- They must allow helpful prompting; built into the exemplar solutions were coloured coded comments that might typically be used by a teacher when teaching that topic.
- They must encourage students to articulate understanding; extension questions and ideas must be provided to encourage students to have a conversation on the topic

To facilitate this I produced hand written resources, which were branded as 'You teach' – 'You do'. These resources planned typically as the second activity on each new topic. The students would typically be using these when have not formed deep connections with the topic, and certainly would not have yet been exposed to answering detailed questions on the topic. I wanted them to be in a receptive frame of mind on the topic, requiring teaching guidance from their partner.

The 'You teach' – 'You do' resources were provided in complementary pairs of handwritten sheets. Each sheet has a 'You do' side and a 'You teach' side. The 'You do' side had a series of progressive questions on the topic; the 'You teach' side contained annotated solutions to the questions on the other sheet. The two sheets were labelled A and B each being the complement of the other: Sheet A having B's answers and visa-versa. So when students were put into pairs and given one of each sheet they had a complete resource to work from when working in collaboration. Student A was instructed to do their question 1, whilst student B monitored and prompted as required. Students were implicitly instructed not to show their sheets to their partner insuring no passive information transfer. Students had to 'teach' the method to enable their partner to complete their question. After each question the students would reverse roles, with both students turning over their sheets.

These 'You teach' – 'You do' resources empowered the students to work independently of the teacher, and allowed them to review each other's mathematical workings with reference to an exemplar set of worked solutions. Students really enjoyed teaching each other in this manner; from a students' perspective the action research project was a great success.

Resources produced

The resources were a consistent format using a "You teach" - "You do" double sided sheets (Appendix A: Figures 1-8). Sheets were hand written in pairs: sheet A and sheet B. Each of the two sheets was double sided with a 'You teach' side and a 'You do' side. The idea for the 'you teach' resource was to provide a set of prompts they could use along with a clear written solution. Prompts and solutions were colour code to make it very accessible to the students when teaching. Students were told not to show / share their 'you teach' resource with their partner. Thus all information transfer was through verbal communication.

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The pairings were made differently with each of the three classes I used these resources with. One class had mixed ability pairings, one used peer selected pairings based on their current seating position in class, and the final group had random selected pairings.

“

You teach - You do” resources were produced for the following Mathematics topics:-

- Core 2 - Binomial expansion
- Core 2 - Exponential and logarithms
- Core 3 – Integration by substitution
- Core 4 - Vectors
- Mechanics 1 - Projectiles

Preparation of these sheets took between 1 to 3 hours. I would endeavour to get a range of questions into each sheet, ensuring there was some real stretch and challenge questions to test the most able students.

They would use these resources immediately after a topic had been taught by myself. So the students would have seen but not really formed any deeper connections with the topic.

These resources would be used for between 30 and 45 minutes of a 90 minute lesson. Typically it would be the second activity of the lesson. When working in this “You teach” - “You do” manner students would be stopped mid way through and asked for how they felt about working in this manner. They were asked to score the activity out of three - these results are presented in the feedback section.

FINDINGS

The feedback is based upon five sources:-

1. Student polls.

A poll was taken when the students were engaged with their teaching and doing. They were asked to stop briefly for 20 seconds, then without referring to peers asked to hold up a score of 1 to 3 using their fingers. They were made very aware this was part of an action research project, and it really didn't matter to them which score they gave.

They were asked to score as follows:-

Score 1: If the current task was less useful than 'a normal teaching activity'.

Score 2: The activity was the same as a normal teaching activity.

Score 3: If the task was more useful than a normal teaching activity

2. Anecdotal student feedback

Comments made by students to each other were recorded whilst the activity was taking place. In addition some informal questions were done whilst the activity was taking place.

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3. Anecdotal staff feedback
Staffs were given the opportunity to use these resources. Four staff member did so, and their feedback from these lessons was recorded.
4. Presentation of research at St Vincents college.
An audience of experienced mathematics teachers were presented this approach to peer teaching. They then openly discussed this approach, with a vote for or against using it in their classrooms at the end.
5. My own perception as a teacher in the classroom at the time of the activities.

Feedback Results

1. Student polls

Class	Number students	1's	2's	3's	Total	Total / Number
S11maf.02	22	2	10	10	52	2.4
S11mas.12	21	6	8	7	43	2.0 *
S11mas.12	21	2	8	11	51	2.4

* Friday afternoon last period lesson.

2. Student anecdotal evidence

"Great, I love these you teach resources." Comment by student A to student J in stats class whilst I was handing out "You teach-You do" resources.

"These are really useful; I get to do harder questions by myself." L says to me.

I never hear one complaint from students using these resources. When I explicitly questioned those who had voted 1, they stated that they had found the task useful but had not necessarily enjoyed doing it. When again explicitly asked what they would prefer as an activity they generally referred to a 'solo' type activity. So they may be some measure of reluctance for group work being measured here.

3. Staff feedback

Staff member V:-

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“My mechanics students who are generally very chatty really engaged with the “You teach - You do” binomial task sheet”.

Staff member M (very experienced mathematics teacher):-

“I’ll use that resource for teaching logs with my AS class.”

Staff member MJ:-

“I used the integration by substitution “You teach” – “You do” resources with my double mathematics class. They found the sheets easy to follow, and challenging in content. When I asked they stated they preferred this approach to topics where there is a significant amount of mathematical grammar to reproduce. The sheets gave them immediate and high quality feedback in reproducing this level of mathematical grammar.”

MJ went on to state that it would be worthwhile listing the topics within each module that would be applicable to this method.

Some topics are initially identified as:-

Core 1

Solving K questions

Core 2

Binomial expansion

Solving trig equations involving transformations, limited x domain

Core 3

Integration by substitution

Differentiation product and quotient rule

Core 4

Vectors – shortest distance

FP1

General solution to Trig equations

M1

Projectiles

M2

Vertical circular motion

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This initial list of target topics validates those that were chosen for the action research project, and gives a starting point for future “You teach” – “You do” resources.

4. Feedback from 25 mathematics teachers

Would other mathematics teachers/departments adopt this approach?

As a final test, I wanted to present the ‘You teach’ – ‘You do’ resources to 25 experienced teachers of mathematics at an inset day at St Vincents College, Hampshire. All the resources in appendix A were provided for the teachers, and they were explicitly asked to review the Binomial expansion ‘You teach’ – ‘You do’ resource. Firstly they were asked to review and add to the ‘teaching comments’ that have been annotated in red on this resource.

They collectively agreed the comments were very pertinent to the teaching, and added the following additions:-

“Remember to refer to the formulae book when doing a binomial question.”

“It is easier to add coefficients when in columns.”

“What would change if the x coefficient was negative?”

The teachers were very enthusiastic about the resources and all requested personal copies to take with them. A final survey of the 25 mathematical teachers present at St Vincents on June 6th 2011 for Maths training sessions gave a 100% positive feedback to the question: “Would you use these resources in your teaching”.

They had overwhelming positive comments to make on the approach. Teacher M made the comment:-

“We need to think of ways to disseminate these resources to the whole department.”

DISCUSSION

Teachers will agree that peer teaching is a good strategy, and that to a greater of lesser extent this takes place in their classrooms. The key question arising from this action research project is does the ‘You teach’ – ‘You do’ style of resources make a significant change to this.

Fundamentally is the idea of a pair of hand written sheets with annotated answers a resource worth developing further? Does it REALLY assist the students in their learning of A level mathematics? If so, what is it about these resources that make this different?

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As a teacher in my fourth year of teaching and am well aware of the plethora of resources that are available². We really are not short of resources. Most these resources provide questions and or investigations for students to do. These activities can be done individually or in groups. I'm not aware that there are resources that target the 'see one' - 'do one' idea, especially with the seeing being done by a peer. I'm also aware that it is teacher that makes the resource come to life (the Indians not the arrows). So a given resource can be used creative by a particular teacher to produce a different end result. That said, teachers are busy, and will tend to use resources that work for them. A good resource is one that is used! Typically this is one which does not take much preparation time, and has the ability to be accessible to all students, and offers stretch and challenge to all.

The question of are these resources useful will in part be answered by whether teachers adopt them in their own teaching. If they see students benefiting from peering teaching using these 'You teach' – 'You do', then they will adopt using them.

CONCLUSIONS

This action research project has taken me in part back to what it was like doing my PGCE training year. I have had to read more, write more and think outside my current teaching bubble.

The preparation of the resources and time students spent looking over these enabled me to expose the students to 'correct' mathematical grammar when solving problems. This usage of good grammar in mathematics can be a key factor in enabling students to progress beyond GCSE level mathematics. So even without the peer teaching benefits, the resources were very beneficial to the students.

The action research also underlined to me how much students enjoy learning from each other. It has also shown that it is possible to make hand written resources that facilitate this approach in timely and cost effective manner.

I will continue to develop the "You teach" - "You do" resources. I would welcome the opportunity to collaborate on a project to produce a mathematical set of resources that was focuses on a peer teaching strategy.

² Ten ticks is one major mathematic resource for questions, there are many others.

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