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AN ICT DRIVEN CURRICULUM: DEVELOPING STUDENTS UNDERSTANDING OF PROOF AT KS4 WITH A DYNAMIC GEOMETRY PACKAGE AND AN INTERACTIVE WHITEBOARD

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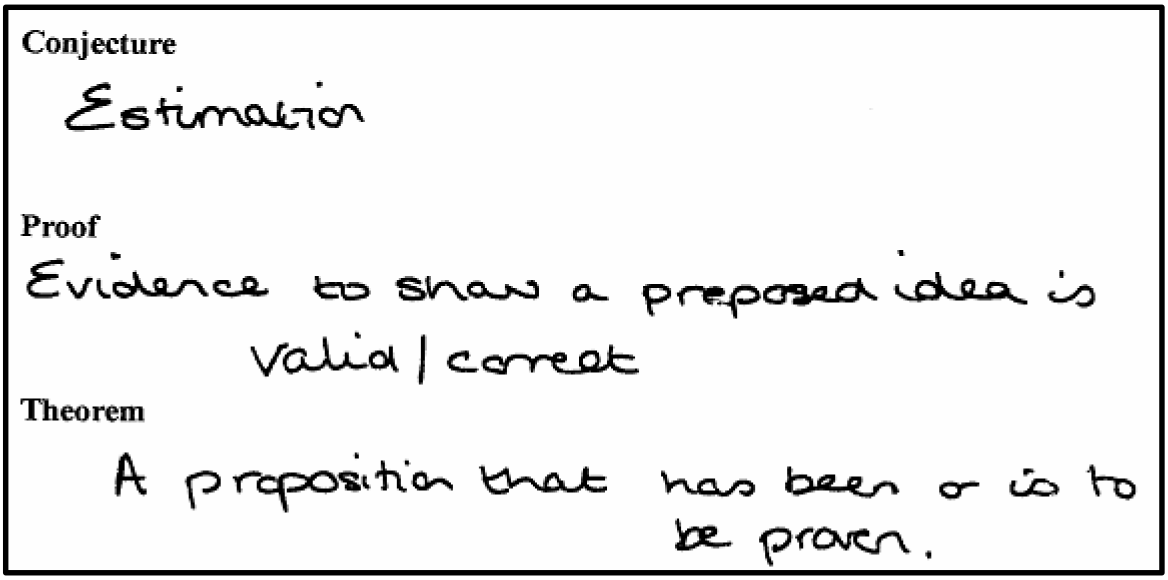
This short paper will address the teaching and learning of proof in secondary schools with special regard to recent changes to GCSE Mathematics specifications. I will focus on the teaching of the Circle Theorems to Higher Level GCSE Students before summarily developing a generalised model of an 'ICT Driven Curriculum' applicable to the teaching of geometrical knowledge and reasoning at either Key Stage Three or Four.

INTRODUCTION

The work presented in this paper was carried out at Poole High School during the past year and was motivated by the introduction of formal proofs of the circle theorems into the Higher Tier GCSE Specifications (EdExcel, 2000). With two year 11 (16 years old) classes, and having never been taught or attempted the proofs of these theorems before, I was presented with a unique opportunity to investigate how best to tackle their teaching and learning. The paper initially focuses upon problems students have learning to do proofs before dealing with how Cabri-Geometre (Cabri) and an Interactive White Board (IWB) can be exploited to assist with the teaching and learning of proofs based on the problems my students initially encountered. Finally, I will discuss a more generalised model of teaching and learning that emerged from this work and which I am continuing to develop.

TRIALING WITH YEAR 12

A week before our first lesson on the circle theorems I set my students the task of defining the words 'conjecture', 'theorem' and 'proof' in a mathematical context so I could judge their understanding of the vocabulary I would be using. An example of work produces by the class is shown in sample 1 and this can be considered representative of the class as this work was done more or less collaboratively. Being a year group that has not been taught formal proof at either Key Stage Three (due to being post Framework) or Key Stage Four (due to being post Curriculum 2000), these responses did not surprise me. Further discussion with the students revealed that their definition of conjecture originated from their science teaching whilst their definitions of proof and theorem were dictionary based.


Conjecture

Estimation

Proof

Evidence to show a proposed idea is valid | correct

Theorem

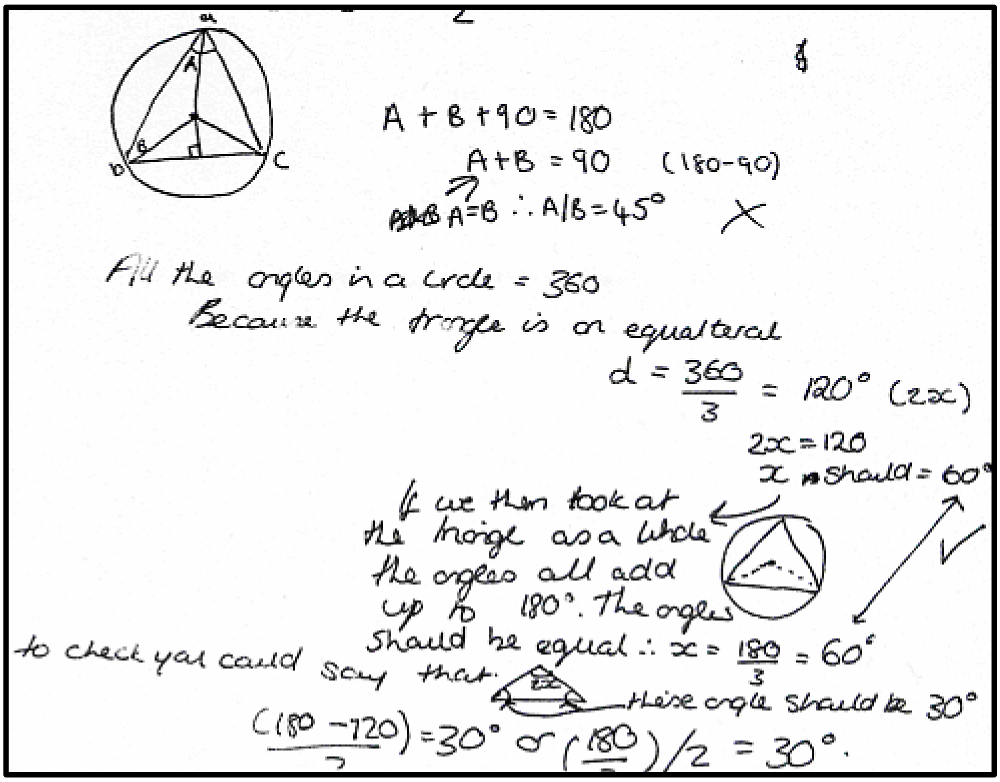
A proposition that has been or is to be proven.

(sample 1)

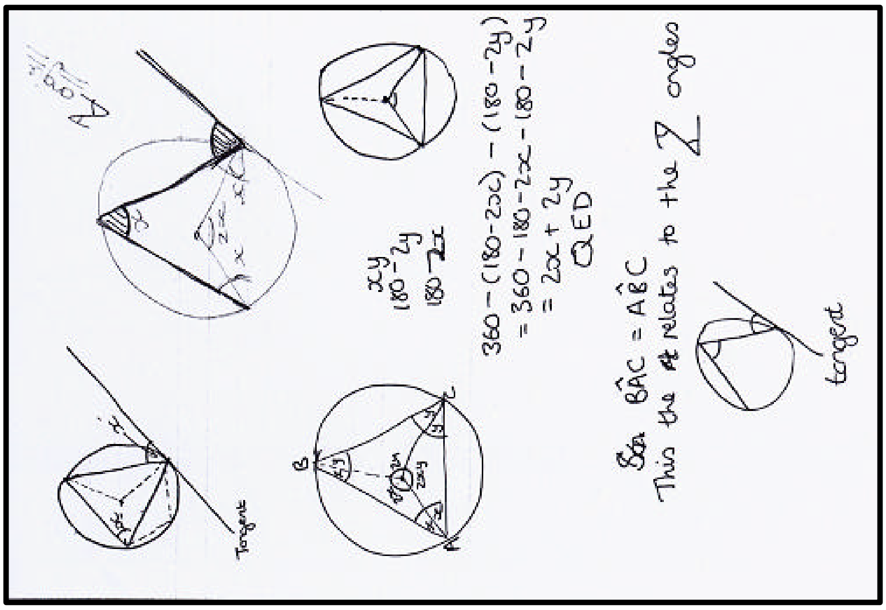
In light of this I explained to the class the mathematical meaning of the words conjecture, theorem and proof before modelling how I would go about proving that 'the sum of the internal angles in a triangle is 180^{o}' and that the 'external angle of a triangle is equal to the sum of the internal angles at the other vertices.' Having modelled the thought and presentation process behind these two proofs I set the class the task of proving that 'the angle at the centre is twice the angle at the circumference' for homework with a view to discussing it at the start of the next lesson. A typical solution offered is shown in sample 2. From the sample it can be seen that it was incorrectly assumed that AC was equal to AB and AC thus making ΔABC an equilateral triangle. Having corrected this, it can be seen again, that despite a spirited attempt, a similar type of mistake can be seen in sample 3 where it was incorrectly assumed that the tangent and the chord formed a z (alternate) angle.

Though the samples above can only give a small flavour of the problems my students encountered, there were at the end of this trailing session, a number of key issues that I needed to address when I implemented with my programme of teaching proof to my year 11 classes.

- Students with a weak grasp of the language of proof.
- Weak understanding of the need for proof.
- A tendency for students to make false assumptions whilst proving.



(sample 2)

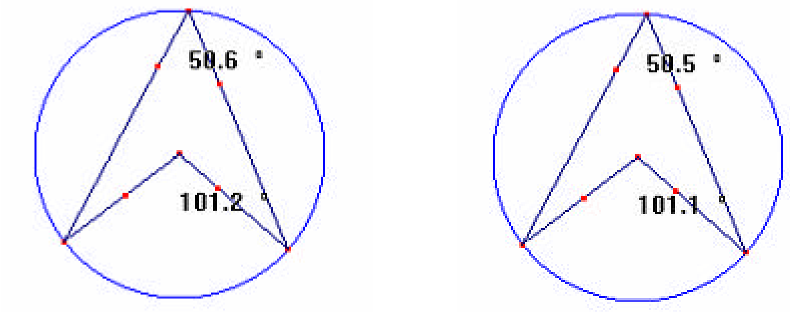


(sample 3)

IMPLEMENTING WITH YEAR 11

My experience with year 12 informed me that students were unlikely to grasp the language of proof intuitively. In line with Moore (1994, page 265) who advocates "*transition courses on mathematical language and proof*" to those who are required to prove for the first time, I formally taught my students the meaning of the words conjecture, theorem and proof.

To address the need for proof with my students, I exploited Cabri's weaknesses to provide a motive for wanting to do a formal proof. As can be seen from slide 1 below, the rounding errors that occurs as a point moves only a very small way around the circle provides an excellent demonstration that a proposition might be true and thus considered a conjecture. It also poses fairly squarely the question "is it true or not?" This error in my opinion is an important pedagogical tool as it forces the teacher to not consider attempting to pass his or her students with what Marrades and Gutierrez (2001) describe as an *"empirical justification."*



(demo 1)

To answer the "true or not?" question I used Oldknow and Talyor's (2000, pg 101) method of using Cabri to *"suggest the usual proof."* The series of slides shown presented overleaf illustrate how Cabri and an IWB can be effectively used to provide an initial demonstration (demo 1), a construction which suggests a proof (slide 5)* and finally how a more formal presentation of how a proof might be developed (slide 4).

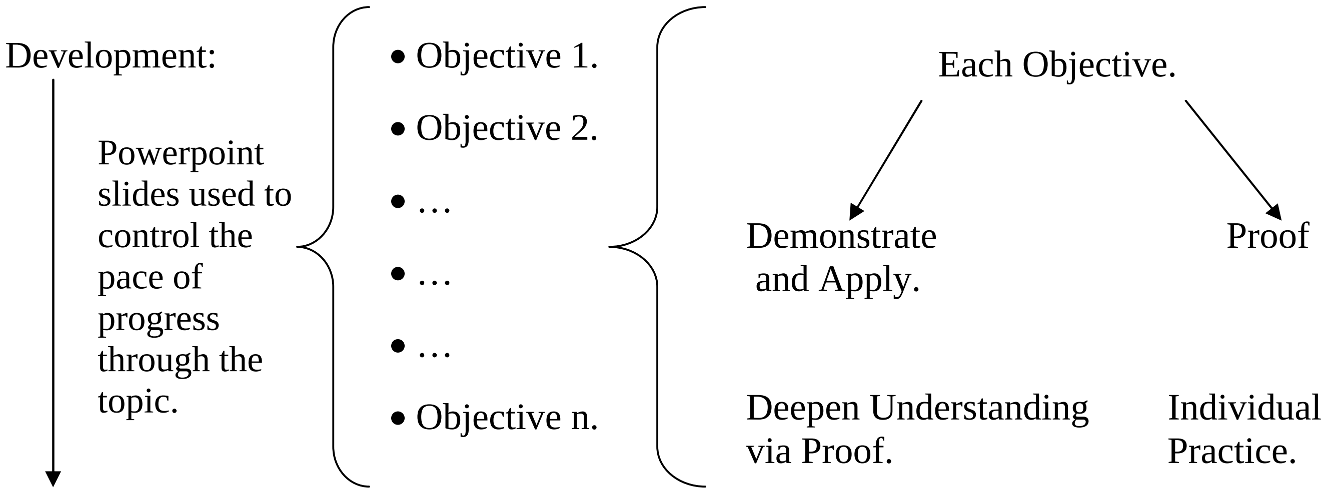
As can be seen in slide 5, the 63° angle at the centre is twice the 31.5° angle at the circumference. This was formally developed into x and x/2 in slide 4 via several intermediate steps of reasoning as annotated on the left hand side of the slide.

AN ICT DRIVEN APPROACH

From the very specific approach on the circle theorems discussed above, a more general model of an ICT Driven Curriculum emerged which offers an insight into how many geometrical topics could be taught in a dynamic and interactive way.

* With reference to slides on final page

Start: • Whole class discussion of topic objectives with a view to turning verbal/written descriptions into a diagrammatic summary.



Plenary: • Examination question discussed as a whole class to consolidate learning.

The above can easily be facilitated via hyperlinks between Powerpoint slides and Cabri pages as described pictorially on the final page. This said, it should be noted that the printed version cannot demonstrate the power of these techniques as was possible at the day conference on 7th June 2003.

CONCLUSIONS

Thought the course of this work, I was constantly aware of the tension between teaching students to do proofs and letting them attempt proofs for themselves. Whilst trailing my work with my year 12 class, more was learnt from attempting the proofs and failing than from them actually succeeding. When teaching a GCSE class, I was very much more conscious of my desire for them to know how to do the proof in preparedness for their examination which may have detracted from the educational benefits of attempting and failing.

Keeping this mind, I firmly believe that the powerful combination of Powerpoint and Cabri controlled via an IWB can be used to promote the need for proof. As previously discussed, Cabri can be manipulated to raise in students minds the question “is it true or not?” which opens the door to the IWB being used to develop in outline, a more detailed argument.

Acknowledgements

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