NUI MAYNOOTH

Ollscoil na hÉireann Má Nuad

The Teaching of Mathematics at Post-Primary Level in Ireland

A Review of Traditional Patterns and an Exploration of Future Practices

In Two Volumes

APPENDICES

Volume 2

This Thesis is presented by

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November 2007

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APPENDIX FOR CHAPTER 7: FINDINGS FROM THIRD YEAR

Section 1: Multiple Choice Questions

Show your answer by circling the letter beside the answer that you think is correct

Two groups of tourists each have 60 people. If $\frac{3}{4}$ of the first group and $\frac{2}{3}$ of the second group board buses to travel to a museum, how many more people in the first group board buses than in the second group?

A. 2

B. 4

C. 5

D. 40

E. 45

In a discus-throwing competition, the winning throw was 61.60 m. The second-place throw was 59.72 m. How much longer was the winning throw than the second-place throw?

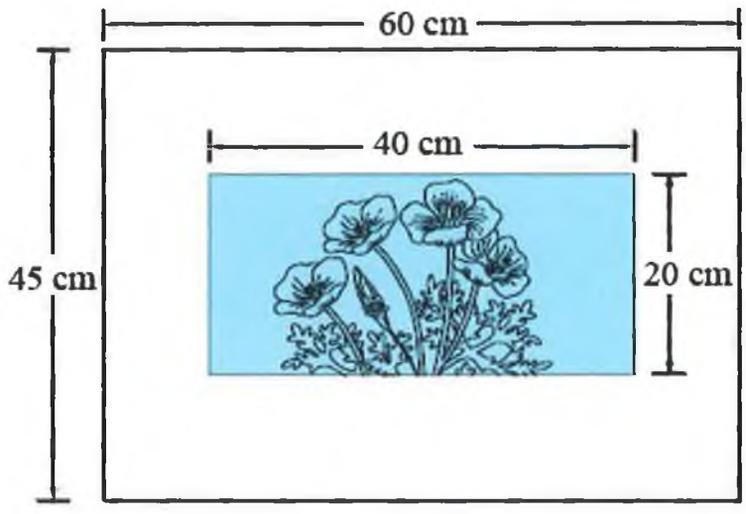
A. 1.18 m

B. 1.88 m

C. 1.98 m

D. 2.18 m

A rectangular picture is pasted to a sheet of white paper as shown.



What is the area of the white paper not covered by the picture?

A. 165 cm^2

B. 500 cm^2

C. 1900 cm^2

D. 2700 cm^2

A quadrilateral MUST be a parallelogram if it has

A. one pair of adjacent sides equal

B. one pair of parallel sides

C. a diagonal as axis of symmetry

D. two adjacent angles equal

E. two pairs of parallel sides

Divide: $0.004\overline{)24.56}$

A. 0.614

B. 6.14

C. 61.4

D. 614

E. 6140

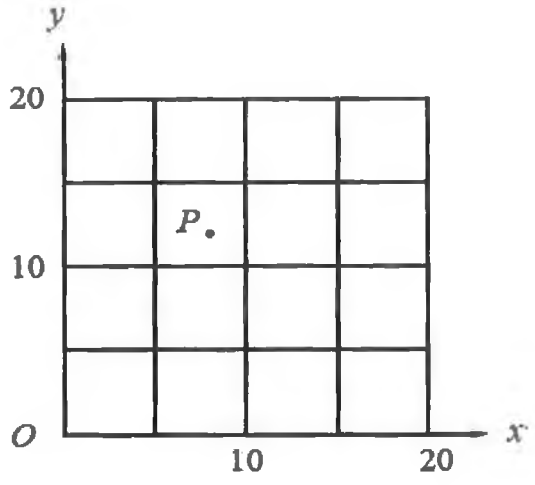
Which of the following are most likely to be the coordinates of point P ?

A. (8, 12)

B. (8, 8)

C. (12, 8)

D. (12, 12)



The table represents a relation between x and y.

What is the missing number in the table?

A. 2

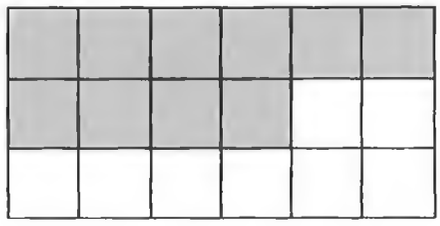
B. 3

C. 4

D. 5

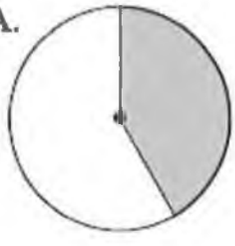
E. 6

x	y
1	1
2	?
4	7
7	13

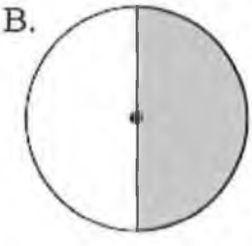


Which circle has approximately the same fraction shaded as that of the rectangle above?

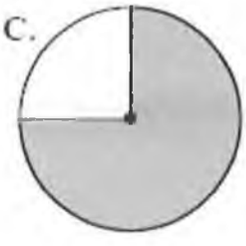
A.



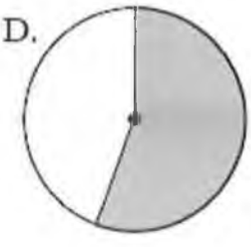
B.



C.

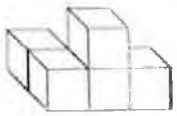


D.



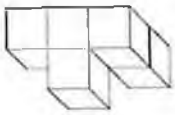
E.

This figure will be turned to a different position.

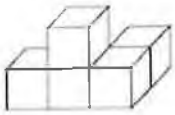


Which of these could be the figure after it is turned?

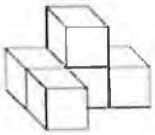
A.



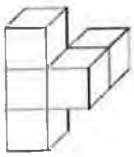
B.



C.



D.



Last year there were 1172 students at Beaton High School. This year there are 15 percent more students than last year. Approximately how many students are at Beaton High School this year?

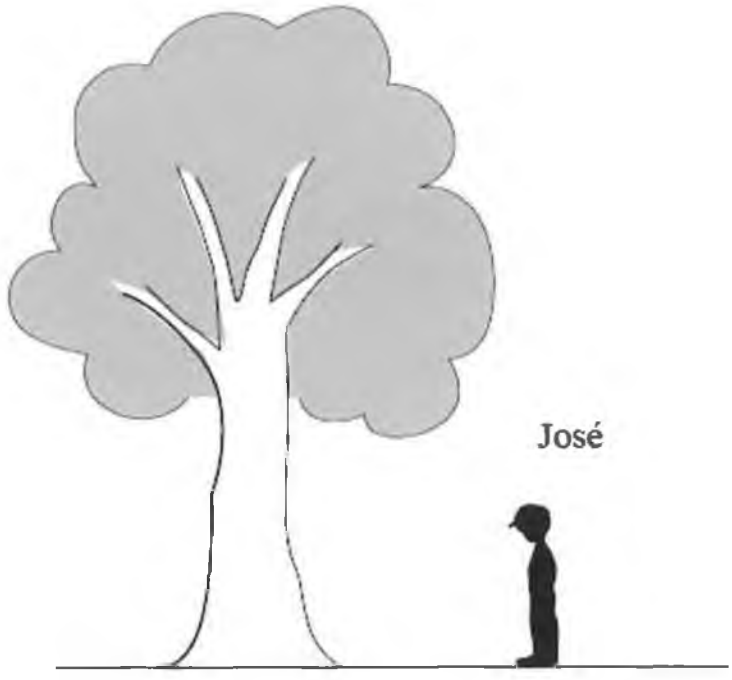
A. 1800

B. 1600

C. 1500

D. 1400

E. 1200



José is 1.5 m tall. About how tall is the tree?

A. 4 m

B. 6 m

C. 8 m

D. 10 m

A rubber ball rebounds to half the height it drops. If the ball is dropped from a rooftop 18 m above the ground. what is the total distance traveled by the time it hits the ground the third time?

A. 31.5 m

B. 40.5 m

C. 45 m

D. 63 m

These shapes are arranged in a pattern.

Which set of shapes is arranged in the same pattern?

A. 

B. 

C. 

D. 

What is the value of $\frac{2}{3} - \frac{1}{4} - \frac{1}{12}$?

A. $\frac{1}{6}$

B. $\frac{1}{3}$

C. $\frac{3}{8}$

D. $\frac{5}{12}$

E. $\frac{1}{2}$

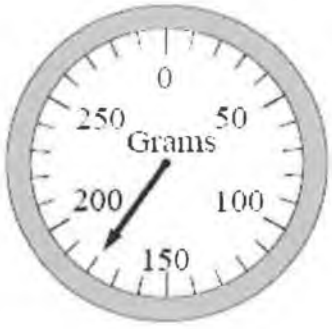
What is the weight (mass) shown on the scale?

A. 153 g

B. 160 g

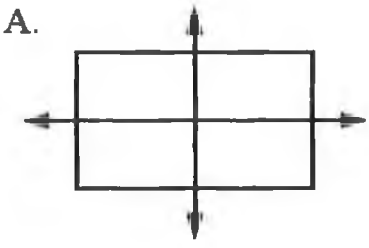
C. 165 g

D. 180 g

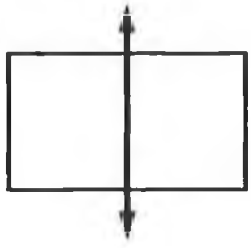


Which shows all of the lines of symmetry for a rectangle?

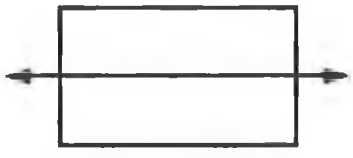
A.



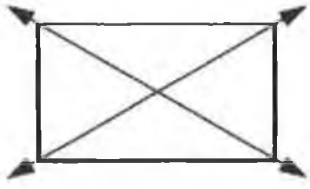
B.



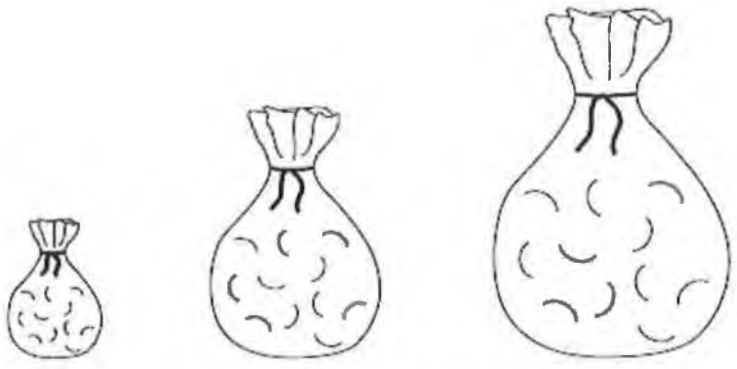
C.



D.



There is only one red marble in each of these bags.



10 marbles 100 marbles 1000 marbles

Without looking in the bags. you are to pick a marble out of one of the bags. Which bag would give you the greatest chance of picking the red marble?

A. The bag with 10 marbles

B. The bag with 100 marbles

C. The bag with 1000 marbles

D. All bags would give the same chance.

Which number is largest?

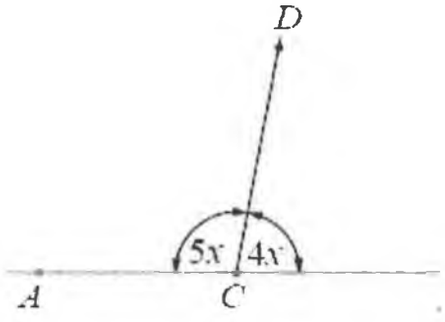
A. $\frac{4}{5}$

B. $\frac{3}{4}$

C. $\frac{5}{8}$

D. $\frac{7}{10}$

In this figure AB is a straight line.



What is the measure, in degrees, of angle BCD ?

A. 20

B. 40

C. 50

D. 80

E. 100

L10. **This chart shows temperature readings made at different times on four days.**

TEMPERATURES					
	6 a.m.	9 a.m.	Noon	3 p.m.	8 p.m.
Monday	15°	17°	20°	21°	19°
Tuesday	15°	15°	15°	10°	9°
Wednesday	8°	10°	14°	13°	15°
Thursday	8°	11°	14°	17°	20°

When was the highest temperature recorded?

A. Noon on Monday

B. 3 p.m. on Monday

C. Noon on Tuesday

D. **3 p.m. on Wednesday**

In which list of fractions are all of the fractions equivalent?

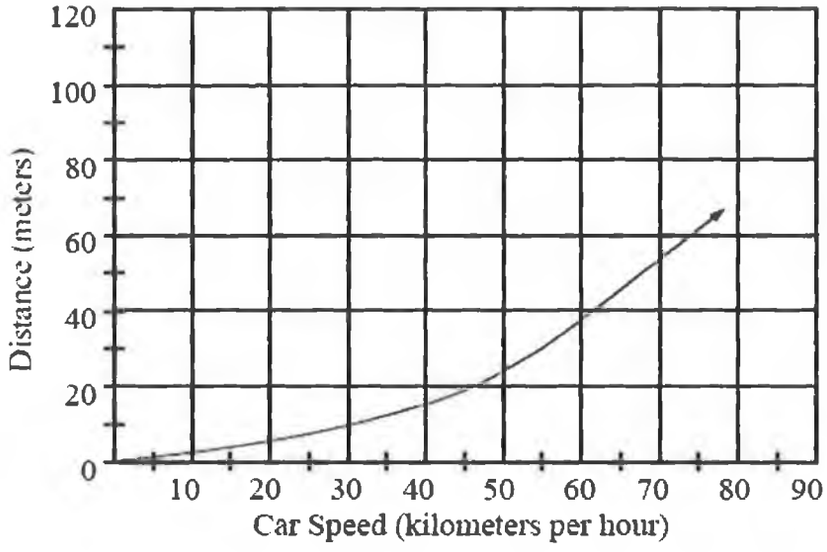
A. $\frac{3}{4}, \frac{6}{8}, \frac{12}{14}$

B. $\frac{3}{5}, \frac{5}{7}, \frac{9}{15}$

C. $\frac{3}{8}, \frac{6}{16}, \frac{12}{32}$

D. $\frac{5}{10}, \frac{10}{15}, \frac{1}{2}$

The graph shows the distance traveled before coming to a stop after the brakes are applied for a typical car traveling at different speeds.



A car traveling on a highway stopped 30 m after the brakes were applied. About how fast was the car traveling?

A. 48 km per hour

B. 55 km per hour

C. 70 km per hour

D. 160 km per hour

Which of these is 89.0638 rounded to the nearest hundredth?

A. 100

B. 90

C. 89.1

D. 89.06

E. 89.064

If m represents a positive number, which of these is equivalent to $m + m + m + m$?

A. $m + 4$

B. $4m$

C. m^4

D. $4(m - 1)$

Janis, Maija, and their mother were eating a cake. Janis ate $\frac{1}{2}$ of the cake. Maija ate $\frac{1}{4}$ of the cake. Their mother ate $\frac{1}{4}$ of the cake. How much of the cake is left?

A. $\frac{3}{4}$

B. $\frac{1}{2}$

C. $\frac{1}{4}$

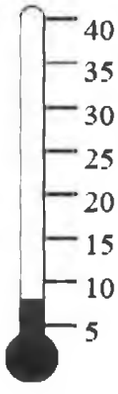
D. None

17. This table shows temperatures at various times during the week.

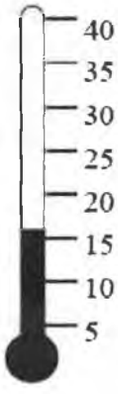
TEMPERATURES					
	6 a.m.	9 a.m.	Noon	3 p.m.	8 p.m.
Monday	15°	17°	20°	21°	19°
Tuesday	15°	15°	15°	10°	9°
Wednesday	8°	10°	14°	13°	15°
Thursday	8°	11°	14°	17°	20°

Which thermometer shows the temperature at 8 p.m. on Monday?

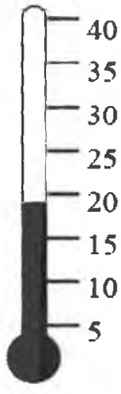
A.



B.



C.



D.

Which of these is the longest time?

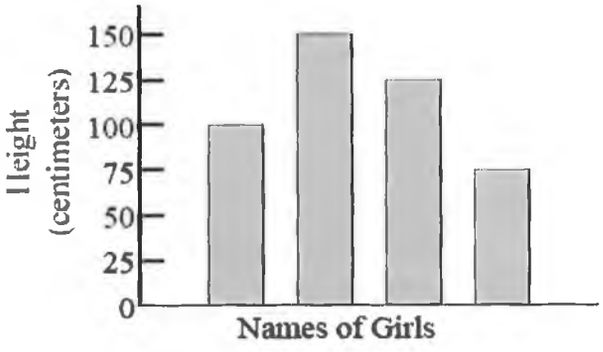
A. 15 000 seconds

B. 1 500 minutes

C. 10 hours

D. 1 day

4. The graph shows the heights of four girls.



The names are missing from the graph. Debbie is the tallest. Amy is the shortest. Dawn is taller than Sarah. How tall is Sarah?

A. 75 cm

B. 100 cm

C. 125 cm

D. 150 cm

The Smith family uses about 6000 L of water per week. Approximately how many liters of water do they use per year?

A. 30 000

B. 240 000

C. 300 000

D. 2 400 000

E. 3 000 000

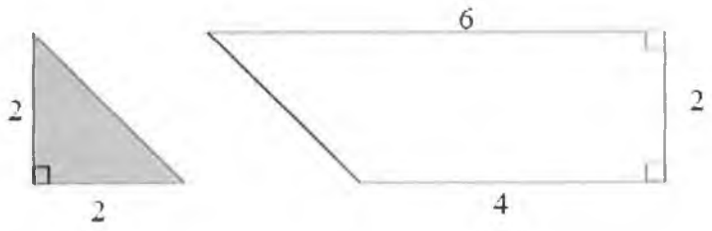
A stack of 200 identical sheets of paper is 2.5 cm thick. What is the thickness of one sheet of paper?

A. 0.008 cm

B. 0.0125 cm

C. 0.05 cm

D. 0.08 cm



How many triangles of the shape and size of the shaded triangle can the trapezoid above be divided into?

A. Three

B. Four

C. Five

D. Six

SECTION 2

The numbers in the sequence 2, 7, 12, 17, 22, … increase by fives. The numbers in the sequence 3, 10, 17, 24, 31, … increase by sevens. The number 17 occurs in both sequences. If the two sequences are continued, what is the next number that will be seen in both sequences?

Answer:_____

Write a fraction that is larger than $\frac{2}{7}$.

Answer: _____

The length of a rectangle is 6 cm, and its perimeter is 16 cm. What is the area of the rectangle in square centimeters?

Answer:_____

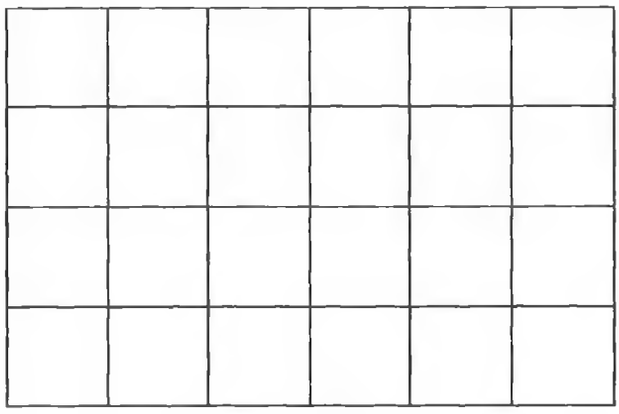
Find x if $10x - 15 = 5x + 20$

Answer: _____

A class has 28 students. The ratio of girls to boys is 4 : 3. How many girls are in the class?

Answer:_____

Shade in $\frac{5}{8}$ of the unit squares in the grid.



A cake is put in the oven at 7:20. If the cake takes three quarters of an hour to bake, at what time should it be taken out of the oven?

Answer: _____

Luis exercises by running 5 km each day. The course he runs is $\frac{1}{4}$ km long. How many times through the course does he run each day?

Answer:_____

Mr. Lewis had \$360. He spent $\frac{7}{9}$ of it. How much money did he have left?

Answer:_____

Appendix 2 to Chapter 4

Education Department

National University of Ireland, Maynooth

CONFIDENTIAL

Student Questionnaire

SURVEY OF YOUNG PEOPLE'S EXPERIENCES AND VIEWS OF MATHEMATICS

Dear Student

The purpose of this set of questions is to get your views about education and particularly about your experience of mathematics.

The information you give will be of great help in improving the way mathematics is taught and in developing new ways to help young people with their educational problems.

The answers which you give will be treated with the strictest confidence. No one at the school will see the completed questionnaires. The research worker is the only person who will ever see the questionnaire.

I really appreciate your help in answering the questions. However, I wish to stress that if you do not want to fill out this questionnaire you may do something else at this time.

Thank You

Ms Anne Brosnan

Section One: Personal Details

Q.1 What is your date of birth? ☐☐ day ☐☐ month ☐☐ year

Q.2 What is your sex? male ☐ female ☐

Section Two: Subject Choice

Q.3 What subjects are you taking at school?

(i) Tick the box for each subject you are now taking at school.

(ii) Indicate the level you are taking, Foundation, Ordinary (pass), Higher (honours), Don't know.

Subject		Foundation	Ordinary	Higher	Don't Know
Irish	☐	1	2	3	4
English	☐	1	2	3	4
Maths	☐	1	2	3	4
History	☐	n/a	2	3	4
Geography	☐	n/a	2	3	4
Technology	☐	n/a	2	3	4
Metalwork	☐	n/a	2	3	4
Woodwork	☐	n/a	2	3	4
Technical Graphics	☐	n/a	2	3	4
Home Economics	☐	n/a	2	3	4
Music	☐	n/a	2	3	4
Business Studies	☐	n/a	2	3	4
Art	☐	n/a	2	3	4
Science	☐	n/a	2	3	4
French	☐	n/a	2	3	4
Spanish	☐	n/a	2	3	4
German	☐	n/a	2	3	4
Italian	☐	n/a	2	3	4
C.S.P.E.	☐	n/a	2	3	4
Other (Say Which)	☐	n/a	2	3	4

Section Three:

Q.4 Thinking about your mathematics classes this year so far, would you say

Circle one number 1, 2, 3 ,or 4 for each line

	Very often	Often	A few times	Never
I understand the mathematics	1	2	3	4
I don't feel able to ask questions when I want to	1	2	3	4
The teacher asks me questions	1	2	3	4
I ask my classmates for help with my mathematics	1	2	3	4
The atmosphere in the class is competitive	1	2	3	4
My classmates ask me for help with their mathematics	1	2	3	4
I offer to answer questions without the teacher asking me to do so	1	2	3	4
I cannot do my homework	1	2	3	4
I pay attention and work hard in the class	1	2	3	4
I mess about in the class	1	2	3	4

Section Four: Experience of learning mathematics

Q.5 Do you think you are good, ok or bad at the mathematics you do in school?

- Good ☐
- OK ☐
- Bad ☐

Q.6 Do you enjoy the mathematics you do at school?

- Always ☐
- Most of the time ☐
- Sometimes ☐
- Hardly ever ☐
- Never ☐

Q.7 Do you think mathematics is an easy subject?

- Very easy ☐
- Quite easy ☐
- Quite difficult ☐
- Very difficult ☐

Q.8 In you mathematics class <u>this year</u>, would you say that....

Circle one number 1, 2, 3, or 4 for each line

	Strongly Agree	Agree	Disagree	Strongly Disagree
Students are generally not interested in their maths class	1	2	3	4
Students are orderely and quiet during maths class	1	2	3	4
Students do exactly as the teacher says in maths class	1	2	3	4

Q.9 To do well in Mathematics at school you need…

Circle one number 1, 2, 3, or 4 for each line …

	Strongly Agree	Agree	Disagree	Strongly Disagree
Lots of natural ability	1	2	3	4
Good luck	1	2	3	4
Lots of hard work	1	2	3	4
To like maths a lot	1	2	3	4
To learn the textbook or notes	1	2	3	4
To have a good teacher	1	2	3	4

Q.10 What do you generally think about Mathematics?

Circle one number 1, 2, 3, or 4 for each line

	Strongly Agree	Agree	Disagree	Strongly Disagree
I enjoy learning mathematics	1	2	3	4
Mathematics is boring	1	2	3	4
Mathematics is important to everyone's life	1	2	3	4
Mathematics has very little to do with people	1	2	3	4
Mathematics is more suited to girls than boys	1	2	3	4
I like mathematics	1	2	3	4
I would like mathematics more if it were not so difficult	1	2	3	4
Nobody can be good at every subject and I am just not talented at mathematics	1	2	3	4
Sometimes when I do not understand a new topic in maths at the start, I know that I will never really understand it	1	2	3	4

Q.11 I need to do well in Mathematics

Circle one number 1, 2, 3, or 4 for each line

	Strongly Agree	Agree	Disagree	Strongly Disagree
To get the job I want	1	2	3	4
To please my parents	1	2	3	4
To get into the university/college I prefer	1	2	3	4
To please myself	1	2	3	4
Because we have to do mathematics in school	1	2	3	4
To help me in everyday life	1	2	3	4

Q.12 Thinking about this year so far, how often does this happen in your Mathematics class?

Circle one number 1, 2, 3, or 4 for each line

	Very often	Often	A few times	Never
The teacher shows us how to do our problems	1	2	3	4
We copy notes from the board	1	2	3	4
We have a test	1	2	3	4
We have a quiz	1	2	3	4
We work from workbooks or textbooks on our own	1	2	3	4
We work on maths projects	1	2	3	4
We use calculators	1	2	3	4
We use computers	1	2	3	4
We work together in pairs or small groups	1	2	3	4

The teacher gives more attention to the boys than the girls	1	2	3	4
The teacher gives us homework	1	2	3	4
We can begin our homework in class	1	2	3	4
We check each other's homework	1	2	3	4
The teacher gives more attention to the girls than the boys	1	2	3	4
The teacher gives us a maths problem and asks us to work on it on our own	1	2	3	4
We discuss our homework	1	2	3	4
Teacher uses the board	1	2	3	4
Teacher uses an overhead projector	1	2	3	4
Students use the board	1	2	3	4
Students use the overhead projector	1	2	3	4
We do hands-on activities	1	2	3	4
We play mathematical games	1	2	3	4
The teacher uses teaching aids	1	2	3	4
We make presentations in class	1	2	3	4
We do surveys using questionnaires	1	2	3	4

Q.13 When we begin a new topic in mathematics, we begin by…

Circle one number 1, 2, 3 or 4 for each line

	Very Often	Often	A few times	Never
Having the teacher explain the rules and definitions	1	2	3	4
Discussing a practical problem related to everyday life	1	2	3	4

Working together in pairs or small groups on a problem or project	1	2	3	4
Having the teacher ask us what we know related to the new topic	1	2	3	4
Looking at the textbook while the teacher talks about it	1	2	3	4

Q.14 We use our calculator

Circle one number 1, 2, 3 or 4 for each line

	Very often	Often	A few times	Never
We use our calculators in class	1	2	3	4
We use our calculators for tests/exams	1	2	3	4
We use our calculators to check answers	1	2	3	4

SECTION FIVE: PROGRESS IN SCHOOL

Q.15

	Top/Well Above Average	Just Above Average	Average	Just Below Average	Well Below Average
Thinking of everyone in your mathematics class this year, where would you place yourself?	1	2	3	4	5
Thinking of everyone in your maths class in primary school, where would you place yourself	1	2	3	4	5

SECTION SIX: PERSONAL EXPERIENCE OF SCHOOL AND LEARNING

Q.16 Over the last two weeks that you have spent in mathematics class, how often have you had the following experiences.

Circle one number on each line.

	Very Often	Often	A few times	Never
Have you been told that your work is good	1	2	3	4
Have you been asked questions in class	1	2	3	4
Have you been praised for answering a difficult question	1	2	3	4
Have you been given out to because your work is untidy or not done on time	1	2	3	4
Have you wanted to ask or answer questions in class but were ignored	1	2	3	4
Have you been given out to for misbehaving in class	1	2	3	4
Have you been praised because your written work is well done	1	2	3	4
Have you wanted to ask a question in class but didn't because you were worried what other people in the class would think of you	1	2	3	4
Have you wanted to ask a question in class but didn't because you were worried your teacher would lose their patience with you.	1	2	3	4
Has your teacher been sarcastic with you for not understanding what he/she has explained	1	2	3	4

Q.17 How strongly would you agree or disagree with each of the following statements?

Circle one number 1, 2, 3 or 4 on each line

	Strongly Agree	Agree	Disagree	Strongly Disagree
I wouldn't ask my maths teacher to explain something if I didn't understand it	1	2	3	4

My maths teacher pays more attention in class to what some pupils say than to others	1	2	3	4
I find my maths teacher is hard to talk to	1	2	3	4
I'm usually well ahead of others in my maths class	1	2	3	4
In maths I can do just about anything I set my mind to	1	2	3	4
I am as good at my maths school work as most other people of my age	1	2	3	4
I'm hardly ever able to do what my maths teacher expects of me	1	2	3	4

Q.18 List your two favourite subjects at school

1._____

2._____

Q.19 List your two least favourite subjects at school

1._____

2._____

Q.20 For each of the following 6 subjects state, circling the appropriate number whether you think the subject is:

(i) **Useful** or not, and

(ii) **Interesting** or not, and

(iii) **Difficult** or not

There are no right or wrong answers.1

It is what you think about the subjects that it important.

(Please **answer for all subjects** whether you are taking them or not)

	(i) This subject is Useful		(ii) This subject is interesting		(iii) This subject is difficult	
	YES	NO	YES	No	YES	No
Maths	1	2	1	2	1	2
Art	1	2	1	2	1	2
History	1	2	1	2	1	2
English	1	2	1	2	1	2
Science	1	2	1	2	1	2
P.E. GYM	1	2	1	2	1	2
French	1	2	1	2	1	2

Section Seven: Homework

Q.21 How long do you spend doing maths homework every evening?

0 – 30 minutes ☐

31 – 45 minutes ☐

46 – 60 minutes ☐

61 – 90 minutes ☐

91 + minutes ☐

Q.22 (a) Do you get maths homework most evenings?

Yes ☐ No ☐

Q.22 (b) How is your mathematics homework checked (Tick one box only)

It is collected and given back with a lot of comments

and/or corrections ☐

It is collected and given back with a little comment

and/or corrections ☐

Pupils check their own homework in class in discussion

with the teacher ☐

It is not usually checked ☐

Q.23 (a) Have you had grinds or private tuition during the last three months for mathematics?

Yes ☐ No ☐

If "Yes" go to Q 23 (b)

If "No" go to Q 24

Q.23 (b)

How often do you receive a mathematics grind:

1 per week ☐

2 per week ☐

1 every two weeks ☐

1 per month ☐

Other (Please Specify) _____

Q.23(c)

What does each grind cost you per hour? €_____

Q.23(d) Apart from grinds, do you get extra classes outside of the main classes in school for mathematics?

	Yes I get help in school	No I do not get help
Mathematics	1	2

Q.24 Do you ever receive help with your maths homework/study from your parents or a brother/sister?

Yes, often ☐ Yes, sometimes ☐ No ☐

Section Eight: Questions relating to the class periods Videoed

When you are answering the questions in the following section I want you think about the maths class you just had.

Q.25 (a) Do you feel you understood the maths in the class? Yes ☐ No ☐	
Q.25 (b) **IF YES to question 25 (a)** How well would you say you understood the maths in this class? **TICK ONE** Very well ☐ Well ☐ Fairly Well ☐	**Q25. (c)** **IF NO to question 25 (a)** Could you say the reason why you did not understand the Maths in this class? **TICK MAIN REASON** Was it because….. The lesson was difficult ☐ I wasn't interested in the maths being taught ☐

	The teacher is not very good ☐ The teacher went too fast ☐ I missed the past few maths classes ☐ I wasn't listening/concentrating at the time ☐ Other (Please say)---- ☐
Q.26(a) Did you ask the teacher a question in class? Yes ☐ No ☐	

If **"Yes"** go to **Q26. (b).**

If **"No "** go to **Q.26 (c)**

Q.26 (b) Which of the following happened when you asked the teacher a question?

The teacher answered and I understood what he/she said ☐

The teacher answered but I did not understand what he/she said ☐

The teacher did not answer my question ☐

GO TO Q.27

Q.26(c) Would you have liked to have asked a question(s)
Tick One
YES ☐ NO ☐

If **"Yes"** go to **Q.26 (d)**

If **"No"** go to **Q.26 (e)**

Q.26(d) What is the main reason why you did not ask a question?

TICK ONE

There was no time to ask a question ☐

I did not want to let the teacher know that I did not understand ☐

I did not want to let my classmates know I did not understand ☐

I would rather ask a friend than the teacher ☐

Other (SAY WHY) ☐

Q. 26 (e) Which one of the following best describes why you did not want to ask the teacher a question?

TICK ONE

I understood the maths ☐

I wasn't interested in what was being taught ☐

I don't like the teacher ☐

I feel the teacher does not like me ☐

I would rather work it out myself ☐

I would rather ask a friend then the teacher ☐

Other (SAY WHY) ☐

Q27 (a) Did you ask another student for help during the class?

Yes ☐ No ☐

Q27 (b) Did this student help you?

Yes ☐ No ☐

Q28 (a) Did another student ask you for help during the class?

Yes ☐ No ☐

Q28 (b) Did you help this student?

Yes ☐ No ☐

Q29 (a) Did you show the teacher that you wanted to answer the question in class?

Yes ☐ No ☐

If "**Yes**" go to **Q29 (b)**

If "**No**" go to **Q29 (c)**

Q29 (b) How many times did you offer to answer questions?	**Q29 (c)** Which one of the following best explains why you did not offer to answer any questions during the class? TICK ONE
More than others in my class ☐	I wasn't interested in what was being taught ☐
About the same as others in my class ☐	I don't like answering questions in maths class ☐
Less than most in my class ☐	I didn't know the answer to any of the questions ☐
Go to Q 29 (d)	I didn't understand any of the questions ☐
	I was afraid my answer would be wrong ☐
	I didn't want to look like a know-it-all ☐
	I get teased if I answer ☐
	Other (please specify) ☐
	_____
	Go to Q 30.

Q29 (d) Which of the following best explains why you wanted to answer questions during class?

TICK ONE

I like to participate in maths class ☐

I enjoy getting the answer right ☐

Answering keeps me from getting bored ☐

I wanted to show the teacher that I knew the answer(s) ☐

I wanted to show my classmates that I knew the answer(s) ☐

I want to get a good end of year report ☐

Q29 (e) When you showed the teacher that you wanted to answer a question, did she/he let you?

Yes ☐ No ☐ If "**NO" go to Q 30 (a)**

Q29(f) How many times did the teacher get you to answer questions?

More than others in my class ☐

About the same as others in my class ☐

Less than most in my class ☐

Q29 (g) Was the answer you gave correct

Yes ☐ No☐

If "Yes" go to Q30 (a)

If "No" go to Q 29(h)

Q29 (h) Which of the following best describes how you felt when you did not get the correct answer?

TICK ONE

Everyone gets the wrong answer sometimes ☐

I felt really stupid ☐

It put me off answering questions in the future ☐

I didn't care, maths is stupid anyway ☐

Q.30 (a) Did the teacher ask you a question in the class without you first showing that you wanted to answer the question?

Yes ☐ No☐

If "Yes" go to Q 30 (b)

If "No" go to Q 31 (a)

Q.30 (b) How many times were you asked to answer questions?

Was it…

More than others in my class ☐

About the same as others in my class ☐

Less than most in my class ☐

Q31 (a) If the teacher gave work during the class observed

Did you work on your own or together with some of your classmates? ☐

On my own because that is how I wanted to work ☐
On my own because we are not allowed to work with anyone ☐

With other classmates ☐

Q 31 (b) Were you able to do the work set by the teacher in the time allowed in the class?

Tick the box that best describes how you got on with the work given by the teacher

I did all the work in the time allowed ☐

I did all the work but barely got it finished in the time allowed ☐

I did all the work but had problems doing it ☐

I did part of the work but had problems doing it ☐

Q32 (a) If there was homework set for the following day Do you feel you will be able to the homework for the next class Yes ☐ No ☐ If "**Yes**" go to **Q33** If "**NO**" go to **Q32 (b) and Q32 (c)**	
Q32 (b) Will you ask anyone for help with your homework? Yes ☐ No ☐ If "**Yes**" go to **Q32 (c)** If "**NO**" go to **Q32 (d)**	**Q32 (c)** Who will you et help from? TICK ALL THAT APPLY A classmate☐ My maths teacher☐ Someone at home☐ Other (Please Specify) ☐---------- ----------

Q32 (d) What is the main reason why you will not get help with your homework? TICK ONE I feel there is nobody at school that I can ask for help☐ I feel there is nobody at home I can ask for help☐ I don't really care if I do not get my maths homework done☐ Other (Please Specify) ☐---------- ----------	

Q33 Thinking about the maths class you just had, how strongly would you agree or disagree with the following statements?

Circle one number 1,2,3 or 4 on each line

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
The maths class was very interesting	**1**	**2**	**3**	**4**
The atmosphere in the maths class was very competitive	**1**	**2**	**3**	**4**
I felt able to ask questions when I wanted to	**1**	**2**	**3**	**4**
The teacher explained the maths very well	**1**	**2**	**3**	**4**
The maths class was good fun	**1**	**2**	**3**	**4**
The teacher did not go too fast or too slow-the pace of the lesson was just right	**1**	**2**	**3**	**4**
I thought the maths class was really challenging	**1**	**2**	**3**	**4**
The maths we did in	**1**	**2**	**3**	**4**

class was irrelevant to my everyday life				
I felt I was being judged in maths class	**1**	**2**	**3**	**4**
Maths is a subject that has very little to do with people	**1**	**2**	**3**	**4**

Q34(a) Thinking about today's maths class, would you say that it was different or about the same as most of the maths classes you had this year

The class about the same as usual ☐

The class was different to our usual class ☐

Q34 (b) IF YOU SAID THAT TODAY'S CLASS WAS DIFFERENT

In what way was it different?

_____

_____

_____

_____

Thank you for your time in completing this questionnaire.

It is greatly appreciated

Appendix 3 to Chapter 4

Education Department

National University of Ireland, Maynooth

Confidential

Mathematics Project: Teacher's Questionnaire

Your participation and the contents of this questionnaire are confidential. The information will be used to form a general picture in relation to the teaching and learning of mathematics.

PERSONAL DETAILS:

1. Age Group:

Under 30	☐
30 – 39	☐
40 – 49	☐
50 – 59	☐
60 or over	☐

2. Length of time teaching maths, counting this academic year as a year:

1 to 5 years	☐
6 to 10 years	☐
1 to 20 years	☐
over 20 years	☐

TEACHER TIMETABLE

Q3 What is the highest year group and level to whom you teach maths? (e.g. Junior Cert. Foundation, Ordinary or Higher Level, first, second or third year, Transition Year, Leaving Cert. Applied, Leaving Cert. Foundation, Ordinary or Higher Level, first or second year of Leaving Cert.) ?

	Year Group	Level
This Year	_____	_____
In the last five years	_____	_____

Q4(a) For how many class contact hours and minutes are you timetabled in a school week this academic year?

HOURS MINUTES

Q 4(b) For how many hours and minutes are you timetabled to teach the following during the school week thisacademic year:

	Hours	Minutes
Mathematics	☐	☐
Applied Mathematics	☐	☐
Science Subjects	☐	☐
Other Subjects	☐	☐

TEACHING MATHEMATICS

Text Books:

Q 5(a) Do you use textbooks in teaching mathematics to your mathematics class group observed in this research project?

Yes ☐ NO ☐

Q 5(b) IF YES, please give author, title and publisher.

_____

_____

Q5(c) Approximately what percentage of your weekly mathematics teaching time with the class observed is based on the text(s) indicated in Q5(b)? TICK ONE BOX

0 – 25 %	☐
26 – 50 %	☐
51-75 %	☐
76 – 100 %	☐

Q5(d) Do you use textbooks in teaching mathematics to your other Junior Cycle mathematics class groups other than the class observed in this research project?

Yes ☐ No ☐

Q5(e) IF YES, please give author, title and publisher.

_____
_____
_____
_____
_____

Q5(f) Approximately what percentage of your weekly mathematics teaching time to your other Junior Cycle class groups other than the class observed in this research project is based on the text(s) indicated in Q7(e)? TICK ONE BOX

0 – 25 % ☐

26 – 50 % ☐

51-75 % ☐

76 – 100 % ☐

Q5(g) If you do not use a textbook all the time, what do you use in its place or in addition to one? Please specify.

_____
_____
_____
_____
_____
_____
_____
_____

ISSUES RE MATHS TEACHING:

Q6(a) How frequently did you have timetabled meetings with other maths teachers in the school to discuss issues related to maths? TICK ONE BOX

Never	☐
Once or twice a year	☐
Every other month	☐
Once a month	☐
Once a week	☐

Q7 To be good at maths in school, how important do you think it is for students to……..

(Tick one box in each line)

	Very important	Somewhat important	Not important
Remember formulas and procedure	☐	☐	☐
Think in a sequential and procedural manner	☐	☐	☐
Understand mathematical concepts, principles and strategies	☐	☐	☐
Be able to think creatively	☐	☐	☐
Understand how maths is used in the real world	☐	☐	☐
Be able to provide reasons to support their solutions	☐	☐	☐
Be able to communicate solutions to problems	☐	☐	☐
Solve practical problems, using maths	☐	☐	☐
Be confident in their ability to learn maths	☐	☐	☐
Be comfortable in competing with their peers	☐	☐	☐

Q8 (a) How often does the following happen in your **FOUNDATION JUNIOR CYCLE** maths classes?
(Tick one box in each line)

	Every lesson	Most lessons	Some lessons	Never or almost never
I show students how to do maths problems	☐	☐	☐	☐
Students copy notes from board	☐	☐	☐	☐
I ask pupils to say or show publicly if they got a question right	☐	☐	☐	☐
Students work from work/text books on their own	☐	☐	☐	☐
Students work on maths projects	☐	☐	☐	☐
I ask students to work out maths problems on the board	☐	☐	☐	☐
Students compete with each other	☐	☐	☐	☐
I encourage students to work in pairs or in groups	☐	☐	☐	☐
Students begin their homework in class	☐	☐	☐	☐
I check homework	☐	☐	☐	☐
I ask students to work out questions out loud on the board	☐	☐	☐	☐
Students check each other's homework	☐	☐	☐	☐
I discuss the homework with the class	☐	☐	☐	☐
I make a conscious decision to pay more attention to the girls in the class	☐	☐	☐	☐

Q8(b) How often does the following happen in your **ORDINARY JUNIOR CYCLE** maths classes?

(Tick one box in each line)

	Every lesson	Most lessons	Some lessons	Never or almost never
I show students how to do maths problems	☐	☐	☐	☐
Students copy notes from board	☐	☐	☐	☐
I ask pupils to say or show publicly if they got a question right	☐	☐	☐	☐
Students work from work/text books on their own	☐	☐	☐	☐
Students work on maths projects	☐	☐	☐	☐
I ask students to work out maths problems on the board	☐	☐	☐	☐
Students compete with each other	☐	☐	☐	☐
I encourage students to work in pairs or in groups	☐	☐	☐	☐
Students begin their homework in class	☐	☐	☐	☐
I check homework	☐	☐	☐	☐
I ask students to work out questions out loud on the board	☐	☐	☐	☐
Students check each other's homework	☐	☐	☐	☐
I discuss the homework with the class	☐	☐	☐	☐
I make a conscious decision to pay more attention to the girls in the class	☐	☐	☐	☐

Q8(c) How often does the following happen in your **HIGHER JUNIOR CYCLE** maths classes? **(Tick one box in each line)**

	Every lesson	Most lessons	Some lessons	Never or almost never
I show students how to do maths problems	☐	☐	☐	☐
Students copy notes from board	☐	☐	☐	☐
I ask pupils to say or show publicly if they got a question right	☐	☐	☐	☐
Students work from work/text books on their own	☐	☐	☐	☐
Students work on maths projects	☐	☐	☐	☐
I ask students to work out maths problems on the board	☐	☐	☐	☐
Students compete with each other	☐	☐	☐	☐
I encourage students to work in pairs or in groups	☐	☐	☐	☐
Students begin their homework in class	☐	☐	☐	☐
I check homework	☐	☐	☐	☐
I ask students to work out questions out loud on the board	☐	☐	☐	☐
Students check each other's homework	☐	☐	☐	☐
I discuss the homework with the class	☐	☐	☐	☐
I make a conscious decision to pay more attention to the girls in the class	☐	☐	☐	☐

ISSUES RE ACTIVE LEARNING METHODOLOGIES IN JUNIOR CYCLE MATHS CLASSES

Q9 (a) How often do you use active learning methodologies(e.g. alge tiles, clinometer, demonstrations, hands-on activities etc) in Junior Cycle Mathematics classes in the following areas:

(Tick one box in each line)

	Every lesson	Most lessons	Some lessons	Almost Never	Never
Sets	☐	☐	☐	☐	☐
Number Systems	☐	☐	☐	☐	☐
Applied Arithmetic	☐	☐	☐	☐	☐
Measure	☐	☐	☐	☐	☐
Algebra	☐	☐	☐	☐	☐
Statistics	☐	☐	☐	☐	☐
Geometry	☐	☐	☐	☐	☐
Trigonometry	☐	☐	☐	☐	☐
Functions and Graphs	☐	☐	☐	☐	☐
Other (Please Specify) _____ _____	☐	☐	☐	☐	☐

IF YOUR ANSWER IS <u>NEVER TO ALL OF THE ABOVE</u>
➔GO TO Q 12

SOURCE OF IDEAS FOR ACTIVE LEARNING METHODOLOGIES:

Q10 (a) Please tick the source of your active learning methodologies (As opposed to expository teaching *only*)and indicate the degree of influence in each case:

(Please tick one box in each row)

	Major Source	Minor Source	Not a Source
Your own ideas	☐	☐	☐
Teacher in school days	☐	☐	☐
Parents/family friends	☐	☐	☐
Initial teacher education course (H.Dip.Ed.)	☐	☐	☐
Colleagues	☐	☐	☐
D.E.S. Inservice for Revised Junior Cert. Syllabus	☐	☐	☐
Reading/Research	☐	☐	☐
Websites	☐	☐	☐
TL21 Workshops	☐	☐	☐
Other (Please Specify)	☐	☐	☐

Comment (if you wish)

_____
_____
_____
_____
_____
_____

Q10 (b) Which were the two most important influences?

1._____

2._____

BENEFITS OF AND DIFFICULTIES WITH ACTIVE LEARNING METHODOLOGIES:

Q11 (a) What benefits have you found in using such methodologies(as opposed to expository teaching only).

(Tick one box in each line)

	Major Benefit	Minor Benefit	Not a Benefit
Improves students' understanding	☐	☐	☐
Improves students' application	☐	☐	☐
Improves students' motivation	☐	☐	☐
Improves students' communication skills	☐	☐	☐
Improves students' attitude to maths	☐	☐	☐
Improves class discipline	☐	☐	☐
Facilitates course coverage in time available	☐	☐	☐
Enhances your own enjoyment of teaching maths	☐	☐	☐
Improves integration across topic area of maths	☐	☐	☐

Improves integration across subject areas	☐	☐	☐
Generates support among colleagues in school	☐	☐	☐
Produces feedback from parents	☐	☐	☐
Other (please specify)	☐	☐	☐

Which were the two most important benefits?

1. _____

_____

2. _____

_____

Q11 (b) Please indicate the difficulties experienced in using such methodologies (as opposed to expository teaching only).

(Tick one box in each line)

	Major Factor	Minor Factor	Not a Factor
Requires more preparation time	☐	☐	☐
Needs Resources	☐	☐	☐
Cost of resources	☐	☐	☐
Disimproves class discipline	☐	☐	☐
Disimproves student motivation	☐	☐	☐
Does not focus sufficiently on exams	☐	☐	☐
Takes too much time	☐	☐	☐

Causes negativity from colleagues	☐	☐	☐
Causes negative feedback from parents	☐	☐	☐

Which were the two most prominent difficulties?

1. _____
_____

2. _____
_____

Q12 Please indicate the constraints that have prevented you from using active learning methodologies?

(Tick one box in each line)

	Major Factor	Minor Factor	Not A Factor
Needs Resources	☐	☐	☐
Cost of resources	☐	☐	☐
Would take too much time	☐	☐	☐
Does not focus on syllabus material	☐	☐	☐
Approach not reflected by current exam style	☐	☐	☐
Difficulty with using them	☐	☐	☐
Would cause negativity from colleagues	☐	☐	☐
Would cause negativity from parents	☐	☐	☐
Not convinced that they would make any difference	☐	☐	☐
Extra work for me	☐	☐	☐
Would disimprove class discipline	☐	☐	☐
Need more support before I would use them	☐	☐	☐
Not open to new ideas	☐	☐	☐
Not comfortable using them	☐	☐	☐

Which were the two most prominent constraints?

1. _____
_____

2. _____
_____

Q13 To what extent do you agree or disagree with each of the following statements?

(Tick one box in each line)

	Strongly Agree	**Agree**	**Disagree**	**Strongly Disgree**
Maths is primarily an abstract subject	☐	☐	☐	☐
Maths is primarily a formal way of representing the real world	☐	☐	☐	☐
Maths is primarily a practical and structured guide for addressing real situations	☐	☐	☐	☐
Girls have as much confidence in their ability in maths as boys have	☐	☐	☐	☐
In a coed class, boys generally tend to demand more attention than girls	☐	☐	☐	☐
More than one representation (picture, concrete materials, symbol etc.)should be used in teaching a maths topic	☐	☐	☐	☐
Boys and girls tend to prefer different teaching styles	☐	☐	☐	☐
If students are having difficulty, an effective approach is to give them more practice by themselves in class	☐	☐	☐	☐

Thank you for taking the time to complete this questionnaire.

It is greatly appreciated.

Appendix 4 to Chapter 4

Education Department

National University of Ireland, Maynooth

Confidential

Mathematics Project: Students' Group Interview

QUESTIONS RELATED TO THE CLASS AND THE CLASS GROUP OBSERVED

1. Overall, would you say that the students in the class behaved as per normal during the classes I observed?

2. Overall, would you say that the teacher in the class behaved as per normal during the classes I observed?

3. Have you made progress at maths this year? Could you comment on why you think this has happened?

4. Do you tend to spend more time on maths homework than other subjects. Why do you think this is so?

5. What expectations have you for yourself in the Junior Certificate mathematics examination?

6. Do you consider that you will take up a maths-related careers?

EXPERIENCE OF LEARNING MATHS

7. Do you ask for help if you need it/ If not, suggest reasons why not.

8. Could you describe how your teacher teaches mathematics? Is it a good method?

9. From your experience, do you think there is a gender difference in students' level of confidence in doing maths/ If yes, please expand.

10. Did your teacher last year use a different method of teaching maths? How was it different?

11. What do you see as the hardest topics in maths ?

12. Do you find it hard to remember mathematics? Why is this so?

13. If you are confused in class, what helps you most?

14. If you could how would you change maths lessons?

15. Tell me about a time you felt happy in maths class?

16. Tell me about a time you felt anxious in maths class.

17. How do you feel about maths tests?

18. How would you describe maths in post-primary school.

19. Is maths about writing or is there anything practical to it?

20. Do you ever discuss maths problems in class? Does the teacher always show you how to do them?

21. Is your maths class the same as other maths classes in the school?

22. How does your teacher help you to learn maths?

23. Do your classmates help you to learn maths?

24. In your opinion what is knowing maths?

Appendix 5 to Chapter 4

Education Department

National University of Ireland, Maynooth

Confidential

Mathematics Project: Teacher's Individual Interview

QUESTIONS RELATED TO THE CLASS AND THE CLASS GROUP OBSERVED

1. Overall, would you say that the students in the class behaved as per normal during the classes I observed?

2. Can you identify students that appear to have fallen back since they came into school in First Year? Or students who have made a lot of progress? Could you comment on why you think this happens to particular students?

3 .Are there gender differences or any discernible pattern of students making progress or falling back?

4. Could you identify the students you consider are in the highest achieving third, the middle third and the lowest achieving third of the class/ *Checking exercise for TIMSS test.*

5. In relation to the class group observed, do you consider that either boys or girls tend to make more demands on your time in class? Why do you think this is so?

6. In the class just observed, can you identify individuals who tended to require a lot of your attention/ Can you suggest reasons why these individuals needed the extra attention.

7. Do all students ask for help if they need it./ If not, identify those who do not usually ask for help and suggest reasons why not.

8. From your experience, do you consider that there are gender differences in maths ability. Considering your maths classes in general, do you tend to spend more time interacting with boys or girls? Why do you think this is so?

9. What expectations have you for this class in the Junior Certificate mathematics examination.

10. Do you consider that many of the students will take up maths-related careers?

PROFESSIONAL ACTIVITIES

11. Have you been involved in further training in maths education?

What emphasis should be placed on theses courses for teachers?

12. Are you a member of the Irish Maths Teachers' Association?

MATHS TEACHING: THEORY AND PRACTICE

THEORY:

13. Did you have specific instruction during your teacher training or Diploma in Education year on how to teach maths? If yes, could you say what this was? What reforms are needed to improve the current initial, induction and inservice programmes that are now on offer.

14. Apart from formal training, has your approach to maths teaching been influenced by other experiences?

Answers will possibly include: Other inservice, learning from a mentor, learning from school experience, reading pedagogical literature, discussion at Maths Teachers Association meetings, action research project….

15. Could you describe your own approach to teaching maths? Has it changed over the years and what would you attribute the changes to?

16. Explanation of the concepts, followed by demonstration of the procedures and then by student practice is the time-honoured way of teaching mathematics. Did you ever experience any other style of teaching mathematics in your own education, that you recall?

17. It would appear that in some key aspects the teaching of mathematics in Irish secondary schools has remained largely unchanged since the foundation of the state. Why do you think this is the case and why Irish mathematics teachers have clung to traditional methodologies. How might this be changed?

PRACTICE:

18. Do you plan your lessons and how?

19. Do you find, from your own experience, that boys and girls react differently to different styles of teaching maths? If so, please explain.

20. From your experience, do you think there is a gender difference in students' level of confidence in doing maths/ If yes, please expand.

21. In your opinion does your method of teaching vary: (a) for the Junior and Leaving Certificate students or (b) for higher, ordinary or foundation level students?

22. If you have scheduled or formal meetings with other maths teachers in your school to discuss issues related to the teaching of maths, what issues would be discussed?

Possible answers include: textbooks, progress of students, teaching methods, agreed topics to be covered in a year/term, student allocation to classes, other?

23. If you do not have formal meetings, what issues would be discussed with other maths teachers in informal situations?

23. What do you see as the main problems related to the teaching of maths at Junior Certificate level: All three levels to be discussed.

Some issues that may arise: Retention of skills by students, length of syllabus, pressure for points, students opting for level too high or too low, giving up very quickly, too dependent on teacher, retention of work done.

24. Are students reticent to answer in class?

25. How do students learn mathematics? What is a good learner of mathematics?

26. Is it important for students to have (a) mathematical language (b) be able to communicate

27. Are there areas in the Junior Certificate Syllabus that you would like to see changed or where you would like to see the emphasis change? (Refer to all three levels).

28. Did you make a submission to the NCCA on the review of the Senior Cycle mathematics syllabuses? If not why?

29. If a student is confused in class, on what basis do you make the decision to take time in class to explain more fully or to move on for the benefit for the whole group? Is there an opportunity for students who are falling behind to catch up at a later stage?

30. If a student is confused in class, does more practice help the student understand the problem better?

31. Please indicate if any of the following would, in your opinion, improve the teaching of mathematics in this country.

Possible answers may include the following: More inservice courses for maths teachers, (Specify which topics should be dealt with), a change in emphasis in maths

to include more practical examples, a greater emphasis on issues such as problem solving, computing, projects?

Appendix 6 to Chapter 4

Videotape Classroom Study

Mathematics Project: Teacher's Video Analysis

Coding Procedures

SECTION 1: VIDEO ANALYSIS: MATHEMATICAL CONTENT: A PRELIMINARY EXAMINATION

1. Content categories:

☐ 1. Whole numbers

☐2. Common and Decimal Fractions

☐3. Percentages

☐4. Number Sets and Concepts

☐5. Number Theory

☐6. Estimation and Number Sense

☐7. Measurement Units and Processes

☐8. Estimation and Error of Measurement

☐9. Perimeter, Area, and Volume

☐10. Basics of One and Two Dimensional Geometry

☐11. Geometric Congruence and Similarity

☐12. Geometric Transformations and Symmetry

☐13. Constructions and Three Dimensional Geometry

☐14. Ratio and Proportion

☐15. Proportionality: Slope, trigonometry and interpolation

☐16. Functions, Relations, and Patterns

☐17. Equations, Inequalities, and Formulas

☐18. Statistics and Data

☐19. Probability and Uncertainty

☐20. Sets and Logic

☐21. Problem Solving Strategies

☐22. Other Mathematics Content

2. More detailed look at content:

Content	Code
All Review	A R
All New	A N
Mostly Review	M R
Mostly New	M N
Half/Half	H H

3. What teachers wanted students to learn from lesson:

What teachers wanted students to learn from lesson:	**Code**
Mathematical Skills	M S
Mathematical Thinking	M T
Test Preparation	T P
Indeterminable:	I

4. Number of topics in lesson:

Lesson	**Number of Topics**

5. Topics covered in lessons included:

Topics covered in lessons included	Code
Concepts (Presentation of information, concrete examples)	Con
Applications (Developing skills, concept not stated)	App
Both (Concept & Application)	Con/App
Relationship between mathematics and Real-Life situations	Rel Life

6. How concepts are dealt with:

How concepts are dealt with	Code
Concept stated (not derived or explained, but stated by teacher or student)	Con St
Concept developed (derived/explained by teacher or teacher and student collaboratively to improve students' understanding of the concept, derivation through experimentation, proof or both)	Con Dev

7. Changes in Complexity of problems in lesson:

Complexity of problems in lesson	Code
Multiple examples of same level of complexity	Ex same Com
Increase in complexity over course of lesson	C +
Decrease in complexity over course of lesson	C -

8. Methods to Solutions:

Methods to Solutions	Code
Teacher presents solution, students use method	Tchr Pres soln
Students asked to find alternative solutions, examining their advantage	Stud alt soln

9. Kinds of Task Control engaged in:

Kinds of Task Control engaged in	Code
Teacher demonstrates, students apply same method to similar problems, students not asked to make decisions how to approach a problem only to follow what teacher has demonstrated	Tchr Demo

Students asked to think of alternative method for solving problem	Stud Alt

SECTION 2: VIDEO ANALYSIS: ORGANIZATION OF LESSON

1. Arrangement of Desks: Rows, Grouped etc._____

2. A Pre-Lesson Activity: Greetings, announcements _____

2. B Post-Lesson Activity: Announcement about homework, directions re clean up desks_____

Number of homework problems:

_____

3. Lesson:

Lesson	Code
Classwork: CW	
(i)Teacher working with most or all of class.	C W (i)
(ii)Talk predominantly public	C W (ii)
(iii)Activities: Teacher & students engaged in learning new topic	C W (iii)
(iv)Reviewing previously learned material	C W (iv)
(v) Solving problems together	C W (v)
(vi) Sharing solutions to problems being solved	C W (vi)

Seatwork: SW (i)Students working independently on assigned tasks (alone or in small groups) (ii) Talk, predominantly private (iii) Periods of public talk by teacher. announcements to whole class (iv) Individual seat work (v) Grouped seat work	S W (i) S W (ii) S W (iii) S W (iv) S W (v)
Combination Teacher assigns some students to work independently on a task while rest of class works with the teacher	C W /S W

4. Activity Segments: Segments of lesson that serve some specific pedagogical function

A.: Setting Up

Setting Up	Code
Mathematical: Teacher presents task and or situations to the students with explanations or discussion	S U Math
Physical: Teacher presents tasks and or situations without explanation or discussion, handouts, writing down tasks, situations, directions	S U Phy

B: Working on.

Working on.	Code
Working on task: Teacher and students work collaboratively on task	Wk Tk
Working on homework. assigned not necessarily started	Wk Hwk
Working on test	Wk T
Working on checking homework answers	Wk Ch Hwk
Working on a worksheet	W Wk St

C. Sharing: Teacher/student presenting, discussing or reflecting on a previously completed task. Use of visual aids

Sharing	Code
Sharing task	Sh Tk
Sharing homework	Sh Hwk
Sharing test	Sh T

D: Teacher talk/Demonstration: Teacher transmitting, student role to listen. Student could ask questions of teacher. Teacher can ask student question to maintain student's interest.

Teacher talk/Teacher states/Demonstration	Code
Concepts	Con
Ideas	Id
Solution strategies	Soln Strat
Methods	Meth
Lesson goals	Les Gls
Demonstrated solution steps	Demo soln st
Summary at end	Summ

E. Other:

Other	Code
Checks that homework is done	Ch Hwk
Checks discipline	Ch Disc

SECTION 3: PROCESSES OF INSTRUCTION: A CLOSER EXAMINATION

1. Content : Concepts

Concept	Code
Concep Stated	Con St
Concept Developed	Con Dev
(i) Done mostly by teacher	Con Dev (i)
(ii) Done during seatwork segments…student responsible for development of concept. Can be either:	Con Dev (ii)
(a) Some of it during seatwork	Con Dev (ii) (a)
Or	
(b) Actual development by students during seatwork	Con Dev (ii) (b)

2. Use of instructional materials:

Instructional material	Used by teacher % of Time	Used by students % of Time
Chalkboard: Used in: (a) a structured way or (b) a haphazard way		

Overhead projector		
Manipulatives (Cut out circles, resources etc.)		
Posters		
Mathematical tools (compass, ruler etc.)		
Worksheet		
Textbook		
Computers		
Calculators		

3. A :Processes during Seatwork: A Closer Look

Kinds of tasks assigned during seatwork	**Tick Appropriate**	**Number of tasks assigned during each segment**	**Tick Appropriate**
Teacher's example one method provided, followed by one practice of this method from textbook, answer discussed		One task/Identical situation	
Teacher's example two methods provided, followed by one practice of both methods from textbook, answer discussed		Multiple tasks/Identical situation	
Teacher's example one method provided, followed by several practices or		One task/Multiple situations	

exercises from textbook, answer discussed			
Worksheets handed out and a variety of exercises to complete.		Multiple task/Multiple situations	
Practice routine procedures			

3B: Kind of Tasks during Seatwork

Kind of Task Students engaged in	**Code**
Practice routine procedures/Practice previously learned information	Pract
Invent new solutions/proofs/procedures on their own	Invent

4 A. Classroom Discourse: A Closer Examination

Teacher Utterances	**Code**
Elicitation: Ask question to elicit immediate student response	T E
Information: Provide information to students, content related	T I

Direction: To direct students to do some physical activity (Open books etc.)	T D
Uptake: Teacher's response to student's response e.g. Good, Correct, No, Repeats student's response.	T U
Response: Teacher Responds to student's elicitation	T R
Provide answer: Teacher answers their own question	T P A

4 B. Classroom Discourse : Student utterances

Student Utterance	**Code**
Response: Students responds to teacher elicitation or direction	S1
Elicitation: Students utterance to elicit response fro teacher or students	S2
Information: Not intended to elicit any response from teacher or fellow students	S3
Uptake: Student acknowledges another student's elicitation	S4
Other	S5

4 C: A Closer Look at Teacher Elicitation

Teacher Elicitation	Code
Content: The response the teacher wants from the student is primarily concerned with: evaluate, define term, identify shape, directly concerned with procedure being done in lesson	T E1
Meta-Cognitive: To assess student's level of understanding	T E2
Interactional: Asks a question mainly to gain student's attention for behaviour issues	T E 3
Evaluation: Gets a student to evaluate another student's answer	T E 4
None of the above	T E 5

4 D: A Closer Look at Teacher Content Elicitation from table C above:

Content Elicitation	Code
Yes/No Answers	T E 6
Name/State…Short responses, formulas, numbers ,rules	T E 7
Describe/Explain: Explanation rather than an answer. Reason why something is or is not true	T E87
Pursuit of correct answer	T E98
Pursuit of what student has in mind	T E109

5 .Linking of lesson

Linking	Code
To ideas in a different lesson	Lk Diff
To ideas in current lesson	Lk Curr

Appendix 7 to Chapter 4

Teacher Questionnaire

Questionnaire

Videotape Classroom Study

Your Name: _____

Date: _____

School's Name: _____

Name of Course: _____

A. In this section we will ask you a few questions about the lesson videotaped and the students in the classroom

Please describe the subject matter content of today's lesson. ***(Check as many as apply)***

☐ 1. Whole numbers

☐2. Common and Decimal Fractions

☐3. Percentages

☐4. Number Sets and Concepts

☐5. Number Theory

☐6. Estimation and Number Sense

☐7. Measurement Units and Processes

☐8. Estimation and Error of Measurement

☐9. Perimeter, Area, and Volume

☐10. Basics of One and Two Dimensional Geometry

☐11. Geometric Congruence and Similarity

☐12. Geometric Transformations and Symmetry

☐13. Constructions and Three Dimensional Geometry

☐14. Ratio and Proportion

☐15. Proportionality: Slope, trigonometry and interpolation

☐16. Functions, Relations, and Patterns

☐17. Equations, Inequalities, and Formulas

☐18. Statistics and Data

☐19. Probability and Uncertainty

☐20. Sets and Logic

☐21. Problem Solving Strategies

☐22. Other Mathematics Content

2. For this class of students, was the content of today's lesson review, new, or somewhere in between?

☐all review

☐mostly review

☐half review/half new

☐mostly new

☐all new

3. What was the main thing you wanted students to learn from today's lesson?

4a. Was today's lesson planned as part of a sequence of related lessons (e.g., a unit), or was it a stand-alone lesson?

☐stand-alone lesson

☐part of a sequence

4b. What is the main thing you want students to learn from the whole sequence of lessons?

4c. How many lessons are in the entire sequence? _____

4d. Where did today's lesson fall in the sequence (e.g., number 3 out of 5)? _____

5a. Did you previously assign mathematics homework that was due for today?

☐ no (skip to 6)

☐ yes (go to 5b)

5b. Please describe the content of this homework.

6. Was this class formed on the basis of students' mathematics ability? (Choose one):

☐Yes, this is a low ability class

☐Yes, this is an average ability class

☐Yes, this is a high ability class

☐No, this is a mixed ability class

B. In this section we want to compare what happened in today's lesson with what normally happens in your classroom.

7. The teaching methods I used for today's lesson were:

☐very similar to the way I always teach

☐similar to the way I always teach

☐somewhat different from the way I always teach

☐very different from the way I always teach

8. What, if anything, was different from how you normally teach?

_____

_____

9. How would you describe your students' behaviour during today's lesson?

☐very similar to their usual behaviour

☐similar to their usual behaviour

☐somewhat different from usual

☐very different from usual

10. What, if anything, was different about the nature and amount of your students' participation during today's lesson?

_____
_____
_____

11. How would you describe the tools and materials (e.g., worksheets, manipulatives, models, pictures,calculators) used during today's lesson compared to those you normally use?

☐very typical

☐mostly typical

☐not typical

☐completely atypical

12. What, if anything, was not typical about the tools and materials used during today's lesson?

_____
_____
_____

13. How would you describe today's lesson as a whole? Was it typical/representative of the lessons you normally teach?

☐very typical

☐mostly typical

☐not typical

☐completely atypical

14. How nervous or tense did you feel about being videotaped?

☐very nervous

☐somewhat nervous

☐not very nervous

☐not at all nervous

15. Do you think that having the camera present caused you to teach a lesson that was better than usual, worse than usual, or about the same as usual?

☐better than usual

☐same as usual

☐worse than usual

C. In this section we want to find out about the ideas that influence your teaching.

16. How aware do you feel you are of current ideas about the teaching and learning of mathematics?

☐**very aware**

☐**somewhat aware**

☐**not very aware**

☐**not at all aware**

17. How do you usually hear about current ideas about the teaching and learning of mathematics?

_____
_____
_____
_____
_____

THANK YOU!!!

For your cooperation

Appendix A for Chapter 5: Table 1: Content of mathematics lessons

School	Lesson	Topic	Specific	Level
Chestnut Hill	1	Geometry	Circle: Area and Circumference	Mostly New
Chestnut Hill	2	Various	Ratio, Sets, Percentages, Area of rectangle, Isosceles triangle, Simple linear equation	Review
Kenmore	1	Statistics	Bar charts, Trend graphs	Review
Kenmore	2	Algebra	Multiplication	Review
Riverside	1	Algebra	Simultaneous Equations	Mostly Review
Riverside	2	Geometry	Alternate, Corresponding and Opposite angles. Three angles of a triangle sum to 180 degrees	Mostly New

Appendix B for Chapter 5: Illustrative Vignette - Concept Developed (From Riverside)

This extract is from Riverside. It involves a very experienced teacher teaching an all girls class. After correcting the homework the teacher moved onto triangles and her aim is for students to work out by themselves that the three angles of a triangle add up to 180 degrees. As can be seen from the extract that follows the students are involved in developing this concept for themselves.

Note: Time is measured not in minutes and seconds but in minutes and decimal minutes.

Time since start of class	Activity	Lesson Text
5.13		*Teacher: Well* you know your angles well now don't you. Are we all clear that we have three different types from those two parallel lines o.k. So what we've done so far, we know all the different types of angles. We know all about corresponding angles, alternate angles and opposite angles, we've made them all and we What we're going on to do today is take a look at triangles. **[Whiteboard TRIANGLES and underlines TRI]**
	Teacher writes on whiteboard.	
	Teacher asks whole class question.	*Teacher:* Triangles, what does that word mean?
5.65	Class answers question	*Class*: shouting out various suggestions which are inaudible
5.76	Teacher replies to answer from one student.	*Teacher: (*replying to a student) Three cornered shape maybe. O.K. Triangle is a shape that has three angles o.k.
	Teacher gives students direction.	*Teacher:* Take out your classwork copy, ruler and a pencil and you're going to draw three different triangles, any triangles you like on your page. Ruler and pencil
6.70	Student asks question.	*Student*: How big do we have to draw them?
5.80	Teacher answers student.	*Teacher:* Try to fit three on a page.
6.82	Teacher goes down to a seated student	Teacher privately speaks with student.

	who has a question.	
7.05	Teacher speaks to whole class.	*Teacher: Then* you are going to measure the angles. Remember all our practice with the protractor when we were doing opposite angles, measuring angles. So you've drawn yourself three triangles, any three you like. Don't make them too small now cause it's hard to measure the angles if they are too small. Then you are going to take your protractor, take your protractor and you are going to measure each of the three angles and you're going to write into them the size of the measured angle.
8.01	Teacher starts to walk around classroom checking on students' progress. A lot of discussion going on in the classroom. A lot of hands going up looking for the teacher to come over to them. Teacher responds privately to all students.	
17.55	Teacher speaks to whole class.	*Teacher:* OK girls a lot of you when you're measuring your angles you are a step ahead of me. You are so anxious to try and get 180 degrees. [Some students can be heard saying "what"] you are going to be a little bit out. When you measure I do not expect you to get exactly 180 degrees. Are we quite clear that the three angles of a triangle do add up to 180 degrees. You know that already from primary school don't you
17.90	Whole class answers.	*Class:* Yes
17.91	Teacher speaks to whole class. Teacher asks whole class question.	*Teacher: So* when you do measure your three angles I would like you to add them up for me and don't get too hung up on measuring. *Teacher:* If your answers are way out what does that mean?
18.25	A student answers	*Student:* You made a mistake in measuring.
18.29	Teacher repeats what student said.	*Teacher:* You made a mistake in measuring
18.35	Various students put their hands up. Teacher deals with these students	

	privately.	
19.37	Teacher asks whole class question.	*Teacher:* OK what have we discovered?
19.46	Whole class answers.	*Class:* Three angles add up to 180 degrees.
19.57	Several students put their hands up. Teacher deals with these students privately.	
20.84	Teacher speaks to whole class.	*Teacher*: Girls, I wasn't actually expecting you to get exactly 180 degrees. One degree on a protractor is very small as you can see [holding up protractor] and it's very easy to be one or two degrees out. So it's no surprise that they don't add up to exactly 180 degrees but they should be quite close of course.
	Teacher asks whole class question.	*Teacher:* The important thing for you today is that you actually realize that the three angles of a triangle add up to ?
21.43	Whole class answer.	*Class :*180 degrees

Appendix C for Chapter 5: Illustrative Vignette- Demonstration (From Chestnut Hill)

This extract is from Chestnut Hill. It involved a demonstration by a mature teacher to a mixed ability first year class. In the course of this lesson the teacher covered how to get the area, circumference and radius of a circle based on certain given information. In the explanation the teacher reminded the students that they employed similar methods in previous classes. The lesson comprised mainly of drill and practice of a particular method, with no explanation of the concepts involved.

After correcting homework the teacher demonstrated one method of finding the area of a circle given its circumference. Starting with question 1 in the exercise as an example the teacher worked through the example line by line. The demonstration was interspersed with questioning the whole class and individual students. Having completed this example, the teacher worked through another question using this methodology. Overall, the demonstration lasted approximately 10 minutes and clearly illustrates the didactic approach to teaching mathematics that was evident in all of the lessons in this study.

Time	Activity	Lesson Text
1.83	Teacher talks to whole class.	*Teacher:* Before we go to the question there we're going to look at question 1 on page 219 alright so if you take this down as an example in your copies and we'll explain it as we go along. Now the question says if you read it the table below shows certain information on circles, including the value of π used. In each case write down the equation given in disguise and use this to find the radius and complete the tables:

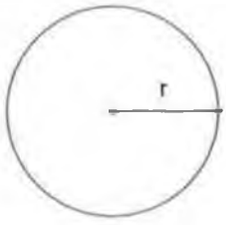
	π	Circumference	Area	Radius
1	π	8π cm		
2	π	18π cm		
3	3.14		$314\,cm^2$	
4	3.14		$706.5\,m^2$	
5.	$\frac{22}{7}$	132 mm		
6	$\frac{22}{7}$		$616\,cm^2$	
7	π		$16\pi\ cm^2$	
8	3.14	78.5 m		

9	$\frac{22}{7}$		$2{,}464\,cm^2$	
10	π		$81\pi\ cm^2$	

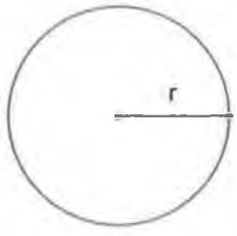
(**Textbook:** George Humphrey, Concise Maths 1 p219)

Teacher: Now the first thing you do in these questions

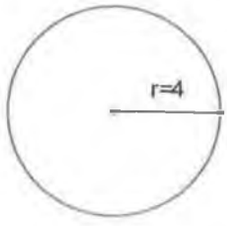
	Teacher talks to whole class.	
2.25	Class answer whole class question.	*Class:* Draw the circle
2.30	Teacher repeats answer.	*Teacher:* Exactly, Now draw the circle
	Teacher draws the circle on the board.	 (Whiteboard)
	Teacher asks whole class question	*Teacher*: Do you know what the radius is?
2.33	Class answer whole class question.	*Class* :No
2.37	Teacher repeats whole class answer	*Teacher:* No, so you call it r. There's the middle, centre of the circle and call the radius r.
	Teacher draws in radius.	(Now draws in radius)

		 (Whiteboard)
	Teacher asks whole class question.	*Teacher:* Now what value do you want to take for π , if you look at number 1
2.55	Class answer whole class question	*Class:* π
2.60	Teacher asks whole class question.	*Teacher:* So π =
2.62	Class answer whole class question	*Class:* π
2.63	Teacher explanation	*Teacher:* Let's look at the next part of the information. The circumference is 8π . So you write that down as information
	Teacher writes on board.	Writes on board C=8π
	Teacher explanation	*Teacher:* Now you have to concentrate on the next part, it's tricky Shane so you need to try and concentrate hard on this. We've got our diagram, we've got our information.
	Teacher asks whole class question	What's the next thing you write down? Diagram, information. What's the next thing you write down?
3.12	Student volunteers an answer	*Student*: mumbles something
3.13	Teacher replies to incorrect answer that has been volunteered.	*Teacher*: No, you have to write down the formula now because they've given you the circumference. Watch because I'm going to show you this right because they've given you the circumference write down the formula for circumference, which is.
		Teacher: C=2π r
	Teacher states formula and carries on with explanation.	*Teacher:* So you write down the formula. Now once we've been able to set it up and write it down to this point you can all put your pens down and just watch the board. Now in this question what's very important is this. They've given you the circumference but disguised the radius as r. You don't know what the radius is and it's your job to work this out. Is that

		clear.
	Teacher asks whole class question	You do it by filling in the formula. Now what way do we always fill the formula in?
3.92	Class answer whole class question	*Class:* Left to right
3.94	Teacher asks whole class question	*Teacher:* Exactly, left to right now you'll always have enough information to fill in the formula and find out the thing you're missing so from left to right take out C and what do we put in?
4.08	Class answer whole class question	*Class:* 8π
4.09	Teacher explanation.	*Teacher*: 8π so you take out C and put in 8π, now you just have to watch this don't take anything down for the moment.
	Teacher asks whole class question	What comes next?
4.20	Class answer whole class question	*Class:* =
4.21	Teacher asks whole class question	*Teacher*: What comes after that?
4.23	Class answer whole class question	*Class:* 2
4.24	Teacher asks whole class question	*Teacher:* We take out π and put in?
4.29	Class answer whole class question	*Class:* π
4.30	Teacher asks whole class question	*Teacher*: And r is just? (pointing at circle)
4.32	Class answer whole class question	*Class:* r
4.35	Teacher asks whole class question	*Teacher:* Now because there's an equation these π s what do we do with them?
4.42	Class answer whole class question	*Class:* Cancel

4.46	Teacher explanation	*Teacher:* You cancel them because you've a π on the right and a π on the left and you can just cancel them off. (Whiteboard) $\pi = \pi$  $C = 8\pi$ $C = 2\pi r$ $8\pi = 2\pi r$ *Teacher:* Now left with 8=2r. We're back to solving equations. We're back to what we were doing yesterday. What's stopping you from getting r on its own?
	Teacher asks whole class question	
4.64	Class answer whole class question	*Class:* The 2
4.66	Teacher asks Michael question	*Teacher:* The 2, Michael when you bring the 2 over where does it go?
4.69	Michael answers teacher question	*Michael:* Under the 8.
4.75	Teacher asks whole class question	*Teacher:* Very good, so 8 over 2 equals r What is r equal to
4.80	Teacher and class answer whole class question	*Class and teacher together:* 4 (Whiteboard) $8 = 2r$ $\frac{8}{2} = r$ $4 = r$
	Teacher explanation	*Teacher: At* the start of the question r was disguised. You didn't know it so if they disguise one piece of information they have to give you another piece of information in return and when you fill it all in you find the radius to be 4.
	Teacher asks whole class question	Is it possible to work out the area now?

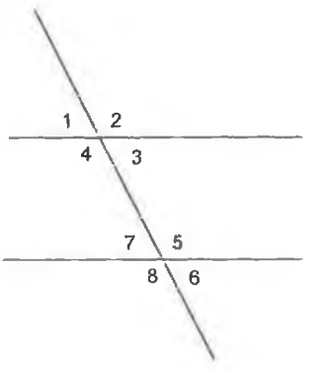
5.09	Class answer whole class question	*Class*: Yea
5.10	Teacher explanation	*Teacher:* Now that we know the radius it is so again. Don't take it down just watch the board. Now that we've got the answer what do we do just like in geometry, put it into the diagram. (fills in 4 on diagram of circle) That's very important. Now if you want to work out the area the question said work out the area. You write down Area = πr^2 That's the formula.
	Teacher asks whole class question	How do you fill the formula in?
5.44	Class answer whole class question	*Class:* Left to right
5.46		*Teacher:* That's right. As just A
	Teacher asks Emma a question	Now take out the π and put in…Pause(*Looks at Emma)* Look at the question (*Prompts Emma)*
5.59	Emma answers teacher question	*Emma :* π
5.60	Teacher asks Emma a follow on question	*Teacher:* π , take out the r and put in Emma?
5.64	Emma answers teacher question	*Emma :*4
5.66	Teacher asks Emma a follow on question	*Teacher:* In?
5.69	Emma answers teacher question	*Emma:* Brackets
5.72	Teacher asks Emma a follow on question	*Teacher:* In brackets. What's after the r?
5.74	Emma answers teacher	*Emma:* Squared

	question	
5.75	Teacher asks whole class question	*Teacher*: The Squared. Now what's 4 squared? Anybody?
5.82	Class answers whole class question	*Class:* 16
5.83	Teacher explanation	*Teacher:* 16, So the answer is $16\pi\ cm^2$ and that's how you get the area.
	Board looks like this now	(Whiteboard) $\pi = \pi$ $C = 8\pi$ $C = 2\pi r$ $8\pi = 2\pi r$ $8 = 2r$ $\frac{8}{2} = r$ $4 = r$ Area $= \pi\ r^2$ Area $= \pi (4)^2$ Area $= 16\ \pi\ cm^2$  *Teacher: Is* that clear to everybody?
	Teacher asks whole class question.	
5.93	Class answer whole class question	*Class: (Mumbles)* Yea
5.95	Teacher explanation	*Teacher:* So the questions we're going to be doing today, they're going to give you the information (points at first part on board). But they're going to disguise one piece of information and if they disguise one piece of information they have to give you another piece in return. Before taking that down I want to give you another example that involves area. It's number three; this is the one we're going to do now. Look at this, then you can take it down and you can try a few for yourselves.

Appendix D for Chapter 5: Illustrative Extract: Homework Whole Class Correction

This vignette from Riverside begins with the correction of homework from the previous day. It involves a very experienced teacher teaching a mixed ability all girls first year class. The teacher is correcting homework problems assigned to the students the previous day and involves finding angle sizes, pairs of alternate, corresponding and vertically opposite angles. Throughout this phase the students were called on to give the correct answer. The teacher did not stop to see how many students got the correct answer as later in the class she checked students' homework privately.

Time	Activity	Lesson Text
Since start Of class		
0.60		*Teacher:* Let's look at the homework. I think the quickest way is for me to call out the answers
0.92		*Class:* Yea
1.16	Homework correction Teacher calls out answers	*Teacher:* The first answer is 53 Next one 133 Next one 70 Next one 130 degrees Next one 40 degrees Next one 105 degrees Are they all ok? y=50 x=120 degrees x is 110 and y is 70 degrees x is 48 degrees y is also 48 degrees part (iv) x equals 100 y is also 100 Question 5 X is 83 Y is 97 Last one X is 70 Y is 110 degrees And then the last question number 6. This is quite similar to what we did in class yesterday.

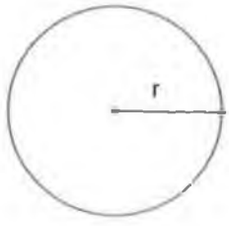
	Teacher writes on whiteboard	[Whiteboard ]
	Teacher asks Laura question	*Teacher:* and you were asked to name four pairs of vertically opposite angles. Hands up vertically opposite angles, Laura.
3.10	Laura answers question	*Laura*: 1 and 3 2 and 4 5 and 8 10 and 6
3.25	Teacher asks whole class question	*Teacher:* Do we all agree
3.27	Class answer whole class question	*Class:* Yea
3.31	Teacher asks Nora question	*Teacher:* Excellent. Now we're asked for 2 pairs of corresponding. Nora, 2 pairs of corresponding.
3.37	Nora answers question	*Nora:* 1 and 7 4 and 8
3.47	Teacher asks whole class question	*Teacher:* you're only asked for two pair but there are more so you might have said 2 and
3.56	Class answer whole class question	*Class:* 5
3.58	Teacher asks whole class question	*Teacher:* And you might have said
3.60	Class answer whole class question	*Class:* 3 and 6
3.61	Teacher asks whole class question	*Teacher:* 3 and 6 So any two of those are perfect and the last one two pairs of alternate angles.
3.75	Stephanie volunteers answer	*Stephanie:* 7 and 3

3.77	Teacher repeats Stephanie's answer	*Teacher:* 7 and 3
3.78	Stephanie volunteers answer	*Stephanie:* 4 and 5
3.80	Teacher repeats Stephanie's answer	*Teacher:* 4 and 5 perfect o.k.
	Teacher asks whole class question	Any questions on that?
3.91	Class answer whole class question	Class: No

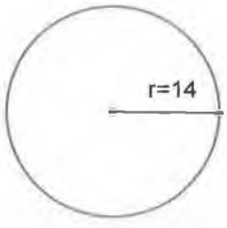
Appendix E for Chapter 5: Illustrative Extract: Student Practice (From Chestnut Hill)

Practice of the demonstrated procedures by the students was the second prevailing pedagogical practice in the lessons observed. The students had been taught how to get the area of a circle given its circumference. Following that demonstration the teacher did another example of how to get the circumference of a circle given its area. Following both demonstrations the teacher moved the lesson onto the student practice phase of the lesson, saying: "I want you to try a few questions". The students were required to take down the two examples and move onto question 6 question 8 and question 10.

Time since start of class	Lesson Activity	Text of Lesson
10.20	Teacher gives instruction	*Teacher:* I want you to try a few questions from page 219
		(Whiteboard)
	Teacher writes on whiteboard	Pg. 219 6
	Teacher speaks to whole class	*Teacher:* O.K.
		That's what I want you to start with.
		So take that down and do question 6 and then question 8 all the even numbers.
10.62	Teacher starts to walk around while students take down work from board.	
	Teacher also stops and has private words with several students	
11.50	Teacher speaks to whole class	*Teacher:* Don't forget these are examples. So you can look back and check how to do them so write example over each question
11.64	Teacher walks around while students take down examples from board.	
	Teacher checks students' work privately.	
12.20	Teacher calls the roll.	
13.05	Teacher walks, checks students' work privately	.
24.37	Teacher explanation	*Teacher:* Right, everyone seems to be getting on o.k. with those. For homework it's going to be question, 6,8 to

		question 10 all the even numbers. I'm going to do number 6 on the board. Take this down it's part of your homework. Now would everyone look at number 6 there and you have to work out, it's a circle and either they give you the area or the circumference. Draw your diagram first, always begin perimeter and area questions with a diagram Mark in the radius as r. Now you need to look carefully at this because some of you are just going away and putting in π as π all the time.
	Teacher asks Mikey a question	*Mikey:* can tell us what's π
25.38	Mikey answers teacher question	*Mikey:* $\frac{22}{7}$
25.47	Teacher asks Paul a question	*Teacher:* Good man, so π is 22 divided by 7. Right now if you look at the question there they'll either give you the area or the circumference. *Paul:* Which are they giving you in number 6
25.67	Paul answers teacher question	*Paul:* Area
25.68	Teacher asks another question	*Teacher:* And what is it?
25.70	Paul answers teacher question	*Paul:* 616
25.77	Teacher explanation Teacher asks Michelle a question	*Teacher:* That's all the information they've given you. Shane will you stay with us for the last minute. Now we've got a circle, π is 22 over 7, area is 616. What formula will we begin with Michelle. (Whiteboard)  $\pi = \frac{22}{7}$ A = 616
25.90	Teacher repeats question	*Teacher:* Area formula or circumference formula?
26.01	Michelle answers teacher question	*Michelle:* Area
26.03	Teacher states formula Teacher asks John a question	*Teacher:* So the area formula is πr^2. Now let's fill that in John from left to right

26.25	John answers teachers' question	*John:* $616=\frac{22}{7}r^2$
27.30	Teacher asks whole class question	*Teacher:* Very good. Now everyone's at that point. To get r^2 on its own, what do you have to get rid of
26.46	A student volunteers answer	*Student:* $\frac{22}{7}$
26.48	Teacher explanation	*Teacher:* The $\frac{22}{7}$ remember you have to get r^2 on its own then r on its own.
	Teacher asks whole class question	Where is $\frac{22}{7}$ going to go when you bring it over
26.58	Class answer whole class question	*Class* Underneath
26.68	Teacher asks Laura question	*Teacher* So all you have to write is 616 divided by $\frac{22}{7}$
		Laura how will you handle $\frac{22}{7}$ on the calculator.
	Laura doesn't answer	(No answer)
	Teacher prompts Laura	What button
26.80	Laura answers	*Laura:* abc button.
26.84	Teacher asks whole class question	*Teacher:* Now will someone do that for us 616 divide 22 abc 7.
26.93	Boy volunteers answer	*Boy:* 196 (Whiteboard) $\pi r^2 = 616$ $\frac{22}{7} r^2 = 616$ $r^2 = 616 \div \frac{22}{7}$ $r^2 = 196$
26.94	Teacher asks whole class question Teacher asks Rachael question	*Teacher:* What is it 196. And we're back to these questions we did last night and earlier on in the class Rachael. To get r on its own what will I have to get rid of?
27.12	Rachael answers teacher	*Rachael*: Square

	question	
27.20	Teacher asks Rachael question	*Teacher:* Bring it over and what will it become?
27.21	Rachael hesitates	*Rachael: Eh*
27.22	Teacher asks Rachael same question	*Teacher:* What does it become
27.23	Rachael answers teacher question	*Rachael:* Square root
27.27	Teacher asks whole class question	*Teacher:* The square root. The square root of 196 is
27.32	Class answer whole class question	*Class:* 14
27.33	Teacher repeats answer	*Teacher:* 14. What's the radius 14 cm.
27.35	Student volunteers	*Student:* 14 cm ^{2}
27.36	Teacher corrects wrong answer	*Teacher:* No not cm ^{2} it's just length not the area. Go back up and put in 14 into the diagram. (Whiteboard)  $\pi = \frac{22}{7}$ A = 616
	Teacher writes on board	$\pi r^2 = 616$ $\frac{22}{7} r^2 = 616$ $r^2 = 616 \div \frac{22}{7}$ $r^2 = 196$ $r = \sqrt{196}$ r=14
	Teacher asks Brendan question	*Teacher:* To work out the circumference Brendan. What's the formula for the circumference
27.74	Brendan answers teacher question	*Brendan:* I don't know

27.77	Teacher prompts Brendan	*Teacher:* Just check it there, it's on the board as well (Points to formula on board)
27.83	Brendan answers teacher question	*Brendan:* Oh Yea um $C = 2\pi r^2$
27.86	Teacher repeats Brendan's answer Asks Richard to continue	*Teacher:* $C=2\pi r$ Richard would you like to fill that in for us. Have you got the radius is 14. C is what we're looking for so away you go.
27.95	Richard continues	*Richard:* C= ……(Someone prompts πr) *Richard:* C = $C=2\pi r$
28.00	Teacher inadvertently corrects Richard	*Teacher:* You go π and then what. Look up at the information
28.21	Richard mumbles and is wrong	*Richard:* Mumbles 616
28.22	Teacher corrects Richard and prompts him again	*Teacher*: No What does it say π is
28.29	Richard answers	*Richard:* Aw $\frac{22}{7}$
28.31	Teacher asks Richard another question	*Teacher:* and the radius?
28.36	Richard answers	*Richard:* 14
28.38	Teacher explanation Teacher asks whole class question	*Teacher:* 14, now to work out the circumference you can just go straight to your calculator and put it all in can't you. 2 brackets 22 abc 7 brackets 14 and when you put it in you get 88 cm. Everyone clear on that?
28.59	Class answers	*Class:* Mmm (Whiteboard) $C=2\pi r$ $C=2\left(\frac{22}{7}\right)14$ $C=88cm$
28.60		*Teacher:* For most of you the homework will be question 8 and question 10. But the homework for everyone is question 6 to question 10 all the even numbers. Make a note of that and continue with what you're doing.

Appendix F for Chapter 5: Illustrative Extract: Student-teacher questions

The example below shows how student questions were of a low cognitive level. In this example a student has come to the board and has written out the solution. The board appears as in the example. The question arises concerning the layout of the work.

	(Whiteboard 3(a+b)+4(2a-b)+3a-b 3a+3b+8a-4b+3a-b 3a+8a+3a = +14a 3b-4b-b = -2b +14a-2b]
Student	Do you have to do it like that or can you just write down.
Teacher	After the second line whichever you're most comfortable with. If you're happy enough to go, work across the line and add them up as you go along that's perfectly fine. But if you want to group them together as on the board that's fine too.

In this example the solution has been written on the board. Approximately three minutes elapsed since the solution was completed when a student asked a question relating to it. After having explained it to the student the class progressed to another problem. The same student two minutes later asked another question in the middle of the teacher correcting the next problem. As can be seen after answering the question the teacher swiftly moved on.

Solution on board	$4(a^2+2a-1)-2(2a^2-3a+4)$ $4a^2+8a-4-4a^2+6a-8$ $14a-12$
Student	Is $4a^2$ take away $4a^2$ not a^2
Teacher	No. $4a^2$ take away $4a^2$ is not a^2. Do you understand? [Teacher takes 4 alge tiles out of a box] You have 4 tiles and you take away 4 tiles. How many have you left?
Student	None

	Teacher None is that OK.
2 minutes later	
Student	Would it still be right if you wrote down $0a^2$
Teacher	Yea, there's nothing wrong with zero a squared but it would be unusual, perfectly fine, it would make it harder to read and would make it more complicated to read. Perfectly fine. 18 a plus six a is 14a. 4a squared minus 4a squared cancel, to give no as at all. Minus 4 and minus 8 are minus 12. Just be careful that people have a habit of saying that like signs give you plus but this is the adding bit it stays minus 12. Don't make it a plus. Anyone write down plus 12?
Class	No
Teacher	We'll do one more.

In this example the teacher had been talking about multiplying signs. He has just completed a procedure involving a minus sign outside the bracket

Student	If it's + outside the bracket does that mean they won't change?
Teacher	Exactly, yea [teacher points to 3(a+b)] they stayed the same.

Appendix G for Chapter 5: Student-Teacher initiated interaction-offering an alternative method

In this extract the teacher was correcting the work from a worksheet that the students had previously being working on. The teacher demonstrated the solution to the problem and a student then voluntarily offered an alternative solution.

Time elapsed since start of class	Activity	Lesson Text
18.62	Worksheet correction.	*Teacher:* The sum of the following numbers 20 +16+18+x is 68. 20+16+18+x must make up 68. So when you add those together (pointing to **20+16+18** written on board)you get 54 take it away from 68 the answer is 14.
19.04	Boy speaks out.	*Liam:* Sir there's another way of doing that
19.06	Teacher answers.	*Teacher:* There is yea, go on.
19.09	Liam explains.	*Liam:* 20, 16 that's 24, 16 and 2 is 18 and then take 4 away It's kinda like up…
19.23	Teacher answers. Teacher praises. Teacher moves on to show how the solution to the next question.	*Teacher:* Levelling it out yea exactly. That's very good. Now the 5th question I'm going to show you the answer to this and then you'll know whether you got it right or wrong. I want you all to take this down on the back of your sheets because you all found this difficult. Look at this everyone take down these sets. Teacher writes on board. (Whiteboard)

From the above vignette the student seems to have difficulty articulating his method but is neither encouraged to explain it to his classmates nor given time by the teacher to explain his method. Instead the teacher appears to be more concerned in showing the class the solution to the next problem rather than discovering what Liam had in mind.

Appendix H for Chapter 5: Illustrative Vignette-Classwork Questioning

This extract from a demonstration classwork phase of the lesson. The students had been doing simultaneous equations for two lessons prior to this lesson. The teacher has brought in a work sheet for the students to practice more of these. The lesson starts with a recap on what they have been doing by using question 1 from the worksheet. The problem is broken down into a number of steps with the whole class being called on to provide the answer to each part of the problem. The emphasis is on obtaining the right answer and moving quickly through the problem.

Time	Activity	Text of Lesson
0.10	Teacher speaks to whole class	*Teacher:* now girls look what I have for you. More questions.
0.12	Class answer whole class question	*Class:* Worksheet
0.13	Teacher asks whole class question	*Teacher:* Because you know what they say about practice.
0.18	Class answer whole class question	*Class:* Makes perfect. [Teacher hands out worksheet]
0.22	Teacher asks whole class question	*Teacher:* I know you had a few last night for homework. We'll correct them don't worry, don't worry. Do you remember what we discussed yesterday, how sometimes if you add the 2 equations together immediately the ys will cancel out for you.
0.60	Class answer whole class question	*Class:* Yes
0.61	Teacher asks whole class question	*Teacher:* So what was it necessary to do first?
0.67	Class answer whole class question	*Class:* in a chorus [inaudible]
0.70	Teacher explains to whole class	*Teacher:* Sometimes you have to take one of the equations and multiply the whole of the equation by something and you have to decide what that number is.
0.87	Student puts hand up and teacher goes down and speaks with the student privately	*Teacher:* private with student
1.05	Teacher explains to whole class	*Teacher:* We're going to do a quick recap of yesterday's work by doing number 1 on your sheet today's on the board.
1.42	Teacher writes on	*Teacher:* let's take a look at question 1 that I've just

	board	given you. [Teacher writes on board $3x + 2y = 9$ $x - y = -2$
1.63	Teacher asks whole class question	*Teacher:* What is the first thing you look for. What is the first thing you ask yourself? And the answer is..
1.73	No Answer	
1.77	Teacher asks whole class question	*Teacher:* Would any of the letters cancel if I were to add them together first?
1.82	Class answer whole class question	*Class:* No
1.83	Teacher asks whole class question	*Teacher:* In this case, no. Why not.
1.89	Class answer whole class question	*Girl:* Because the ys haven't the same number in front.
2.01	Teacher asks whole class question	*Teacher:[*Pointing to 2y] This is a ..
2.02	Class answer whole class question	*Class* :2y
2.03	Teacher asks whole class question	*Teacher:* [pointing to y] This is only a
2.04	Class answer whole class question	*Class:* 1y
2.05	Teacher asks whole class question	*Teacher:* What would we much prefer to see there?
2.07	Class answer whole class question	*Class:* 2
2.12	Teacher explanation Teacher asks whole class question	*Teacher:* We'd much prefer if this were a 2y as well because a plus 2y and a minus 2y. That'd be great. So then you ask yourself how do I do that?
2.25	Class answer whole class question	*Class:* Multiply
2.29	Teacher asks whole class question	*Teacher:* multiply by?

2.33	Class answer whole class question	*Class:* By 2
2.34	A girl answers whole class question	*Girl:* The bottom by 2
2.37	Teacher asks whole class question	*Teacher:* And the important thing is you have to multiply the whole of the equation. So we've decided now that we are going to do what?
2.51	Class answer whole class question	*Class:* Multiply the bottom by 2.
2.60	Teacher explains to whole class	*Teacher:* [Whiteboard $3x + 2y = 9$ $x - y = -2 \quad (\times 2)$ We're going to multiply the whole of the bottom equation by 2 because in an equation two sided don't remain equal unless…
2.66	Class answer whole class question	*Class:* You do the same to both sides
2.70	Teacher asks whole class question	*Teacher:* So we must multiply all of it. OK so we're leaving the top one alone?
2.76	Class answer whole class question	*Class:* Yes
2.81	Teacher asks whole class question	*Teacher:* So call out together what the second equation will be.
2.85	Class answer whole class question	*Class:* 2x-2y= -4 [Teacher writes on whiteboard $3x + 2y = 9$ $2x - 2y = -4$
2.97	Teacher asks whole class question	*Teacher:* So then you stop for a second and you look at it and ask yourself have I got what I want now?
3.03	Class answer whole class question	*Class:* Yea
3.06	Teacher asks whole class question	*Teacher:* Because when I add these two equations together now what's going to happen
3.14	Class answer whole class question	*Class:* The ys will cancel.
3.17	Teacher asks whole class question	*Teacher:* So I'll have +3x and +2x is?

3.21	Class answer whole class question	*Class:* 5x
3.25	Teacher asks whole class question	*Teacher:* +2x-2y?
3.29	Class answer whole class question	*Class:* Nothing
3.37	Teacher asks whole class question	*Teacher:* 9 take away 4?
3.39	Class answer whole class question	*Class:* 5
3.40	Teacher asks whole class question	*Teacher:* Excellent. So what is x.
3.41	Class answer whole class question	*Class:* x is 5 divided by 5
3.42	Teacher asks whole class question	*Teacher:* Multiply by 5 comes across as a divide by 5. So x is 1. Are We Finished? [Whiteboard $3x+2y=9$ $2x-2y=-4$ $5x=5$ $x=\frac{5}{5}$ $x=1$
3.59	Class answer whole class question	*Class:* No
3.60	Teacher asks whole class question	*Teacher:* Why not?
3.62	Class answer whole class question	*Class:* You have to find what y is.
3.64	Teacher asks whole class question	*Teacher:* We know what x is but we don't yet know what?
3.66	Class answer whole class question	*Class:* What y is
3.73	Teacher asks whole class question	*Teacher:* What do we need to do now?
3.75	Class mumbles	*Class:* Mumbles
3.78	Teacher explains to	*Teacher:* This is the part that some of you were having more problems with yesterday than this bit [point at

	whole class	board]. We know what x is now but we want to know what y is. So we go back to one of the equations and suppose I take the first one 3x+2y=9. I now know what x is [pointing to x=1] because we have just discovered x is 1. So instead of 3 times x I can write
4.17	Class answer whole class question	*Class:* 3 times 1 [Board $3(1)+2y=9$]
4.21	Teacher asks whole class question	*Teacher:* What is 3 times 1?
4.24	Class answer whole class question	*Class:* 3
4.28	Teacher asks whole class question	*Teacher:* So what does 2y equal?
4.33	Class answer whole class question	*Class:* 9 minus 3
4.36	Teacher asks whole class question	*Teacher:* So 2y is?
4.39	Class answer whole class question	*Class:* 3
4.40	Teacher speaks to whole class	*Teacher:* You're ahead of yourself.
4.42	Class answer whole class question	*Class:* 6
4.44	Teacher asks whole class question	*Teacher:* So what is y?
4.47	Class answer whole class question	*Class:* 3
4.49	Teacher repeats answer and continues to write on board	*Teacher*: 6 divided by 2. Y is 3. [Board $3(1)+2y=9$ $3+2y=9$ $2y=9-3$ $2y=6$ $y=\frac{6}{2}$ $y=3$
4.63	Teacher asks whole	*Teacher*: What have we done?

	class question	
4.65	Class answer whole class question	*Some girls:* Solved the equation

Appendix I for Chapter 5: Illustrative Examples of teacher-student low-level questioning.

These are some examples of lower order teacher-student questions from three lessons, again illustrating the emphasis on procedural understanding.

In this lesson (From Kenmore) the teacher is involved in revising algebra. The example being demonstrated involves the multiplication of a bracket by the number 5. This extract shows the teacher asking the whole class a question based on the example $5(1+2x-4x^2))$

Teacher:	OK the next section in the book involves removing brackets. If you want to multiply something in a bracket by a number for example 5 by $(1+2x-4x^2)$ OK. So Removing brackets, what do we do? What happens to the numbers in the brackets after they are multiplied by 5? Do we multiply the first one, the second one or the third one?
Class:	All of them.
Teacher:	So the important thing is we multiply everything in the bracket by 5. So if we multiply this out Patricia, what do we get? Multiply everything in the bracket by 5.
Patricia:	5
Teacher:	Yea
Patricia:	10x
Teacher:	Yea , plus 10x
Patricia:	Eh, $-20x^2$

In this extract (From Riverside) the topic being covered is simultaneous equations and the teacher has found a value for x. This part of the procedure involves substituting 3 for x in the equation.

Teacher:	This is the part that some of you were having more problems with yesterday than this bit [point at board]. We know what x is now but we want to know what y is. So we go back to one of the equations and suppose I take the first one 3x+2y =9. I now know what x is [pointing to x=1] because we have just discovered x is 1. So instead of 3 times x I can write

Class:	3 times 1 [Board $3(1)+2y=9$]
Teacher:	What is 3 times 1
Class:	3
Teacher:	Teacher So what does 2y equal
Class:	9 minus 3
Teacher:	So 2y is
Class:	3
Teacher:	You're ahead of yourself
Class:	6
Teacher:	So what is y?
Class:	3
Teacher:	6 divided by 2. Y is 3. [Board $3(1)+2y=9$ $3+2y=9$ $2y=9-3$ $2y=6$ $y=\frac{6}{2}$ $y=3$

Appendix J for Chapter 5: Illustrative Examples of how teachers responded to incorrect answers from teacher-student questions.

In this example the teacher had been correcting algebra revision questions. A student volunteers that she got $3x^4$ instead of $3x^2$ as a solution to $1x^2 + 2x^2$

Student:	I got $3x^4$
Teacher:	Ouch, you're only adding them, if you were multiplying them the powers increase, if you're adding them it's like adding xs, you still keep xs or whatever.
Student:	OK

In this example while the student does not get an incorrect answer it is not the specific response that the teacher wants.

	(Teacher at whiteboard ready to correct sum)
Teacher:	Niamh, when you multiplied out what did you get?
Niamh:	13x mi..
Teacher stops student answering question:	No, no, no the next line please not the answer.
Niamh calls out next line:	Oh 7x+7y
Teacher asks whole class question:	*Teacher*: OK 7x+7y (and writes this on board). Do we all agree with that?
Class answers whole class question:	Yea

Appendix K for Chapter 5: Illustrative Vignette-Rules without Reasons

Rules without reasons appeared in many lessons observed. In this extract from Kenmore the teacher is revising algebra. He uses the word rule explicitly in discussing what the answer to +7-9 is. The rule that he states is "subtract the numbers and keep the sign of the greatest one".

Teacher:	You have +7-9 which is -2.
	What's the rule there?
	Pause.
	What do you do when you have +7-9?
Student:	A student mumbles something
Teacher:	Yes, subtract the numbers and keep the sign of the greatest one.
	So 7 from 9 is 2 and the sign of the greatest one is minus.
	Is everyone OK with that?

This extract is taken from the same lesson just three minutes after the extract above. Here the teacher is dealing with a minus sign in front of a bracket. Again the teacher explicitly states the rule "Unlike signs give minus". Later on he restates this rule as "Minus by plus will give us minus" and also states that "Minus by minus will give us plus".

Teacher:	Teacher Ok Ciarán what happens when you put a minus in front of the bracket.
	[Rubs out $5(1+2x-4x^2)$work and writes -4(2x+3b)]
Ciarán:	Mmm…you multiply
Teacher:	What would the minus do when you multiply?
	What happens when you multiply by a minus?
Ciarán:	You do nothing
Teacher:	Are you sure?
Ciaraán:	No
Teacher:	Well -4 by 2a gives me what?
Ciarán:	-8a
Teacher:	OK and -4 by +3b
Ciarán:	-12b
	[Teacher has written on whiteboard -4(2a+3b)
	-8a-12b]

Teacher	Why are you right?
Ciarán:	Cause – by + gives -
Teacher:	What's the word we use in that rule
Ciarán:	Unlike signs give m..
Teacher:	So unlike signs give minus. Perfect so any time you have a minus number in front of a bracket what will happen the signs inside the bracket? They'll all change whatever they are they'll change to something opposite. So this was +2a [pointing at board] so the answer became -8a, this was +3b the answer became -12b. Similarly [writes on board -3(6x-4y)] if 3 on 6x-4y if you multiply that . If you multiply that 3 6s are
Teacher and Class:	18
Teacher:	18x and it's going to be a?
Teacher and Class:	Minus
Teacher:	And that's going to become?
Teacher and Class:	Plus [Whiteboard -3(6x-4y) -18x+12y]
Teacher:	Do you understand that?
Class:	Yea
Teacher:	So the minus number on the bracket will change all the signs inside. Minus by plus will give us minus. Minus by -minus will give us plus. Do you understand that?
Class:	Yea
Teacher:	Yea OK we'll do some now with minus in them.

Appendix L for Chapter 5 Illustrative Vignette –Student Dependency

The excerpt below is from a student practice phase of the lesson. The teacher has over a period of several lessons covered statistics with this class. In this lesson they have been given a worksheet and asked to draw a graph of the information and find the mean. As soon as the worksheets are handed out the students' hands go up. It was clear from observing the students that they would not draw anything until they checked first with the teacher if what they were doing was correct.

Time	Text of Lesson and Activity
0.13	*Teacher:* Has everyone a sheet? (Teacher hands out sheets)
0.50	Students work on sheets handed out
0.60	Student asks question in private
1.01	Student asks question in private
1.25	Student asks question in private
1.67	*Teacher:* How many of you have the sheet with the temperature for Montreal? (Some students put their hands up) *Teacher:* Where is Montreal?
1.97	*Class:* Canada
2.07	*Teacher:* You'll find that there are positive and negative numbers so you'll have to adjust the scale
2.20	*Student:* Do you include 0?
2.28	*Teacher:* You'll go -20, -10, 0, 10, and so on. I don't know what the highest temperature is. Make sure it fits on your page. (Teacher looks at this student's work)
2.47	Student asks question in private
2.62	Student asks question in private
2.76	Student asks question in private
3.06	Student asks question in private
3.30	Student asks question in private
4.21	Student asks question in private

5.07	Student asks question in private
5.66	Student asks question in private
6.03	Student asks question in private
6.19	Student asks question in private
7.46	Student asks question in private
8.03	Teacher speaks to student (discipline)
8.21	Student asks question in private
8.50	Student asks question in private
9.00	Student asks question in private
9.10	*Teacher:* O.K. How are you getting on? Have we all got our graphs drawn in some shape or form?
9.13	*Class*: Yea/No
9.20	Student asks question in private
9.30	Student asks question in private
9.42	Student asks question in private
9.67	Student asks question in private
10.50	Student asks question in private
11.78	Student asks question in private
12.00	Student asks question in private
12.21	Student asks question in private
12.31	Student asks question in private
12.70	Student asks question in private
13.07	*Teacher:* Most of you are now near the end of drawing your graphs is that correct?
13.12	*Class:* Yea
13.20	*Teacher:* O.K. How do you get the mean?
13.21	*Class*: Mumbles
13.23	*Boy:* Add up all the numbers and divide by the number
13.29	*Teacher:* Yea OK And the mean is the number of months so obviously you're going to divide by..

13.37	Same boy 12 Class begins to mumble
13.70	Student asks question in private
13.84 – 14.20	Student asks question in private
14.44-14.85	Student asks question in private
15.00-15.18	Student asks question in private
15.50	*Teacher:* If you could look up now.

Extracts from Interviews with Teachers Year 1

To protect the identity of students the names used are fictitious.

Appendix M for Chapter 5: Interview Question: How would you describe your approach to teaching mathematics?

Teacher from Kenmore: I suppose I'm traditional, I mean, I teach the way I was taught which was not yesterday. Demonstrate on the board, get them to practise, do their homework. come back in and do the same thing again basically. But I am trying to change, I'm always open to change but I never went about changing myself, and there was no in-service provided to offer me that possibility. A project (TL21) I'm involved in now does offer it. My maths has changed more recently – in the last, sort of, three years, it has changed more than it did in the previous fifteen years. This TL21 project I'm involved in is a much better type of in-service. I think there's no better in-service than discussion with fellow professionals on your own subject and that's what TL21 provides for me. Where the other ones are instructional, somebody is up there in the front on telling what I can do and talking and I don't need that. I mean, I know how to teach my subject in the traditional methods, but the type of student we're getting now requires different things.

Interviewer: How would you describe your approach to teaching mathematics?

Teacher from Chestnut Hill: Eh, I think that the video would be quite typical. I suppose it would be kind of teach, do and review really, you know. Teach the topic to children, get them to practice it, get them to assimilate it and then review what we've just done and to try to structure the class in that way. Maybe about ten, fifteen minutes try to get across the idea. And then trying to, as much as I can, for each topic, as I start it, to introduce it in a different way. You know, maybe with some sort of hands on approach and that type of thing,. I mean, for instance, with the perimeter and area volume - the one we did with the video - the way we began that was I gave out those little sticker things, you know those little yellow things? I got them all to stick them on their copy and they measured the perimeter, they drew the perimeter around it and then they measured it and they measured the area and put it on the sticker sheet and they all loved that. And then, they bring in litres of milk and stuff like that. So, I started like that. That would be the introduction to them, you know, to try to relate it to them .

Interviewer: How would you describe your approach to teaching mathematics?

*Teacher from Riverside:*Try to make it as simple as possible. As clear as possible. Well, we talk about it a lot, we do write on the board and do get notes, we do lots of examples and then, you kind of let them practice. But I encourage them all the time, that tell them okay to get them wrong and just have a try. Basically explain the concept, demonstrate and the students practice. I think my perception of teaching needs changing, I think I need to emphasise things, like I said before

we've done it too much by the book, I think I need to change that And like that, .. geometry as an example, it was the first time that I can remember here when we have actually sat down as a Department and said we're going to teach First Years geometry in a completely different way.

Appendix N for Chapter 5: Construction of Attitude scales

Lyons et al. (2002) constructed a number of attitude scales to survey students' attitudes and beliefs. The scales used in this study are the same as the scales used by Lyons et al., and are presented below. These items were issued to all the students in each of the three classes.

(i) Attitude towards mathematics: Nine Items

Responses to the following 9 items were used in this scale. The scored responses were aggregated in the following way as shown below. To control for non-response, the total score was divided by the number responded to by each student giving the final score with values ranging from 1 (very high liking for maths) to 2 (low liking for maths).

Item	Statement	Response/Score	Response/Score
1	Maths is an easy subject	Very easy/easy = 1	Quite difficult/difficult= 2
2	Maths is useful	Yes = 1	No = 2
3	Maths is interesting	Yes = 1	No = 2
4	Maths is difficult	No = 1	Yes = 2
5	I enjoy maths at school	Always/most of the time/sometimes = 1	Hardly ever/never = 2
6	Maths is important to everyone's life	Strongly agree/agree = 1	Strongly disagree/disagree =1
7	Maths is boring	Strongly agree/agree = 2	Strongly disagree/disagree =1
8	Maths is my 1st or 2nd favourite subject	Yes = 1	No = 2
9	Maths is my 1st or 2nd least favourite subject	Yes = 2	No = 1

(ii) Maths self image; Six Items

This is a six item scale. It indexes the students' image of his/her own mathematical ability relative to that of his/her peers. The scored responses were aggregated in the following way as shown below. To control for non-response, the total score was divided by the number responded to by each student giving the final score. The values range from 0 (very high maths self-image) to 2 (low maths self-image).

Item	Statement	Response/Score	Response/Score	Response/Score
1	This year so far I understand the maths	Very Often= 0	Often = 1	Few times/never = 2
2	Do you think you are good, bad or okay at the maths you do in school?	Good= 0	Okay = 1	Bad= 2
3	Think of everyone in your maths class this year, where would you place yourself	Top/well above average= 0	Just above average/average = 1	Below average/well below average= 2
4	I'm usually well ahead of others in my class	Strongly agree = 0	Agree =1	Few times/never = 2
5	In maths I can do just about anything I set my mind to	Strongly agree = 0	Agree =1	Strongly disagree/disagree = 2
6	I am as good at my maths school work as most other people my age	Strongly agree = 0	Agree =1	Strongly disagree/disagree = 2

(iii) Positive Teacher Interaction

This is a six-item scale. It indexes the students' image of his/her interaction with the maths teacher. The scored responses were aggregated in the following way as shown below. To control for non-response, the total score was divided by the number responded to by each student giving the final score. The values range from 0 (very positive) to 3 (negative interaction).

Item	Statement	Response/Score	Response/Score	Response/Score	Response/Score
1	Over the past 2 weeks in math class I have been told my work is good	Very often = 0	Often = 1	A few times =2	Never =3
2	Over the past 2 weeks in maths class I have been asked questions in class	Very often = 0	Often = 1	A few times =2	Never =3
3	Over the past 2 weeks in maths class I have been praised for answering a difficult question	Very often = 0	Often = 1	A few times =2	Never =3
4	Over the past 2 weeks in maths class I have been praised because my written work is good	Very often = 0	Often = 1	A few times =2	Never =3
5	This year so far, I offer to answer questions without the teacher asking me to do so	Very often = 0	Often = 1	A few times =2	Never =3
6	This year so far, I pay attention and work hard in the class	Very often = 0	Often = 1	A few times =2	Never =3

(iv) Negative teacher interaction

This is five-item scale. It indexes the students' image of his/her interaction with the mathematics teacher. The scored responses were aggregated in the following way as shown below. To control for non-response, the total score was divided by the number responded to by each student giving the final score. The values range from 0 (less negative) to 3 (very negative).

Item	Statement	Response/Score	Response/Score	Response/ Score	Response/ Score
1	Over the past 2 weeks in maths class I have been given out to because my work is not done on time	Very often = 0	Often = 1	A few times =2	Never =3
2	My maths teacher pays more attention in class to what some students say than to others	Very often = 0	Often = 1	A few times =2	Never =3
3	Over the past 2 weeks in maths class I have wanted to ask questions but have been ignored	Very often = 0	Often = 1	A few times =2	Never =3
4	Over the past 2 weeks in maths class I have been given out to for misbehaving in class	Very often = 0	Often = 1	A few times =2	Never =3
5	I find my maths teacher is hard to talk to.	Very often = 0	Often = 1	A few times =2	Never =3

Appendix O for Chapter 5 Table 2: The mean scores for each class on each of these scales

Case Study Schools	**Perceptions of Mathematics**		**Experience with the Class**	**Teacher**	Maths at First Year Level
	Attitude to Mathematics (1-2) 1=High Liking 2=Low Liking	**Mathematics Self-Image (0-2) 0=Very High Self-Image 2=Low Self-Image**	**Positive interaction (Rewards) (0-3) 0=Very Positive 3=Negative interaction**	**Negative Interaction (Correction) (0-3) 0=Less Negative 3= Very Negative**	
	Mean Score	Mean Score	Mean Score	Mean Score	
Kenmore	1.41	0.96	1.54	0.23	Mixed Ability
Riverside	1.45	0.99	1.39	0.38	Mixed Ability
Chestnut Hill	1.49	0.99	1.37	0.85	Mixed Ability
	Ranking	Of School	Out of 3	(1=most positive)	
Kenmore	1	1	3	1	Mixed Ability
Riverside	3	2	2	2	Mixed Ability
Chestnut Hill	2	2	1	3	Mixed Ability
Overall Mean	**1.45**	**0.98**	**1.43**	**0.89**	
Overall Mean of schools from Inside Classrooms	**1.29**	**0.96**	**1.45**	**0.61**	

Appendix O for Chapter 5 Table 3 (i) :Ranking of Case study schools in comparison with ranking of 10 schools from *Inside Classrooms* in relation to Perceptions of Mathematics.

3 Case Study Schools from above Compared with Case Study Schools from *Inside Classrooms* Ranking in Brackets (1=most positive)	**Attitude to Mathematics (1-2) 1= High Liking 2:=Low Liking**	3 Case study Schools from above Compared with Case Study Schools from *Inside Classrooms* Ranking in Brackets (1=most positive)	**Mathematics Self-Image (0-2) 0:=Very High Self-Image 2:=Low Self-Image**
	Mean Score		Mean Score
Case Study School *Inside Classrooms* (1)	1.05	Case Study School *Inside Classrooms* (1)	0.67
Case Study School *Inside Classrooms (2)*	1.14	Case Study School *Inside Classrooms* (2)	0.87
Case Study School *Inside Classrooms* (3)	1.20	Case Study School *Inside Classrooms* (3)	0.90
Case Study School *Inside Classrooms* (4)	1.24	Case Study School *Inside Classrooms* (4)	0.92
Case Study School *Inside Classrooms* (5)	1.28	**Kenmore (5)**	0.96
Case Study School *Inside Classrooms* (6)	1.29	Case Study School *Inside Classrooms* (6)	0.99
Case Study School *Inside Classrooms* (7)	1.35	**Chestnut Hill (7)**	0.99
Case Study School *Inside Classrooms* (8)	1.40	**Riverside (8)**	0.99
Kenmore (9)	1.41	Case Study School *Inside Classrooms* (9)	1.02
Riverside (10)	1.45	Case Study School *Inside Classrooms* (10)	1.05
Chestnut Hill (11)	1.49	Case Study School *Inside Classrooms* (11)	1.08
Case Study School *Inside Classrooms* (12)	1.50	Case Study School *Inside Classrooms* (12)	1.09
Case Study School *Inside Classrooms* (13)	1.56	Case Study School *Inside Classrooms* (13)	1.25

Table 3 (ii): Ranking of Case study schools in comparison with ranking of 10 schools from Inside Classrooms in relation to experience in class.

3 Case Study Schools from above Compared with Case Study Schools from *Inside Classrooms* Ranking in Brackets	**Positive Interaction Perception of frequency of Interaction with teacher, level of praise for achievements. (0-3) 0: Very Positive 3: Negative Interaction**	3 Case study Schools from above Compared with Case Study Schools from *Inside Classrooms* Ranking in Brackets	**Negative Interaction (0-3) Sanctioning/correction for work-related and non-work related behaviour. 0: Less negative 3: Very negative**
	Mean Score		Mean Score
Case Study School *Inside Classrooms* (1)	0.89	**Kenmore (1)**	0.23
Case Study School *Inside Classrooms* (2)	1.14	Case Study School *Inside Classrooms* (2)	0.26
Case Study School *Inside Classrooms* (3)	1.22	**Riverside (3)**	0.38
Case Study School *Inside Classrooms* (4)	1.32	Case Study School *Inside Classrooms* (4)	0.47
Chestnut Hill (5)	1.35	Case Study School *Inside Classrooms* (5)	0.49
Riverside (6)	1.37	Case Study School *Inside Classrooms* (6)	0.57
Case Study School *Inside Classrooms* (7)	1.52	Case Study School *Inside Classrooms* (7)	0.61
Kenmore (8)	1.54	Case Study School *Inside Classrooms* (8)	0.64
Case Study *School Inside Classrooms* (9)	1.58	Case Study School *Inside Classrooms* (9)	0.69
Case Study School *Inside Classrooms* (10)	1.60	Case Study School *Inside Classrooms* (10)	0.77
Case Study School *Inside Classrooms* (11)	1.63	**Chestnut Hill (11)**	0.85
Case Study School *Inside Classrooms* (12)	1.70	Case Study School *Inside Classrooms* (12)	1.06
Case Study School *Inside Classrooms* (13)	1.93	Case Study School *Inside Classrooms* (13)	2.40

Appendix P for Chapter 5: Extracts from Interviews with Students Year 1

To protect the identity of students the names used are fictitious.

To protect the names of teachers the names used are as follows:

Teacher from Chestnut Hill: Mr.C

Teacher from Kenmore: Mr.K

Teacher from Riverside: Ms.R

Appendix P for Chapter 5 (i): Interview question-"How do you find mathematics this year?"

Extract from Riverside

Interviewer: How do you find maths this year? What do you think of them?

All: Excellent.

Michelle: I think it's interesting if you don't understand Ms.R doesn't tell you, you're wrong all the time, I think she's always kind of encouraging you to do your best.

Kate: Good. We have a notes copy and now we keep everything there so when we're doing a test you can just look over it. And we have a folder...., last week we had to make things for homework, we had to get a piece of cardboard and butterfly clips and make some angles.

Interviewer: And what did you think of that?

Kate: I thought it was quite fun.

Nora: You get to keep them, you get to pick your own stuff and you'll understand it better because if you were in a test and if there was an angle on the test page and you say to yourself what's that angle, you think back to when you made it and you just picture it and I find that much easier.

Interviewer: So far this year in mathematics class what's your favourite topic.

Niamh: Geometry.

Interviewer: Geometry, why?

Kate: Because it's just more fun. The other things that we had for homework we had to do work sheets. But for geometry, we're making things, like, angles and finding out, what's the angle, what's the degree.

Nora: I think, that algebra should be taught this way if it was I would find it much easier to learn. If you were to make something to bring home and you were doing your homework and you could see what it was. So, I think if it is there in front of you, you just have to work it out and I find it that much easier because I find geometry is easy this way.

Niamh: Yeah, yeah,, I think that they should teach algebra like geometry, it would make it clearer. You do geometry the way you make the angles, you see the pictures of them, I think if you, make the stuff, it's easier to learn. So when you go back home, you can ask for help and you still have the visual memory in your head.

Laura: Yeah,, I think algebra should be taught differently because, like, when I went to learn it for November, I found, I didn't get it at all and then, when mam helped me I was completely mind-blown by it. I didn't know what to do because I couldn't understand it and I didn't want to get a bad mark in my November exams but, I think it is, like, really complicated for me. I don't know, maybe, like, everyone else found it easier but I found it complicated.

Kate: When I made something for geometry, my mum was kind of saying 'what's that for?' and I was saying that 'it's geometry'. And,, she asked me which model was which and she didn't even know it because she said that when she was in school, they didn't teach like that at all, they just kind of wrote them up on the board and you just had to remember them in your head.

Michelle: My mam said it was a good idea.

Laura: Well, my mam, can't remember, it's not that she's so old and every time I'd show her an angle, she'd remember. She said that she had a maths teacher when she was at school and she was not nice...., and I was describing our teacher, she said her teacher was not like that, she was so strict and she never used to let them cut out things or make angles or anything like that. She just told them to learn them and that was it and that's why my mam forgets so much because it didn't function 'cos her teacher never explained it clearly.

Extract from Kenmore

Interviewer: How do you find maths this year?

Andrew: Very different to Primary school maths and you learn a lot more different kinds of maths. In Primary school like you take just one subject in maths for like two months but in secondary school ah it's much faster.

Aine : Nods yea and it's a bit harder

Conor : I don't think it's harder

Neil: Neither do I.

Rachael: I find it a little bit harder well learning new things that I didn't do in Primary that I do now.

Aoife: I think it's all right maybe a little bit harder.

Extract from Chestnut Hill

Interviewer: How do you find maths this year?

Michael : Boring.

Interviewer: Why are they boring?

Michael: Just we wouldn't really find them interesting and we don't really need them like. That's what I think anyway.

Interviewer: What about the rest of you? How do you find maths this year?

Caoimhe: Grand.

Interviewer: And why are they grand?

Caoimhe: Eh, I don't know.

Padraig: It's alright, it's alright. Not too bad.

Liam : Eh, they're hard enough.

Interviewer: Why are they hard, do you think?

Liam: I don't know.

Appendix P (ii): Interview Question "What is a good mathematics teacher"?

Extract from Riverside

Interviewer: What's a good maths teacher?

Michelle: A teacher that explains loads and like, Miss Riverside she writes up a sum and then she break it up in different pieces and says, 'we'll take this part and this part' and then she kind of puts it together and then she gives an example and she writes down what you do each time, each step and she writes it out again and again, she says it doesn't matter how long it gets as long as you get it right.

Niamh: I think a good maths teacher is probably one who makes you write out notes, so that you can remember them and you can keep that copy for ages

Laura: I think, I'm not being a lick or anything, but I think Miss Riverside is a good maths teacher because she does explain to us really clearly and even if you're having real trouble, as I said, you can go up to her and you can talk to her. She doesn't like leaving you behind. She kind of pushes you because she knows that you can do your best..

Michelle: Yes, if you do something right, you can even feel that she's happy that she felt that she taught something that you couldn't get beforehand, and if you'd get that right then she's just like happy

Niamh: If you were a little bit behind because you can't understand, she still treats you the same as everyone else, you can do it, like,

Niamh: I think Miss Riverside is, like, a real good teacher because, like, she'll always help you out, she's always makes you feel confident. I can feel confident around her because I know, if I don't get something, if I ask her she will give me an extra bit of work or she will explain it to me.

APPENDIX P (iii) Interview Question "Do you ask the teacher questions in class if you don't understand"?

Extract from Riverside

Michelle: I think that's, kind of, scary sometimes (laughter).

Interviewer: Scary?

Michelle: Sometimes you just can't pick it up or, most of the time, you can and it's just, she's so kind of ...., she wants you to do your best, but you can't do it, she's a bit impatient in that way, as in, she'd come over you and she'd start asking questions and makes you feel a fool in front of class

Interviewer: And would you sort of say 'yeah, yeah, I get it now' when you don't get it at all?

Michelle: Sometimes yes.

Interviewer: And what do you do then?

Michelle: I have a friend or ask at home.

Nora: Like if you ask a question...she wouldn't be mean to you but if she said to other people 'If you ask me to explain it again, I'm not going to because you should be listening and if you can't keep up the standard, I'm not going to explain it again because you should be listening'. So, that's why sometimes you'd be afraid to ask her, you'd just be afraid you'd get in trouble or something.

Laura: Well, sometimes if she explained something to you about three times already and then you come in the next day with it wrong, she'd just be a bit angry, a bit .... , but it's not your fault if you don't get it right because, some of the equations that we've just been doing now, I feel really confused after she's explained it. It's just not in my head any more, because you can't remember. Like, sometimes I get really annoyed because I feel, like, Oh my God, it's frustrating and then we have tests on it and if I got a bad mark, I'd know it's because I don't understand them, but, like, it wouldn't be the teacher's fault because she's after explaining it to me, I just don't get it.

Extract from Chestnut Hill

Interviewer: Would you ask your teacher a question?

Michelle: Sometimes, not all of the time, because you should know the answer.

Interviewer How do you find out how to do it if you don't ask?

Michelle: Ask your friend or someone at home.

Laura: I ask and he explains it to me immediately.

Michael: Yeah, he just explains it to you when you ask him. I'd say the odd time I wouldn't ask him.

Interviewer: Why would that be?

Michael: It wouldn't be too often. I don't know. Sometimes he gets annoyed.

Caoimhe: People might laugh at you if you don't understand.

APPENDIX P (iv) Interview Question "Do you like mathematics"?

Extract from Riverside

Interviewer: Do you like mathematics?

Niamh: Yeah, yeah, I like maths because if you want to be, let's say, an accountant, you have to have maths, because you have to be able to add and we'd have very little in the world, if we didn't have maths.

Michelle: Yeah. I find it a bit boring, maths class, you can be, like, 'aw I don't want to have maths now and you'd be, like, 'I don't want to go' and all this when you're actually doing it, it's always better than thinking about it and actually getting on with it.

Nora: I hated maths in Primary school, like, if you didn't get it, they'd move on. I really like maths now because the teacher will do it and if you can't do it, you just tell her. I really didn't like maths in Primary School. I really think I like maths now.

Laura: When I was in Fourth Class, I hated maths. I really thought it was so boring because of the teacher. I remember doing time and decimals and all that and any time I did them, she just said 'why don't you get it?' and she was pushing me and I was, like, afraid of her so I just didn't take any notice of maths, then I came here and my teacher now ., I was, like, 'well, why couldn't my primary school teacher explain it like that?' the way that my teacher does now, I don't know if all the other maths teachers are like this, but, like, I like my teacher now the way she does maths.

Extract from Kenmore

Interviewer: If I asked do you like Maths?

Aoife: It's not my favourite subject?

Aine: I like maths it's probably my favourite subject I like being in maths but I don't actually like maths Because well if I don't get it the first time around and it's hard, I don't know it's just hard. The class is fun but the maths is boring.

Neil: I don't really like it that much but I don't hate maths

Interviewer: But you're good at it (this student had told me he had got 98% in end of term exam)

Neil: Yea but that doesn't mean you like it. I think it's pretty boring I don't hate it but like it's still boring. Well the class is fun but I don't really it's just boring maths.

Conor: The subject is boring but the class is good.

Rachael: I like Maths I always did and I still do.

Andrew: All the classes are the same. The same amount of learning, the same amount of homework and the same amount of humour.

Extract form Chestnut Hill

Interviewer: Do you like Maths?

Padraig: It's alright, it wouldn't be my favourite subject but it's not too bad. I don't know. I just don't mind it, I don't know why I don't . It's not the worst subject. I wouldn't hate it.

Caoimhe: Em, yes, I would like maths, well I just do it.

Michelle: I don't like it but I don't hate it.

Laura: I don't really like it.

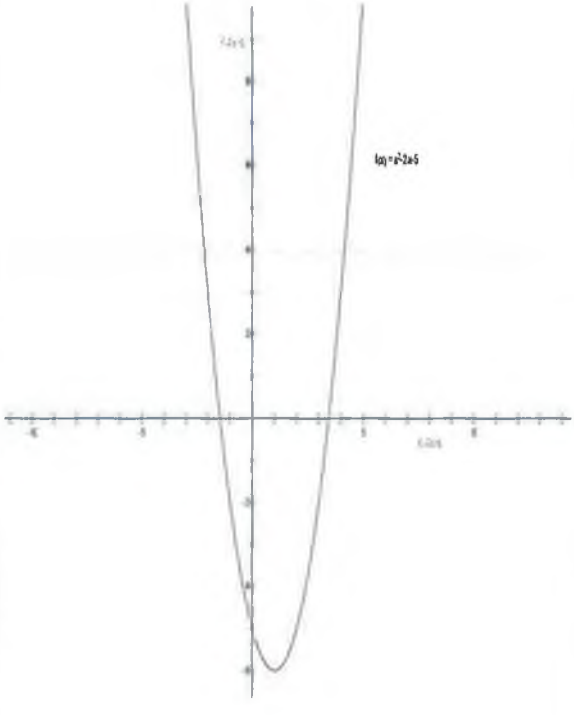
Appendix A for Chapter 6 Table 1: Content of mathematics lessons

School	Lesson	Topic	Specific	Level
Chestnut Hill	1	Trigonometry	Solution of right-angled triangles.	Mostly New
Chestnut Hill	2	Trigonometry	Solution of right-angled triangles.	Mostly New
Kenmore	1	Applied arithmetic	Relationship between average speed, distance and time.	Half Review/ Half New
Kenmore	2	Algebra	Relationship between average speed, distance and time.	Half Review/ Half New
Riverside	1	Functions and graphs	Drawing the graphs of functions $f: x \to ax^2 + bx + c$ $where\ a,b,c \in Z.$ Using the graph to estimate the (range of) value(s) of x for which $f(x)$ is (i) positive (ii) negative.	Mostly New
Riverside	2	Functions and graphs	Drawing the graphs of functions $f: x \to ax^2 + bx + c,$ where $a,b,c \in Z, x \in R.$ Using the graph to estimate the (range of) value(s) of x for which $f(x)$ is (i) increasing (ii) decreasing.	Mostly New

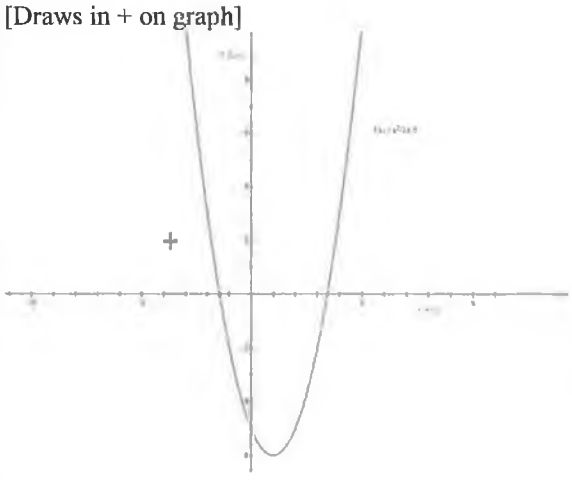
Appendix B for Chapter 6: Illustrative Vignette - Concept Developed (From Riverside)

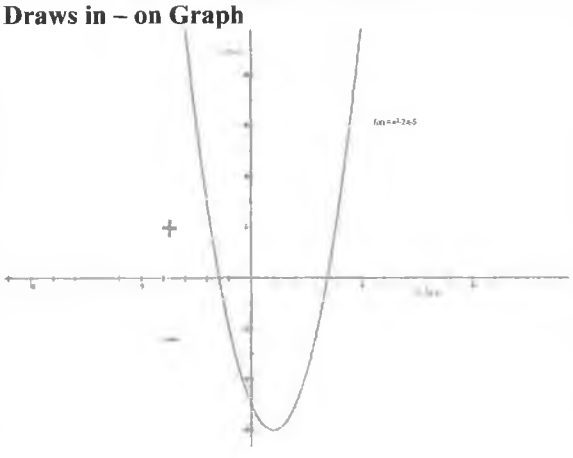
This extract is from Riverside. It involves a very experienced teacher teaching an all girls class. After using a given function and domain to construct a table of values, the students have found couples to plot and have drawn a graph of the function in their copies. The teacher has corrected their work and has drawn a graph of the function on the board. The teacher now moves on to introduce the concept of a function being positive and negative. As can be seen from the extract that follows the students are involved publicly in developing this concept.

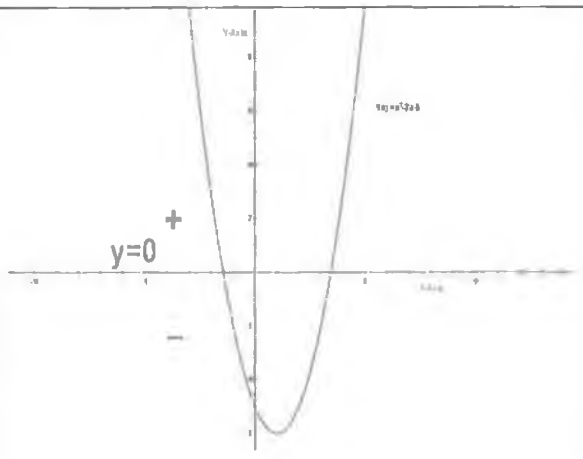
Note: Time is measured not in minutes and seconds but in minutes and decimal minutes.

Time since start of Lesson	Activity	Text of Lesson
11.15	**Teacher Draws graph:** 	
11.45		*Teacher*: If everyone can get that graph drawn and just give it a name f of x equals whatever our function was at the start and then we'll be ready to go.
11.97 **12.57**	**Private with student**	
13.02		If you have different coloured pens or highlighters it might be handy for this.

		So tell me what type this is again , it's type six is it?
13.06		*Class:* Yea
13.21 **14.16**	**Teacher writes on board:** TYPE 6 POSITIVE/NEGATIVE	*Teacher:* I'm going to put the heading down for type six, then we're going to talk about it, then we'll actually answer a question on our graph. Heading for question type six is positive or negative Now that's kinda a bit broad and a bit vague. So we'll have to talk about it a minute before we start answering a question but you can write it down for the minute. These are questions that they'll be asking us about positive parts of the graph and negative parts of the graph. So if everybody's ready with graphs drawn and that taken down you can sit back and look up here for a minute and put your thinking caps on. Right let's see if you can get establish between positive and negative parts of the graph. [Points to graph] When x is zero what's y Zara?
14.29		*Zara:* minus one point five and
14.39		*Teacher:* No, hang on a sec, I think you're thinking, I'm saying when y is zero. When x is zero you drew the point just a few minutes ago.
14.67		*Zara: Mmm...* Minus five.
14.71		*Teacher:* You sound hesitant, are you o.k. with that?
14.73		*Zara:* Yes
14.75	Points to graph	*Teacher:* When x is zero y is minus five down here. What's another name for y?
14.82		*Class:* f of x
14.84 **14.99**		*Teacher :* f of x is our function, so our graph or our function is down at minus five. Anastasia, when x is two where's our graph or our function for y?
15.09		*Anastasia:* Minus four
15.13		*Teacher:* No when x is two, I'm looking for my y-value.
15.24		*Anastasia:* Um..minus five.
15.26 **15.32**	**Point to graph**	*Teacher:* Yea minus five. Etain, when x is four where's y?
15.39		*Etain:* Three
15.41		*Teacher:* Three, so if I asked you where is our function positive, where would you think after hearing

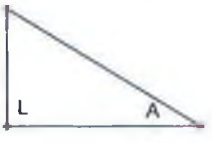
		that brief little discussion that the graph or the function is positive.
15.64		*Kencha:* Above the X-Axis.
15.66 **15.79**		*Teacher:* Above the X-Axis? Now hang on does that make any sense. Kancha said our graph or our function or our ys are all positive above the X-Axis. Well?
16.02		*Class:* Yea
16.05		*Teacher:* Well let's check. When x is minus two where's the graph?
16.07		*Class:* Three
16.10		*Teacher:* Is that positive or negative?
16.12		*Class:* Plus
16.14		*Teacher:* Are you happy with that's positive?
16.16		*Class:* Yea
16.18		*Teacher:* Where is that [points to a point on graph (5,10)?
16.21		*Class:* Above the X-Axis
16.22		*Teacher:* Stephanie, when x is five where's my y?
16.27		*Stephanie:* Ten
16.29		*Teacher:* Up at ten, so my graph or my function is at ten. What is it?
16.39		*Class:* Positive.
16.41 **16.68**	[Draws in + on graph]  	*Teacher:* So it seems that anywhere above the X-Axis gives us a positive part of the graph. Could you write a big positive in here then. So by the same process Kelly where is the graph negative?
16.76		*Kelly:* Below the X-Axis.

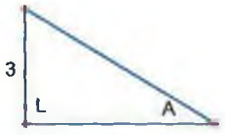
16.79		*Teacher:* Below the X-Axis. Check a point or two if you want to. When x is minus one Yolanta what is y?
16.91		*Yolanta:* Minus two
16.93		*Teacher:* Minus two which happens to be sitting below the X-Axis. Caroline, when x is one what is our y or our f of x?
17.09		*Caroline:* Minus six.
17.12	**Draws in – on Graph** 	*Teacher:* Minus six, so definitely down here underneath the X-Axis seems to be negative.
17.32		So tell me what about on the X-Axis, Emma.
17.34		*Emma:* f of x is y
17.45		*Teacher* : What's y equal to on the X-Axis
17.46		*Emma:* Mmmm..
17.48		*Teacher:* Is it positive or negative and if it's neither of those what is it?
17.59		*Emma:* Both
17.61		*Teacher:* How can something be both positive and negative?
17.63		*Emma:* OK. Well it's in two places.
17.74	**Points to where graph crosses X-Axis**	*Teacher:* No, no, no. OK I see what you're thinking and you mean we have one positive and one negative value over here.
17.78		*Emma:* Yea
17.82		*Teacher:* But what I'm asking is along the X-Axis what will y be equal to?
17.94		*Emma:* Zero
18.02		*Teacher:* Good. Zero. What is y always equal to along our X-Axis?
18.07		*Class:* Zero.
18.10	**Teacher draws on board**	*Teacher:* So here y is positive, here y is negative and if we want to make a little note to remind ourselves along the X-Axis y equals zero

18.32 **18.61**		Right, so sometimes you get asked questions about positive bits of the graph or negative bits of the graph and to be honest people do sometimes find these tricky to answer but if you have a n understanding of this (points to + and – on graph) I think it will help. Will we try a question based on it?
18.63		*Class:* Yea

Appendix C for Chapter 6: Illustrative Vignette-Homework Correction (From Chestnut Hill)

This extract is from Chestnut Hill. It involved correcting a homework question completed by students at home. The correction is by a mature teacher to a Higher Level Second Year class. The question involved solving a right angled triangle given certain information. In the correction the teacher mainly questions one student and is intent on that student giving the correct answer to each stage of the solution and getting it corrected as quickly as possible. Little explanation is given by the teacher to incorrect answers given by the student.

Time since start of Lesson	Activity	Text of Lesson
0.75	Teacher speaks to Padraig	*Teacher*: Padraig do you see sixteen
0.81	Padraig answers	*Padraig:* Yea, Uh Um
0.83	Teacher reads out question 16	*Teacher:* It says A is an acute angle such that Tan A=3, find as surds the value of Cos A and Sin A. Right.
0.89	Padraig answers	*Padraig:* Yea I think so
0.91	Teacher asks Padraig question Teacher writes on board: Board: Tan A=3=$\frac{3}{1}$ Teacher asks Padraig question	*Teacher:* Right what do you do? *Teacher:* What is the first thing you do?
1.04	Padraig answers	*Padraig:* Ah, put down.
1.10	Teacher interrupts	*Teacher:* You drew a right-angled triangle?
1.11	Padraig answers	*Padraig:* Yea.
1.16 1.20	Teacher draws on board  Teacher speaks to Padraig	*Teacher:* That's the first thing. *Teacher*: Take it away, now go on.
1.21	Padraig answers	*Padraig:* Ah $H^2 = O^2 + A^2$
1.23	Teacher speaks to Padraig.	*Teacher:* Yea, ok, but you need to fill in the triangle first.
1.30	Padraig speaks	*Padraig:* Oh, sorry, yea.
1.33	Teacher asks Padraig question	*Teacher:* What do you do?
1.37	Padraig continues	*Padraig:* Hypotenuse is 1
1.44	Teacher points to wall where Tan A = $\frac{O}{A}$ is written	*Teacher:* No Tan is Opposite over…..
1.51 1.53	Padraig says nothing Teacher calls out what it should be Padraig now answers at the same time as the teacher	*Teacher:* Tan is opposite over adjacent. *Padraig:* Opposite over hypotenuse

	Teacher writes it on the board: Tan A = $\frac{3}{1} = \frac{O}{A}$	
1.56	Teacher replies to Padraig's answer and points to the triangle on the board  	*Teacher:* The hypotenuse isn't 1. So look at angle A. You had angle in there?
1.63	Padraig answers	*Padraig:* Yea
1.67	Teacher asks Padraig question	*Teacher:* Right what's opposite A ? What number?
1.71 1.75	Class and Padraig answer	*Class:* 1 *Padraig:* 3 (which is the correct answer)
	Teacher writes in 3 on the board on triangle  	
1.79	Teacher asks Padraig question	*Teacher:* 3, So what's the adjacent going to be?
1.81	Padraig answers question	*Padraig:* 1
1.85	Teacher asks Padraig question	*Teacher:* Where does 1 go? (Referring to the triangle on the board)
1.87	Padraig answers question	*Padraig:* Bottom
1.91	Teacher replies to Padraig's answer. Teacher writes 1 in on board.  	*Teacher:* Yea, Very Good.
	Teacher speaks to Padraig	*Teacher:* Now you can fill this in pointing to $H^2 = O^2 + A^2$
1.95	Teacher asks whole class question Teacher writes on board $H^2 = O^2 + A^2$ $H^2 = 3^2 + 1^2$	*Teacher:* Is everyone clear on this? Are they? We're just going over what we've done at the weekend. So you have H squared equals three squared plus one squared.
2.09	A boy asks a question	*Boy:* What about the x^2 Sir?
2.12	Teacher replies to question. Teacher asks Padraig question	*Teacher:* You can put x^2 or leave it as H^2 **Right what do you do then?** **What's three squared plus one squared.**

2.21	Padraig answers	*Padraig:* 9
2.24 2.33	Teacher carries on . Teacher asks question	*Teacher:* yea, nine plus one So the answer…pause What's H^2 then?
2.36	Class and Padraig answer	*Class & Padraig:* 10
2.43	Teacher continues and then writes on board. $H^2 = 9+1$ $H^2 = 10$ $H = \sqrt{10}$	*Teacher:* Ten yea, so the answer is H equals the square root of ten. $H = \sqrt{10}$ isn't it?

Appendix D for Chapter 6 (i): Illustrative Vignettes- Introducing New Content (From Chestnut Hill)

After correcting homework the teacher introduced the students to a new concept that 1 degree = 60 minutes. The teacher also introduced the students to how to input degrees and minutes into their calculators. The introduction of this new content was carried out in a transmission style and interspersed with questioning the whole class. Having completed this introduction, the teacher worked through an example using degrees and minutes and calculator. Overall, the introduction of new content lasted approximately 4 minutes and clearly illustrates the didactic approach to teaching mathematics that was evident in Chestnut Hill in this study.

Time since start of Lesson	Activity	Text of Lesson
4.97 **5.14** **5.70** **5.80**	Teacher writes on board HOUR → 60 MINUTES Board 1 DEGREE = 60 MINUTES	*Teacher:* I want to introduce you to a new idea and it's this. You know the way you have hours and they're divided into sixty minutes right. Write that down. Now if hours were divided into decimals then you'd have one hundred minutes but it's actually sixty and sixty comes up an awful lot and it all goes back thousands of years ago, it's go to do with a civilization that existed thousands of years ago and they used sixty an awful lot and we just kept it on. Now we've switched most things over to decimal. Some things are still at sixty and degrees are the same. One degree can actually be broken up. If you had one degree and you wanted to break it up into smaller parts you could actually break it up into sixty minutes. Right so if for example you really wanted to make an accurate measurement so say for example you had this measurement, remember yesterday we had twelve and a half degrees in the experiment, remember that? We measured t angle from the clinometer up to the base of the clock it was twelve and a half degrees, but twelve and a half degrees is..? What's half an hour?
6.01		*Class:* thirty minutes
6.03		*Teacher*: Thirty minutes, so half a degree is going to be thirty minutes, so twelve and a half degrees is going to be twelve degrees and
6.08		*Class and Teacher:* Thirty minutes

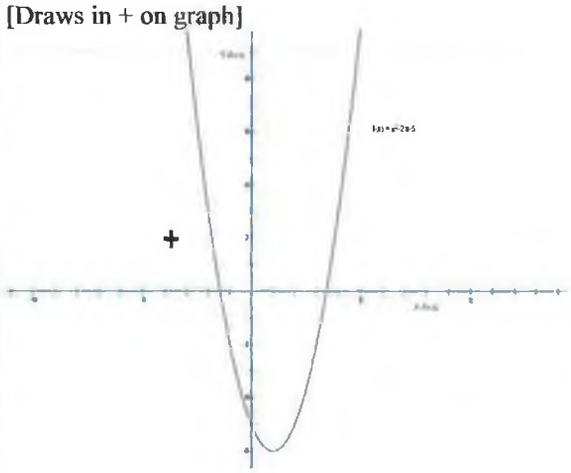
6.09	Teacher writes on board $12\frac{1}{2}^{\circ} = 12^{\circ}30'$	*Teacher:* So that is actually twelve degrees thirty minutes and we write thirty minutes is thirty with an apostrophe there
6.19		If you look at your calculator you'll find a button called DMS or the CASIOS you'll find a button that looks like
	Teacher draws button on board ° ' "	If you look at your calculator you'll find a button called DMS or the CASIOS you'll find a button that looks like this:
6.60	Chatter in class/students looking at calculators	Degree and dash and double dash. Can everyone find that either DMS which is on the SHARP and on the CASIO you should see that button
6.61	Private with student	
6.65	Interrupted by student	*Teacher:* Just look at it you don't have to press it now.. This here is degrees, that's minutes and that's seconds (pointing to CASIO button drawn on board) Now you don't have to worry about seconds all you have to worry about is minutes. So twelve and a half degrees is twelve degrees
6.92		*Student:* Where is it on the CASIOS
7.01	A lot of chatter in class Teacher writes on board 20°30'	*Teacher:* On the CASIOS, there (points to board where a picture of the button is drawn). Find that symbol there, see it there. So what I want you to do now is look at number eight. Everyone have a look at number eight. Everybody do you see number eight, so twenty degrees and thirty minutes. I want you to enter that into your calculator.
	A lot of chatter	So the way your gonna enter that is this. You press twenty. So everybody type in twenty now. (Question asked by student and is ignored by teacher) Twenty degrees, so twenty DMS and that enter the degrees in, twenty D, is twenty degrees, now if you type in thirty and press your DMS button again now the thirty minutes is entered okay, press equals okay. What should be on your calculator.. What should be on your calculator is twenty degrees thirty minutes alright. Now on the CASIOS only on the CASIOS now press DMS again and what o you get?
8.19		*Class:* twenty point five.
8.22		*Teacher:* Press DMS again and what are you back to?
8.24		*Girl:* The original
8.26		*Teacher:* The original , so that means (boy tries to interrupt) twenty degrees and thirty minutes is twenty and a half now the people on SHARPS go

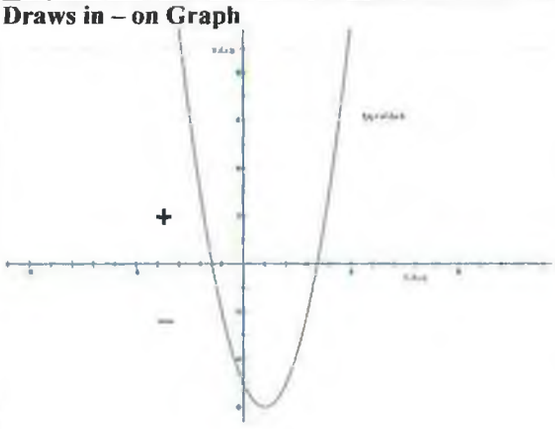
		second function DMS on the SHARPS and you should get twenty and a half and..
8.50		*Some students:* No
8.52	Private with student	*Teacher:* Okay, and Press second function DMS again on the SHARPS and your back to twenty degrees thirty minutes again. Is that clear to everybody?

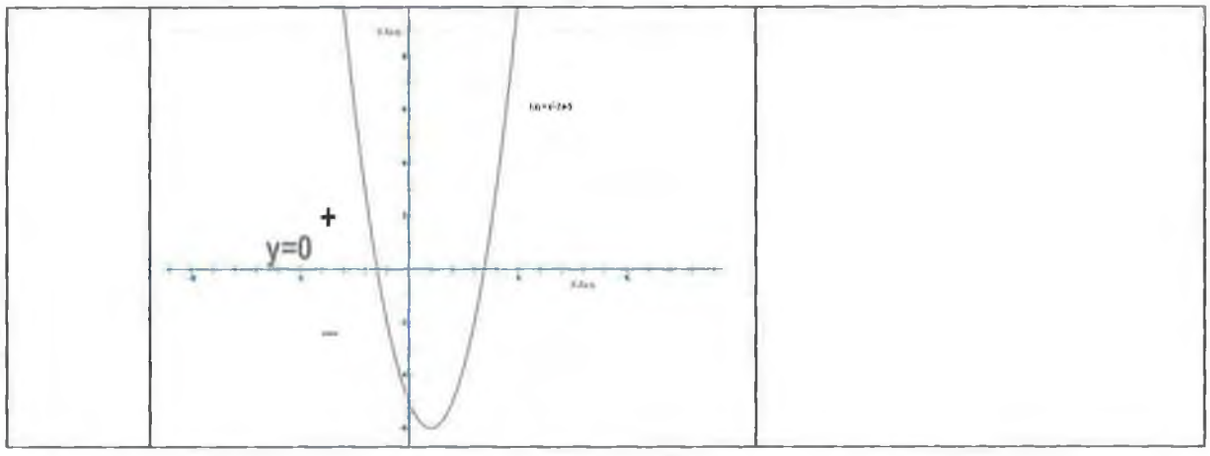
Appendix D (ii): Illustrative Vignettes- Introducing New Content (From Riverside)

This vignette from Riverside begins with the teacher introducing the idea of a graph being positive or negative. Throughout this phase the students were called on to give their understanding of what the teacher was asking them and errors were acceptable and analysed by the teacher and students. Thus the students were actively engaged in constructing mathematical ideas. The introduction lasted approximately 4 minutes.

Time since start of Lesson	Activity	Text of Lesson
14.16	**Teacher writes on board:** TYPE 6 POSITIVE/NEGATIVE	*Teacher:* Right let's see if you can get establish between positive and negative parts of the graph. [Points to graph] When x is zero what's y Zara?
14.29		*Zara:* minus one point five and
14.39		*Teacher:* No, hang on a sec, I think you're thinking, I'm saying when y is zero. When x is zero you drew the point just a few minutes ago.
14.67		*Zara: Mmm*...Minus five.
14.71		*Teacher:* You sound hesitant, are you o.k. with that?
14.73		*Zara:* Yes
14.75	Points to graph	*Teacher:* When x is zero y is minus five down here. What's another name for y?
14.82		*Class:* f of x
14.84 **14.99**		*Teacher:* f of x is our function, so our graph or our function is down at minus five. Anastasia, when x is two where's our graph or our function for y?
15.09		*Anastasia:* Minus four
15.13		*Teacher:* No when x is two, I'm looking for my y-value.
15.24		*Anastasia:* Um..minus five.
15.26 **15.32**	**Point to graph**	*Teacher:* Yea minus five. Etain, when x is four where's y?
15.39		*Etain:* Three
15.41		*Teacher:* Three, so if I asked you where is our function positive, where

		would you think after hearing that brief little discussion that the graph or the function is positive.
15.64		*Kencha:* Above the X-Axis.
15.66 **15.79**		*Teacher:* Above the X-Axis? Now hang on does that make any sense. Kancha said our graph or our function or our ys are all positive above the X-Axis. Well?
16.02		*Class:* Yea
16.05		*Teacher:* Well let's check. When x is minus two where's the graph?
16.07		*Class:* Three
16.10		*Teacher:* Is that positive or negative?
16.12		*Class:* Plus
16.14		*Teacher:* Are you happy with that's positive?
16.16		*Class:*Yea
16.18		*Teacher:* Where is that [points to a point on graph (5,10)?
16.21		*Class:* Above the X-Axis
16.22		*Teacher:* Stephanie, when x is five where's my y?
16.27		*Stephanie:*Ten
16.29		*Teacher:* Up at ten, so my graph or my function is at ten. What is it?
16.39		*Class:* Positive.
16.41 **16.68**	[Draws in + on graph]  	*Teacher:* So it seems that anywhere above the X-Axis gives us a positive part of the graph. Could you write a big positive in here then. So by the same process Kelly where is the graph negative?
16.76		*Kelly:* **Below the X-Axis.**

16.79		*Teacher:* Below the X-Axis. Check a point or two if you want to. When x is minus one Yolanta what is y?
16.91		*Yolanta:* Minus two
16.93		*Teacher:* Minus two which happens to be sitting below the X-Axis. Caroline, when x is one what is our y or our f of x?
17.09		*Caroline:* Minus six.
17.12	**Draws in – on Graph**  	*Teacher:* Minus six, so definitely down here underneath the X-Axis seems to be negative.
17.32		So tell me what about on the X-Axis, Emma.
17.34		*Emma:* f of x is y
17.45		*Teacher* : What's y equal to on the X-Axis
17.46		*Emma:* Mmmm..
17.48		*Teacher:* Is it positive or negative and if it's neither of those what is it?
17.59		*Emma:* Both
17.61		*Teacher:* How can something be both positive and negative?
17.63		*Emma:* OK. Well it's in two places.
17.74	**Points to where graph crosses X-Axis**	*Teacher:* No, no, no. OK I see what you're thinking and you mean we have one positive and one negative value over here.
17.78		*Emma:* Yea
17.82		*Teacher:* But what I'm asking is along the X-Axis what will y be equal to?
17.94		*Emma:* Zero
18.02		*Teacher:* Good. Zero. What is y always equal to along our X-Axis?
18.07		*Class:* Zero.
18.10	**Teacher draws on board**	*Teacher:* So here y is positive, here y is negative and if we want to make a little note to remind ourselves along the X-Axis y equals zero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y=0
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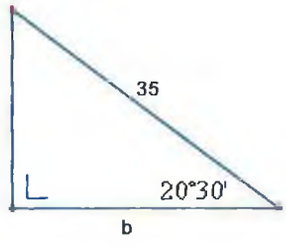
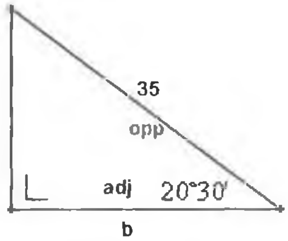
Appendix E for Chapter 6: Illustrative Example: Student Practice (From Chestnut Hill)

Practice of the demonstrated procedures by the students was a prevailing pedagogical practice in the lessons observed. The students had been taught how many minutes were in a degree and how to input this into their calculators. Following that demonstration the teacher did an example of how to get the length of a side of a triangle given the length of another side and an angle measured in degrees and minutes. Students had in previous classes been taught how to solve right angled triangles using Sin, Cos and Tan. The students here are involved in the student practice phase of the lesson and can be seen being led by the teacher in applying procedures.

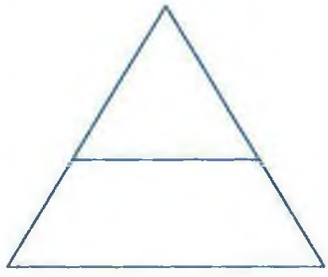
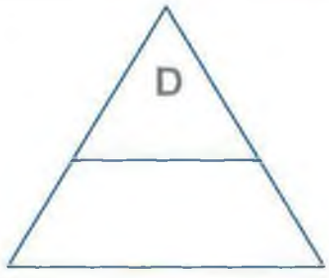
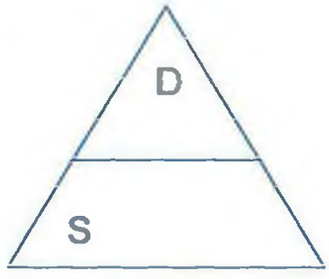
Time since start of Lesson	Activity	Text of Lesson
8.62		*Teacher* :So you should be all able to have a go at number eight. So I want you all to have a look at number eight there and draw the triangle and I want you to think about it the problem and then we'll finish the experiment from yesterday. Board
	Teacher draws on board  	
8.90		The angle is twenty degrees and thirty minutes you have to find B and they tell you that the hypotenuse is thirty five. Now I want everybody to have to draw that triangle, I want you to have a look at it and Peter could you suggest what you think is the link between the angle, between b and between thirty five. Now think about it. Can you see what the link is between the angles that's given, b and thirty five. In other words what links all the stuff you know.
9.71		Everybody think about it and don't say the answer and Peter will say what he thinks is the answer. Okay Peter any suggestions.
9.73		*Peter:* No
9.79 **9.82**		*Teacher:* That's okay. Em Michelle any suggestions.
9.86		*Michelle:* Is it Cos cause it's adjacent over hypotenuse.
9.93	Teacher draws on board	*Teacher:* Very good, if you look at this angle here this thirty five has to be the hypotenuse because it's opposite ninety degrees, this one b is right beside the angle it can't be the opposite so it must be the adjacent.

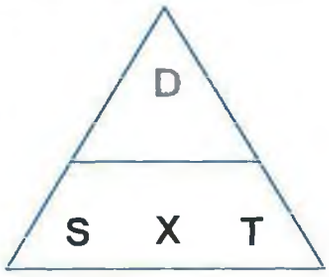
		Look up there (at wall) what links up the adjacent with the hypotenuse.
10.26		*Class:* Cos
10.30 **10.59**	Teacher writes on board $Cos20°30' = \frac{A}{H} = \frac{b}{35}$	*Teacher:* Cos. So in order to find the missing side you go Cos twenty degrees thirty minutes equals A over H which is b over thirty five. Do you follow it Adrian, do you see how to make the link.
10.61		*Adrian:* Ah ha
10.67		*Teacher:* Alright go to your calculator everybody and work out the Cos of twenty degrees thirty minutes. So you go Cos twenty DMS thirty DMS and press equals.
10.86		*Boy:* Point nine three six six seven
10.91 **10.98**	Writes on board $Cos20°30' = \frac{A}{H} = \frac{b}{35}$ $.93667 = \frac{b}{35}$ $.9367 = \frac{b}{35}$ Interrupted by Robbie	*Teacher:* Point nine three six six seven. Do you all agree with that? It's very important that everyone can do this. You could actually say, look point nine three six seven Wouldn't that be a better answer? Just…
11.60		*Robbie:* How did you get that?
11.63		*Teacher:* What's the number after the two sixes Robbie?
11.65		*Robbie:* Seven:
11.67 **11.87** **12.09**	$\frac{.9367}{1} = \frac{b}{35}$	*Teacher:* So (pointing to the seven) therefore six six becomes six seven. If you round off to four places that six becomes (pointing to second six) seven. Right you should know that. So what you do is put that over one and then to get them onto one line you cross multiply. Paul why are you allowed to cross multiply?
12.15		*Paul:* Cause em.
12.22		*Teacher:* Cause what?. Now you should've paid better attention to the last time we did that. You're allowed to cross multiply because you have one fraction equal to

12.59	$b = 35(.9367)$	another. So cross multiply there to get b equals thirty five multiplied by point nine three six seven. You work out that answer John.
12.61		*John:* thirty seven point seven eight.
12.63		*Teacher:* No, it has to be less than thirty five.
12.71		*Class:* Thirty two point seven eight four five.
12.77 **12.98** **12.03** **13.12**	$b = 32.78$	*Teacher:* And round that off to two decimal places and the answer is approximately thirty two point seven eight. And that's how you find b there. Right is that clear? Have you any questions on that, particularly the people who were out yesterday. Does that make sense what we're doing? Yea .Okay.

Appendix F for Chapter 6 (i) Illustrative Vignette Classwork Questioning: Extract from Kenmore

This extract is from a classwork phase of the lesson. The students had learned how to get distance, speed and time prior to this lesson. The lesson starts with the teacher recapping on this, demonstrates an example and has brought in a work sheet for the students to practice more of these. A student is brought to the whiteboard to write down how to do the next question after the teacher demonstration. The emphasis is on obtaining the right answer and moving quickly through the problem. These are some examples of lower order teacher-student questions from three lessons, again illustrating the emphasis on procedural understanding.

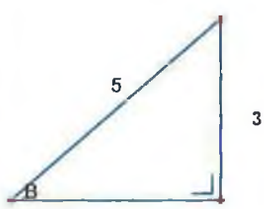
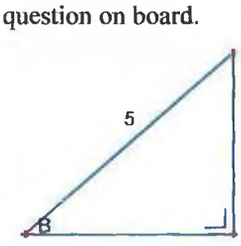
Time since start of Lesson	Activity	Text of Lesson
0.06	**Teacher draws triangle on board** 	
0.23		*Teacher:* What letter goes on top
0.27		*Ellie:* D
0.29		*Teacher:* OK D, and D stands for what?
0.30		*Ellie:* Distance
0.31		*Teacher:* OK Distance. OK What now, moving out here.(points to left hand side of triangle)
0.42		*Enda:* S
0.43		*Teacher:* For

0.45		*Enda:* Speed
0.47		*Teacher:* And Emmett the last one.
0.49		*Emmett:* Multiplied by time.
0.52		*Teacher:* So we put a multiplication sign in here. So Emmett if you want to find distance how do we work it out?
0.62		*Emmett:* Sir, Say it again Sir.
0.63		*Teacher:* If we want to work, find distance and we know the speed and the time how do we do it then?
0.70		*Emmett:* Divide speed by Time.
0.72		*Teacher:* Are you sure?
0.75		*Emmett: Yea*
0.77		*Teacher:* What does it say on the board.
0.83		*Emmett: Oh let me see, you multiply speed by time.*
0.87		*Teacher:* OK multiply speed by time and Sara if you want to find the time what do you do with the distance and the speed?
0.99		*Sara:* Distance and by speed.
1.03		*Teacher:* Is it D multiplied by ,added to, D divided by?
1.09		*Sara:* What
1.11		*Teacher:* What is it, what do you, I do with distance and speed. Yes, you were right, it is D and S.
1.19		*Sara:* Em, ah, multiply them.
1.23		*Teacher:* OK, Distance is over speed (points to triangle) What does that mean
1.27		*Sara:* Divide them, OK?
1.31		*Teacher:* Divide them and we want to find speed Emma. Look at the board, if you want speed what do you do?
1.43		*Emma:* Distance divided by time.
1.53 **1.66** **2.25** **2.51**	**Hands out worksheets** **Chatter in room** [Board: 4 Hours avg speed o 44 km? hr]	*Teacher:* OK We have a worksheet based on D, S and T. I'm going to do the first question the board, the you can try the next couple. It says… Ok Question one find the distance travelled when a car travels a distance measured in kilometres at question one said four hours and an average speed of forty four kilometres per hour. OK Emmett we're asked to find the distance so what are we going to do with the time and the speed
2.59		*Emmett:* Multiply it.
2.60	**Students get calculators**	*Teacher:* Multiply the speed by the time.

2.97	[D = S x T D =4 x 443.02	Emmett. If you don't have a calculator there are calculators here for anybody When you multiply four by forty four Emmett
3.02		*Emmett:* You get one hundred and seventy six, Sir.
3.16		*Teacher:* And that distance is?
3.24	[Board D = 176 km.]	*Class:* One hundred and seventy six kilometres.
3.32		*Teacher:* Will everyone go ahead and do the second question.
3.39		*Girl:* Do I put hours behind it
3.41	**Sara brought up to board do to the next question seems to be struggling**	*Teacher:* No because it's the distance not kilometres per hour because that would be the speed. This is just distance.
3.94		*Teacher* [to Sara at board]: You're asked to find distance. So what's distance equal to.... Look at the triangle on the board.
3.98		*Sara:* Distance is speed by time.
4.10 **4.22**	**Girl writes on board** [Board D=S X T]	*Teacher: to Sara:* OK so write that down on the board D=S by T So in question two Sara what's the speed?
4.32	*Sara writes:[*Board D = 130 x]	*Sara:* One hundred and thirty kilometres
4.43		*Teacher:* OK so fill it in and it's multiplied by the time
4.46	Sara writes: D = 130 x 5	*Sara:* Five hours
4.52 **4.62** **4.70** **4.81**	**Sara had written down 0 and now rubs it out**	*Teacher:* OK so it's multiplied by five. Five noughts You're right nothing. Take your time. Five threes
4.86		*Sara:* Fifteen, do you carry the one?
4.90		*Teacher:* Yea, Five ones are
4.95		*Sara:* Five
4.97		*Teacher:* And the one you carried
4.98	[Board D= 650]	*Sara:* Six
5.00		*Teacher:* OK Perfect, so it's six hundred and fifty You're measuring it in? It's in the question
5.13		*Sara:* Kilometres
5.15 **5.23**		*Teacher:* So it's six hundred and fifty kilometres. Alright, thanks.

Appendix F (ii) Illustrative Vignette Classwork Questioning: Extract from Chestnut Hill.

This extract is from a classwork phase of the lesson. The teacher has corrected the previous night's homework and sets out to demonstrate with the class an example that the following night's homework will resemble. The emphasis is on obtaining the right answer and moving quickly through the problem.

Time since start of Lesson	Activity	Text of Lesson
3.45		*Teacher:* (Have a read at that question 21. What do you think it means? [Q21 from textbook: Verify that $\frac{SinB}{CosB} = TanB$ ]
3.60 3.94	Boy answers (not audible) Teacher draws question on board.  Teacher asks whole class question Teacher asks Conor to answer	*Teacher:* Not really, no. Have a think about it. *Teacher:* Everyone now has read it? Now Conor.
3.98	Conor reads question from book	*Conor:* Sin B over Cos B equals Tan B.
400	Teacher replies and writes in board	*Teacher:* Excellent, so you read it correctly (with good humour)
4.05	Conor makes comment. Class laughs.	*Conor:* Did everyone get that? *Class:* Laughter
4.21	Teacher asks whole class question	*Teacher:* How is he going to go about doing it? Use Sin B.
4.28	Conor and class answer question	*Conor & Class:* Use Sin B.

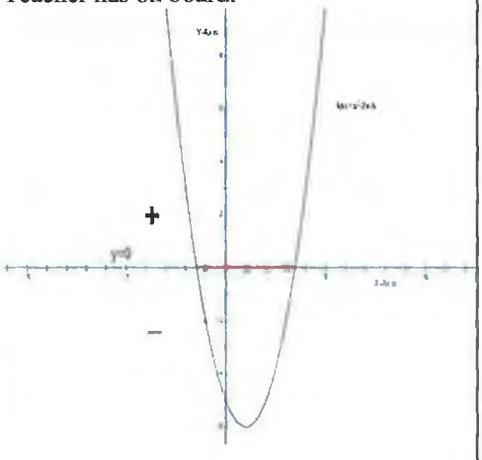
4.30	Teacher asks Conor question	*Teacher:* Very Good. Now what's Sin B? B is there. (pointing to diagram on board)
4.39	Conor replies to teacher question	*Conor:* B is……
4.41	Teacher asks Conor question	*Teacher:* So in B is what. It's up there. [Pointing to wall where the trigonometric identities are written]
4.45	Conor replies to teacher question	*Conor:* B is $\frac{A}{H}$
4.53	Teacher asks Conor question Teacher writes on board: [Board Sin B=$\frac{O}{H}=\frac{3}{5}$]	*Teacher:* It's O over H. So what is it there? It's three over five, would you agree with that?
4.58	Conor replies to teacher question	*Conor:* Yea
4.70	Teacher asks Conor question	*Teacher:* What do you suggest we do next then
4.74	Conor replies to teacher question	*Conor:* Find Cos B
4.79	Teacher asks Adrian question	*Teacher:* We'll ask someone else. Adrian what's Cos B?
4.83	Adrian replies to teacher question	*Adrian:* A over H
4.89	Teacher asks Adrian question	*Teacher:* Very Good, what's that?
4.99	Adrian replies to teacher question	*Adrian:* 4 over 3
5.05	Teacher correct answer and asks Adrian question Teacher writes on board: Cos B =$\frac{4}{5}$	*Teacher:* It's four over five. Why…Why?
5.17	Adrian replies to teacher question	*Adrian:* Because it's A over H. Class laughs at whatever he said.
5.24	Teacher asks Adrian question	*Teacher:* How do you know where the hypotenuse is?
5.28	Adrian replies to teacher question	*Adrian:* It's opposite the right angle.
5.36	Teacher repeats answer Teacher asks Conor question	*Teacher:* It's opposite the right angle. Back to you then Conor.
5.39		*Conor:* You divide them
5.41 5.58	Teacher writes on board: Board $\frac{\frac{3}{5}}{\frac{4}{5}}$	*Teacher:* Very Good. Excellent. So that works out as three over five divided by four over five. Answer to this given by someone not picked up on by teacher. How do you divide a fraction?
5.61		*Pupil:* Turn it upside down and multiply
5.65		*Teacher:* Very Good. Yea so that three fifths multiplied by five

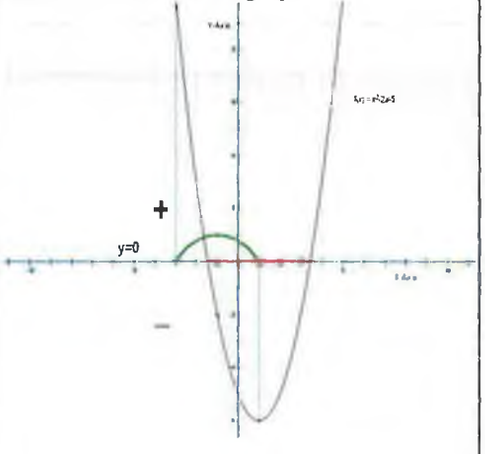
	Teacher writes on board: Board: $\frac{\frac{3}{5}}{\frac{4}{5}} = \frac{3}{5} \times \frac{5}{4} = \frac{3}{4}$	over 4 which is three over four.
5.75		*Conor:* And that tells us what Tan B is.
5.80 5.89	Board: Tan B=$\frac{O}{A} = \frac{3}{4}$ Full board looks like Tan B= $\frac{O}{A} = \frac{3}{4}$  4 $\frac{SinB}{CosB} = TanB$ $\frac{SinB}{CosB} = \frac{\frac{O}{H}}{\frac{A}{H}} = \frac{\frac{3}{5}}{\frac{4}{5}} =$	*Teacher:* Very Good. Tan B equals O over A which is three over four. So therefore it's true isn't it?
5.99		*Boy:* Three quarters, which three quarters?
6.01		*Teacher:* This one? (pointing to $\frac{3}{4}$ with Tan B)
6.05		*Boy:* No, the other one. (The answer to $\frac{\frac{3}{5}}{\frac{4}{5}} = \frac{3}{5} \times \frac{5}{3} = \frac{3}{4}$)
6.07		*Teacher:* Oh this, if you go three fifths divides by four fifths (points to this) if you divide by a fraction you turn it upside down and multiply.
6.14		*Boy:* Not that thing the three fifths multiply by five over four.
6.26		*Teacher:* This here $\frac{3}{5} \times \frac{5}{3}$ can you not figure it out by looking at it? $\frac{3}{5} \times \frac{5}{3}$

6.26 6.35 6.49 6.51 6.58	 Direction to whole class	 Five and Five right. See that? You're allowed to cancel those, they're all the one way. And doesn't that prove it? Very Good Conor. Everyone put that into your copies.

Appendix F (iii) Illustrative Vignette Classwork Questioning: Extract from Riverside.

This extract is from a classwork phase of the lesson. The teacher has explained what it means when a graph is increasing and decreasing and sets out to demonstrate with the class how to find the values for x for which f(x) is decreasing. The questioning features sustained and thoughtful development of key ideas. The teacher paused when she asked a question to allow students time to process the question and at least to formulate responses especially when the question required the student to engage in higher-order thinking.

Time since start of Lesson	Activity	Text of Lesson
		Teacher: Find the range of values for x for which f of x is (i) increasing and (ii) decreasing. [Board: Find the range of values for x for which f(x) is (i) increasing and (ii) decreasing] I will ask this because for later work, what I know is coming next when we go on to the practical use of this graph. It's important here to know where our answers lie then
0.24		*Student:* On the X-Axis
0.25 **0.71**	Teacher has on board:  	*Teacher:* If we're looking for values of x they will lie on the X-Axis so we know that from work we've done yesterday and from previous questions we've been doing that if you're looking for values of x you will find them on the X-Axis. Look at the graph, find the values of x for which the graph is decreasing. *Niamh:* would you give it a go.
0.74		*Niamh:* Ten
0.75		*Teacher:* Ten , pardon.
0.76		*Niamh:* Ten
0.77		*Teacher:* Ten, what?

0.82		*Niamh:* Ten, minus three
0.83		*Tecaher:* Ten, minus three is out here somewhere(points to board to show it's not part of the graph)
0.89		*Niamh:* Oh, minus three, ten.
0.99		*Teacher:* Minus three, ten that's minus three (points to minus three on the X-Axis) a value of x , minus three, and its y part
1.11		*Niamh:* Minus three, minus two and four and five.
1.20		*Teacher:* Do you think the graph is decreasing over here? (points to right hand side of graph)
1.25		*Niamh:* (Laughs) Minus three, minus two and then minus one and eh minus five and zero.
1.38		*Teacher:* Zero.
1.44		*Niamh:* And then not one
1.45		*Teacher:* Exactly, not one, and what about here (points close to one on X-Axis)
1.52		*Niamh:* OK everything from minus three to one but not one.
1.62	Teacher draws line on graph 	*Teacher:* But not including one, now that's very good. Let's see if we can get the range just a bt better, do you remember? Take a ruler and drop a line down and put a little cross where it touches the X-Axis. It should be exactly three by the way because we plotted that point three, minus ten, and wherever we think the curve stops decreasing stops falling down we decided a few minutes ago that's down here it stops, it's having a rest, it's doing nothing down there so take a ruler and plot a little dotted line and mark where it touches the X-Axis with a little cross as well.
2.44 **3.04**		Now what Niamh was describing was all the values for x between minus three to one but not including one so how do we use from yesterday write this? Em, Rebecca.
3.08		*Rebecca:* Em
3.19		*Teacher:* We want to describe from minus three to one.
3.34	Board -3<x	*Rebecca:* Minus three is less than x
3.42		*Teacher:* Yea, or x is greater than minus three.
3.46		*Rebecca*: Greater than, less than one?
3.52		*Teacher:* Greater than one or less than one. Well what do you think, look at it. Is x going to be less than one or greater than one.
3.63		***Rebecca:*** **Less than.**

3.65	[Board -3<x<1]	*Tecaher:* Yea, less than one. Now as it stands you've done well but this isn't fully fully answered Anastasia?
3.83	[Board $-3 \leq x < 1$]	*Anastasia:* Minus three is less than or equal to x and less than one
3.94 **4.26**		*Teacher:* And just less than one. This is what Anastasia is offering. I don't know if you heard it, she's saying minus three is less than or equal to x is less than one, she's saying that x is bigger than or equal to minus three but less than in other words but only just less than one. We're not allowed to include one. Now hang on let's just check that. (points to x=-3 on graph) Are we allowed use this value of x?
4.38		*Class:* Yea
4.38	**Class start calling out answers**	*Teacher:* Why? Yolanda.
4.49		*Yolanda:* Because the graph is decreasing there.
4.55		*Teacher:* Because the graph is decreasing there. Good. But are we allowed to include this value here (points to one on X-Axis)
4.57		*Class:* No
4.56		*Teacher:* Why not?
4.67		*Kancha:* Because it's stationary.
4.70 **5.58**		*Teacher:* Because it's stationary. The graph is not doing anything here, it's not decreasing, it's not increasing, it's just having a rest. So you have to think each time before you give these range of values of x for your answer.

Appendix G for Chapter 6: Illustrative Examples of how teachers responded to incorrect answers from teacher-student questions.

The examples that follow show how the teachers responded to incorrect answers given by students by (i) dismissing it, (ii) answering it himself, (iii) pursuing the correct answer by asking another student and (iv) pursuing what the students had in mind.

Example (i) Dismisses incorrect answer

Teacher (asks boy a question):	What's Cos B?
Boy:	A over H
Teacher:	What's that
Boy:	4 over 3
Teacher:	It's 4 over 5

Example (ii) Teacher answers the incorrect answer himself.

Teacher:	What do you do? What's the first thing you do?
Boy:	Put down $H^2 = ...$ (interrupted by teacher)
Teacher (answers the question himself):	You drew a right-angled triangle
Boy:	Yea

Example (iii) Pursues correct answer by asking another student.

Teacher:	On the triangle distance is over speed, what does that mean?
Boy:	I dunno, 400?
Teacher:	Amy, do you know.
Amy:	The distance divided by the speed

Example (iv) Pursues what student had in mind

Teacher: If we're looking for values of x they will lie on the X-Axis so we know that from work we've done yesterday and from previous questions we've been doing that if you're looking for values of x you will find them on the X-Axis.
Look at the graph, find the values of x for which the graph is decreasing.
Niamh would you give it a go.

Niamh: Ten
Teacher: Ten , pardon.
Niamh: Ten
Teacher: Ten, what?
Niamh: Ten, minus three
Tecaher: Ten, minus three is out here somewhere(points to board to show it's not part of the graph)
Niamh: Oh, minus three, ten.
Teacher: Minus three, ten that's minus three (points to minus three on the X-Axis) a value of x , minus three, and its y part
Niamh: Minus three, minus two and four and five.
Teacher: Do you think the graph is decreasing over here? (points to right hand side of graph)
Niamh: (Laughs) Minus three, minus two and then minus one and eh minus five and zero.
Teacher: Zero.
Niamh: And then not one
Teacher: Exactly, not one, and what about here (points close to one on X-Axis)
Niamh: OK everything from minus three to one but not one.
Teacher: But not including one, now that's very good.

Appendix H for Chapter 6: Extracts from Interviews with Teachers Year 2

Questions asked by Interviewer:

To protect the identity of students the names used are fictitious.

Appendix H (i)

(i) How would you describe your approach to teaching mathematics?

(ii) Would your approach be different in let's say a Higher level class to a Foundation level class?

(iii) What do you see is the main problem in relation to the teaching of Maths at Junior Certificate level?

(iv) Has your approach changed over the years, would you think?

(i) Teacher from Kenmore

Interviewer: How would you describe your approach to teaching mathematics?

Teacher from Kenmore: I think I'm very, let's see, I'm not sure how I teach maths, I mean, in general, classes, I would take the roll, I'd check homework, if it's been done that is if I'd given homework. With most classes, (apart from my better students)I discuss homework prior to them going home, the weaker the student, the more time I spend with them in class doing homework before they go home. Like, that class we videoed we'd do most of the homework , actually, before they go home.

I would like to think that I allow the students discuss problems but, but I know I don't spend time letting them do it and I've done stuff myself on wait time etc., I cannot, I just can't make myself wait, I can't wait for answers, it's something I never did and I find it, I'm finding it difficult to change, I almost do it for them. I suppose I would try to give them good examples, we started using in a lot of my classes, notebook copies that they have examples in, they go back to and refer to, them, I suppose I'm, I'm going away from the idea almost of using a book, I'm not completely but I'm moving away from a book and producing more of my own work.

Interviewer: So, has your approach changed over the years, would you think?

Teacher from Kenmore: Ah, it's, it's changed, it's probably changed more since I've become involved with the TL21 than it's had for the previous, we won't tell what number of years. I mean, more than I ever thought it would, or any other in-service has ever done. I think, more than anything and this may not have been the aim of TL21 it's made me more professional, and more professional in what I do, the way I deliver lessons, I'm more professional by the way, the way I prepare, I nearly question certain things that I believed about maths or thought ….., or things I didn't think about maths, so, I

suppose as an educator and teacher, it made me think more. It's made me think about me as a teacher and that's the most important thing.

Interviewer: Would your approach be different in let's say a Higher level class to a Foundation level class?

Teacher from Kenmore Yeah, I, I suppose it's slightly different, but not a whole lot…., I mean, yeah, there's more spoon-feeding involved with the weaker class, well I do more spoon-feeding with the weaker class. In terms, in terms of handouts, in terms of explanation of concept, in terms of giving more and more examples. But, the class you videoed, for example, I mean, to get them to have the book, to have the stuff with them, I bring the stuff to class, I bring paper, I bring pencils, I bring calculators, I bring all the stuff they use because they …., their organisational skills aren't able to cope with school life, never mind my maths class.

Interviewer: What do you see as the main problem in relation to the teaching of Maths at Junior Certificate level?

Teacher from Kenmore: It probably depends on the teacher, I mean, the problems are my fault rather than the student's fault, I mean, you make the student dependent or not. If you continually, I just noticed, in the last year or so in my own teaching, I probably did too much work for the students, you know? I mean, you prepare your classes and you get ready examples etc., etc. but, allowing the students the time to try and actually do the work in class, I find that difficult. It's, it's not something that you can change overnight, I've made a conscious effort to try and change it but it is a slow process. I'm finding it difficult I suppose to let go of control and allow them to do it, you know, and I get frustrated by them not being able to do things as quickly as I think they should be, do you know what I mean? Consequently they get lazy, they don't do their work basically. They will make excuses they couldn't do it. If you let them do it themselves, they will come up with an answer, you know? If you don't let them, give them the time to write down something, they will inevitably not write it down.

(ii) Teacher from Chestnut Hill

Interviewer: How would you describe your approach to teaching mathematics?

Teacher from Chestnut Hill: (pause) it's …, I don't know how I'd describe it. I suppose you'd teach through your personality , so, I'd hope I'd reflect some way the personality I have and the enthusiasm I'd have for maths, that's the first thing, I'd hope I teach with passion and enthusiasm. I think I do. I

suppose the teaching style would be, I'd hope would be varied because I mean, I'm a different teacher at Foundation level than I am in Higher Level but you have to be, because you have to be flexible.

Interviewer: Okay, so, at Higher Level how would you describe your approach?

Teacher from Chestnut Hill: At Higher Level, I'd be, I think, I think it would be fairly, very work orientated, very much, explaining my ideas, and then discussing similar questions on it and then doing the questions. A lot of it is really expository at Higher Level and getting into it. There's very little room for anything else, I think. And, you know, you'd hope, you'd introduce it well enough to spark the enthusiasm so, it's really the first couple of classes, I think, when you introduce a new topic, that's where I'd put a lot of the creativity. Explanation of a concept followed by demonstration of the procedures and then the student to practice, would be the most dominant way that I would teach. It's important to have that as part of your teaching, an integral part of teaching, a dominant part of teaching.

At Foundation Level Junior Cert, I would be very personal with the kids. The biggest thing there really is that within those classes, you would tend to have the biggest behavioural problems. That's, that's the reality of this school, I don't know if it's true in general. But that's the reality of this school, the weakest kids, some of them are majorly dysfunctional and have severe problems with learning, full stop and severe problems with understanding how to behave in a classroom. So you have to deal with all that. So, the approach is, the approach is just, it's completely different, I mean, there's more stories involved, there's more discussion involved, let them talk about any topic they wanted to, and it was all geared towards how to behave in a classroom and how they view themselves, that type of thing, so, that was part of maths, maths classes, it had to be, otherwise you'd never going to get on with the kids.

Interviewer: And at Ordinary Level?

Teacher from Chestnut Hill: With Ordinary Level, it gets more into the actual concepts that they're going to be asked in the exam. So you can blend teaching them the concepts in a kind of …, in a creative approach, give them out special sheets with puzzles on them, related to what they've done. There is also the other idea of being able to do the Junior Certificate questions, you have to be effective at that as well.

Interviewer: So, has your approach changed over the years, would you think?

Teacher from Chestnut Hill: Yes.. I think a lot of ideas come to you at the blackboard. I think that's where most ideas come to you. Because you try it out and you see students, getting it or not getting it. So, then, you change tack and it's just by trial and error, trying and improve and getting better. The classroom is where you are aware of it when you think about it, you think about how you can make it better.

Interviewer: What do you see is the main problem in relation to the teaching of Maths at Junior Certificate level?

Teacher from Chestnut Hill: Well, part of it, I think, is the language of maths, when you're writing equations and when you're writing inequalities, when you're solving, you know, various problems that aren't directly related to, real life in the immediate fashion, for instance, surds, that's, that's very foreign to them, so, unless they're just naturally interested in it, they're not going to remember it because it's, it's making no sense to them. I think the language is a barrier, yeah, there's no doubt. When you get on to the more practical stuff, when you get on to the area volume stuff and, and when you get on to income tax, that's type of thing, where they might have a better chance, but it kind of comes down to the method you have for teaching maths.

I would say, one big problem is dependency on the teacher. The students tend not to want to think for themselves, they want to hear it from the teacher and be told how to do it. Academically they don't show great initiative, the children.

(iii) Teacher from Riverside

Interviewer: How would you describe your approach to teaching mathematics?

Teacher from Riverside: I think my way of teaching it tends to lean towards, eh, trying to make it very straightforward and not very aloof or abstract. When they come in to First Year at twelve, I sit down and I have a chat with the First Years and I say 'Listen, how many of your really love this subject? How many of you are not so fond of it? How many of you are a bit afraid of it, nervous of it?' All the hands are up, they're coming in at twelve, terrified of maths. I'm not apportioning blame but somewhere out there, something happens and one or two might say they really love and you know, straight away, they're going to be the bright kids. I'm guilty of telling the children how to do sums and I think it's wrong because I think, for example, on a Monday, if I show somebody how to do something, they can do it on a Monday night, of course and they can do it on the Tuesday and they'll

pass an exam in it the following week but they won't know how to do it or understand it the following year.

Interviewer: Would your approach be different in let's say a Higher level class to a Foundation level class?

Teacher from Riverside: I don't teach Foundation Level. In First Year, it's much more, I won't say disorganised but, for example, the kids don't have any formal set of notes or any format of anything, there's more discussion, there's more time and there's more, I dunno, the little things they bring in or bits and bobs like that. In Third Year at Higher Level, it's quite formal, they would have formal notes that they would keep very well, carefully and they would …., there wouldn't be much discussions or there wouldn't be much time, the sense of time has gone and the teaching is much more, "this is what this is", let's try a few of these", "let's see what this one looks like" you know, it's much more serious. With a brighter class, again, you're probably ploughing through stuff and they're just sitting and being taught and working.

Interviewer: So, has your approach changed over the years, would you think?

Teacher from Riverside: Yes I think I'm less afraid of silence and less afraid of …, I'm not in such a hurry to get everything finished all the time. Because I've done the course often enough to know that I'll be able to get it done and I suppose I trust in taking an extra, a little bit of extra time now, it pays off somewhere else, you know? At the beginning, my teaching was very strongly from my own experiences in school and then, just through my own experiences as a teacher and understanding kids and understanding the subject more and all that kind of thing, things changed. The TL21 project would have been a big factor and my own colleagues. TL21 provides a place or a forum for us to discuss and talk things it facilitated awareness and, and from there, you can move in different directions and try things out and discuss.

Interviewer: What do you see is the main problem in relation to the teaching of Maths at Junior Certificate level?

Teacher from Riverside: I think a large problem is that they already have a mental block about the subject when they arrive so, you are first breaking down barriers that have been built, if they're there. I don't know if it's a cultural thing or not, but this idea that, the students coming in, 'Miss, I couldn't do that, couldn't do that' and it's just the apathy and the, "I couldn't do it attitude", the giving up or whatever. It's actually nerve wracking to think how much they're depending on me, just to even show

them the stuff. I think there's the nature of the subject and, possibly, the way it's being taught. and, for the most part, the weaker ones need to see the identical questions, like, it's incredible because I guess they don't get the point, they can do it on the day, but they've never really got an understanding of it, so they can't apply any understanding.

Appendix H (ii): Can you identify any students who appear to have fallen/made progress since they came into Second Year?

(i) Teacher from Kenmore:

Interviewer: Can you identify any students who appear to have fallen/made progress since they came into Second Year?

Teacher from Kenmore: Probably there are two students who have made progress, Daniel, who is a very good student and has made definite progress, particularly in using the calculator to work out something, now he can write things down whereas before he wasn't and also Dorothy, who has improved an awful lot, she may move actually from the class

Interviewer: Could you comment on why you think this has happened to these two students?

Teacher from Kenmore: They've probably matured a little bit themselves and settled down a bit. For Dorothy, it was a discipline issue and she has settled down, for Daniel it's just kind of fitting into the school now.

(ii) Teacher from Chestnut Hill

Interviewer: Can you identify students this year who appear to have fallen back or students that have made a lot of progress this year?

Teacher from Chestnut Hill: Well yeah, there's some students, one or two appear to have made a lot of progress. There's quite a lot of them actually who have made a lot of progress, I think, but the ones who fall behind are falling behind because they're stepping up to another level, that's the reason.

Interviewer: And the students who have made a lot of progress, can you say why you think they have made a lot of progress?

Teacher from Chestnut Hill: I think my confidence probably. I've been teaching Higher Level for a few years, it is my confidence in the classroom, teaching the material.

Appendix H (iii): Do all students ask for help if they need it, do you think? If not, why do you think they don't ask for help?

(i) Teacher from Kenmore

Interviewer: Do all students ask for help if they need it, do you think? If not, why do you think they don't ask for help?

Teacher from Kenmore: The majority of them would. Some would be embarrassed about their lack of ability, or find it difficult to ask questions. In general, most of them would ask questions. There are probably two that wouldn't; Ken is a little bit unwilling to ask for help. He's more academic probably than the rest of the class but doesn't do any work at all, would have no motivation from home to do work, eh, Eddie is extremely weak and doesn't want to show this in class and would rarely ask questions.

Teacher from Riverside: No, not all students would ask for help. I guess part of it is they may not want to ask me or let on that they don't know. I'd say that might be part of it, I don't know and other than that, maybe they don't want their friends to know they don't know something. Some of them are just genuinely shy people, they don't say good, bad or indifferent…., they don't say anything, like, Zoe. She'd never ask a question. I think she's, she's a bright enough kid, I mean, I'll ask her things but she will never really, be the person to instigate a question, no.

Teacher from Chestnut Hill: I think they'd be more inclined to ask the person sitting beside them first, which is what you want, which is better. I think they're more likely to take on board what's said from students than they are from a teacher in a more immediate fashion ….,and, they'll probably get it in their own language. if you were to generalise, I suppose, you'd say it's the type of class where the students tend to …., prefer to ask each other, sort it out, if they can't sort it out, they'll ask me.

Appendix I for Chapter 6 Table 2: Case-study schools (Year 2 of Study) and 10 Schools from *Inside Classrooms*: Performance in TIMSS-related test*

3 Case Study Schools from above Compared with Case Study Schools from *Inside Classrooms* Ranking in Brackets	Mean Score on TIMSS-related test	A %	B %	C %	D %	E or lower %	Group
Case Study School *Inside Classrooms* (1)	29.8	16.0	56.0	24.0	4.0	0.0	Top Set
Case Study School *Inside Classrooms* (2)	28.5	16.0	44.0	28.0	8.0	4.0	Top Band
Case Study School *Inside Classrooms* (3)	27.2	12.9	38.7	29.0	19.4	0.0	Top Stream
Chestnut Hill (4)	**25.6**	**0.0**	**43%**	**38%**	**14%**	**5%**	**Higher Level Group**
Case Study School *Inside Classrooms* (4)	25.6	11.5	26.9	23.1	38.5	0.0	Mixed Group
Case Study School *Inside Classrooms* (5)	24.4	9.1	27.3	22.7	36.4	4.5	Top Stream
Case Study School Inside Classrooms (6)	21.9	4.2	20.8	29.2	25.0	20.8	Mixed Group
Riverside (7)	**19.5**	**0.0**	**4.5**	**23**	**68**	**4.5**	**Higher Level Group**
Case Study School *Inside Classrooms* (8)	18.1	0.0	0.0	33.3	29.7	37.0	Lower Level Group
Case Study School *Inside Classrooms* (9)	16.5	0.0	0.0	10.0	70.0	20.0	Bottom Band
Case Study School *Inside Classrooms* (10)	13.3	0.0	0.0	0.0	33.3	66.7	Bottom band
Case Study School *Inside Classrooms* (11)	13.2	0.0	0.0	0.0	10.0	90.0	Bottom Band
Kenmore (12)	**11.4**	**0.0**	**0.0**	**0.0**	**11**	**89**	**Foundation Level**

- The national mean for second year students in second-level schools was 25 out of a possible forty.
- A:85%-100%, B:70%-84%, C:55%-69%, D: 40%-54%, E: 0%-39%.

Appendix J for Chapter 6: Construction of Attitude scales

Lyons et al., (2003) constructed a number of attitude scales to survey students' attitudes and beliefs. The scales used in this study are the same as the scales used by Lyons et al., and are presented below. These items were issued to all the students in each of the three classes.

(i) Attitude towards maths: Nine Items

Responses to the following 9 items were used in this scale. The scored responses were aggregated in the following way as shown below. To control for non-response, the total score was divided by the number responded to by each student giving the final score with values ranging from 1 (very high liking for maths) to 2 (low liking for maths).

Item	Statement	Response/Score	Response/Score
1	Maths is an easy subject	Very easy/easy = 1	Quite difficult/difficult= 2
2	Maths is useful	Yes = 1	No = 2
3	Maths is interesting	Yes = 1	No = 2
4	Maths is difficult	No = 1	Yes = 2
5	I enjoy maths at school	Always/most of the time/sometimes = 1	Hardly ever/never = 2
6	Maths is important to everyone's life	Strongly agree/agree = 1	Strongly disagree/disagree =1
7	Maths is boring	Strongly agree/agree = 2	Strongly disagree/disagree =1
8	Maths is my 1st or 2nd favourite subject	Yes = 1	No = 2
9	Maths is my 1st or 2nd least favourite subject	Yes = 2	No = 1

(ii) Maths self image; Six Items

This is a six item scale. It indexes the students' image of his/her own mathematical ability relative to that of his/her peers. The scored responses were aggregated in the following way as shown below. To control for non-response, the total score was divided by the number responded to by each student giving the final score. The values range from 0 (very high maths self-image) to 2 (low maths self-image).

Item	Statement	Response/Score	Response/Score	Response/Score
1	This year so far I understand the maths	Very Often= 0	Often = 1	Few times/never = 2
2	Do you think you are good, bad or okay at the maths you do in school?	Good= 0	Okay = 1	Bad= 2
3	Think of everyone in your maths class this year, where would you place yourself	Top/well above average= 0	Just above average/average = 1	Below average/well below average= 2
4	I'm usually well ahead of others in my class	Strongly agree = 0	Agree =1	Few times/never = 2
5	In maths I can do just about anything I set my mind to	Strongly agree = 0	Agree =1	Strongly disagree/disagree = 2
6	I am as good at my maths school work as most other people my age	Strongly agree = 0	Agree =1	Strongly disagree/disagree = 2

(iii) Positive Teacher Interaction

This is a six-item scale. It indexes the students' image of his/her interaction with the maths teacher. The scored responses were aggregated in the following way as shown below. To control for non-response, the total score was divided by the number responded to by each student giving the final score. The values range from 0 (very positive) to 3 (negative interaction).

Item	Statement	Response/Score	Response/Score	Response/Score	Response/Score
1	Over the past 2 weeks in math class I have been told my work is good	Very often = 0	Often = 1	A few times =2	Never =3
2	Over the past 2 weeks in maths class I have been asked questions in class	Very often = 0	Often = 1	A few times =2	Never =3
3	Over the past 2 weeks in maths class I have been praised for answering a difficult question	Very often = 0	Often = 1	A few times =2	Never =3
4	Over the past 2 weeks in maths class I have been praised because my written work is good	Very often = 0	Often = 1	A few times =2	Never =3
5	This year so far, I offer to answer questions without the teacher asking me to do so	Very often = 0	Often = 1	A few times =2	Never =3
6	This year so far, I pay attention and work hard in the class	Very often = 0	Often = 1	A few times =2	Never =3

(iv) Negative teacher interaction

This is five-item scale. It indexes the students' image of his/her interaction with the mathematics teacher. The scored responses were aggregated in the following way as shown below. To control for non-response, the total score was divided by the number responded to by each student giving the final score. The values range from 0 (less negative) to 3 (very negative).

Item	Statement	Response/Score	Response/Score	Response/Score	Response/ Score
1	Over the past 2 weeks in maths class I have been given out to because my work is not done on time	Very often = 0	Often = 1	A few times =2	Never =3
2	My maths teacher pays more attention in class to what some students say than to others	Very often = 0	Often = 1	A few times =2	Never =3
3	Over the past 2 weeks in maths class I have wanted to ask questions but have been ignored	Very often = 0	Often = 1	A few times =2	Never =3
4	Over the past 2 weeks in maths class I have been given out to for misbehaving in class	Very often = 0	Often = 1	A few times =2	Never =3
5	I find my maths teacher is hard to talk to.	Very often = 0	Often = 1	A few times =2	Never =3

Appendix K for Chapter 6 Table 3: The mean scores for each class on each of these scales Year 2 of study.

Case Study Schools	Perceptions of Mathematics		Experience with the Class	Teacher	Maths at Second Year Level
	1.Attitude to Mathematics (1-2) 1=High Liking 2=Low Liking	**2.Mathematics Self-Image** (0-2) 0=Very High Self-Image 2=Low Self-Image	**3.Positive interaction** (Rewards) (0-3) 0=Very Positive 3=Negative interaction	**4.Negative Interaction** (Correction) (0-3) 0=Less Negative 3=Very Negative	
	Mean Score	Mean Score	Mean Score	Mean Score	
Kenmore	1.43	1.65	1.45	0.43	Foundation Level
Riverside	1.2	1.09	1.46	0.36	Higher Level
Chestnut Hill	1.36	1.06	1.57	0.59	Higher Level
	Ranking	Of School	Out of 3	(1=most positive)	
Kenmore	3	3	1	2	Foundation Level
Riverside	1	2	2	1	Higher Level
Chestnut Hill	2	1	3	3	Higher Level
Overall Mean	**1.33**	**1.27**	**1.49**	**0.46**	
Overall Mean of schools from Inside Classrooms	**1.29**	**0.96**	**1.45**	**0.61**	

Appendix L for Chapter 6 Table 4 (i) :Ranking of Case study schools (Year 2 of Study) in comparison with ranking of 10 schools from *Inside Classrooms* in relation to Perceptions of Mathematics.

3 Case Study Schools from above Compared with Case Study Schools from *Inside Classrooms* Ranking in Brackets (1=most positive)	Attitude to Mathematics (1-2) 1=High Liking 2=Low Liking	3 Case study Schools from above Compared with Case Study Schools from *Inside Classrooms* Ranking in Brackets (1=most positive)	Mathematics Self-Image (0-2) 0=Very High Self-Image 2=Low Self-Image
	Mean Score		Mean Score
Case Study School *Inside Classrooms* (1)	1.05	Case Study School *Inside Classrooms* (1)	0.67
Case Study School *Inside Classrooms* (2)	1.14	Case Study School *Inside Classrooms* (2)	0.87
Case Study School *Inside Classrooms* (3) Riverside (3)	**1.20**	Case Study School *Inside Classrooms* (3)	0.90
Case Study School *Inside Classrooms* (4)	1.24	Case Study School *Inside Classrooms* (4)	0.92
Case Study School *Inside Classrooms* (5)	1.28	Case Study School *Inside Classrooms* (5)	0.99
Case Study School *Inside Classrooms* (6)	1.29	Case Study School *Inside Classrooms* (6)	1.02
Case Study School *Inside Classrooms* (7)	1.35	Case Study School *Inside Classrooms* (7)	1.05
Case Study School *Inside Classrooms* (8)	1.40	**Chestnut Hill (8)**	**1.06**
		Case Study School *Inside Classrooms* (9)	1.08
Case Study School *Inside Classrooms* (9)	1.50	**Riverside (10)**	**1.09**
Chestnut Hill (10)	**1.51**	Case Study School *Inside Classrooms* (11)	1.09
Kenmore (11)	**1.52**	Case Study School *Inside Classrooms* (12)	1.25
Case Study School *Inside Classrooms* (12)	1.56	**Kenmore (13)**	**1.65**

Table 4 (ii): Ranking of Case study schools (Year 2 of Study) in comparison with ranking of 10 schools from *Inside Classrooms* in relation to experience in class.

3 Case Study Schools from above Compared with Case Study Schools from *Inside Classrooms* Ranking in Brackets	Positive Interaction Perception of frequency of Interaction with teacher, level of praise for achievements. (0-3) 0=Very Positive 3=Negative Interaction	3 Case study Schools from above Compared with Case Study Schools from *Inside Classrooms* Ranking in Brackets	Negative Interaction (0-3) Sanctioning/correction for work-related and non-work related behaviour. 0=Less negative 3=Very negative
	Mean Score		Mean Score
Case Study School *Inside Classrooms* (1)	0.89	Case Study *School Inside Classrooms* (1)	0.26
Case Study School *Inside Classrooms* (2)	1.14	**Riverside (2)**	**0.36**
Case Study School *Inside Classrooms* (3)	1.22	**Kenmore (3)**	**0.43**
Case Study School *Inside Classrooms* (4)	1.32	Case Study School *Inside Classrooms* (3)	0.43
Kenmore (5)	**1.45**	Case Study School *Inside Classrooms* (4)	0.49
Riverside (6)	**1.46**	Case Study School *Inside Classrooms* (5)	0.59
Case Study School *Inside Classrooms* (7)	1.52	**Chestnut Hill (5)**	**0.59**
Chestnut Hill(8)	**1.57**	Case Study School *Inside Classrooms* (6)	0.61
Case Study School *Inside Classrooms* (9)	1.58	Case Study School *Inside Classrooms* (7)	0.64
Case Study School *Inside Classrooms* (10)	1.60	Case Study School *Inside Classrooms* (8)	0.69
Case Study School *Inside Classrooms* (11)	1.63	Case Study School *Inside Classrooms* (9)	0.77
Case Study School *Inside Classrooms* (12)	1.70	Case Study School *Inside Classrooms* (10)	1.06
Case Study *School Inside Classrooms* (13)	1.93	Case Study School *Inside Classrooms* (11)	2.40

Appendix M for Chapter 6: Extracts from Interviews with Students Year 2

To protect the identity of students the names used are fictitious.

To protect the identity of teachers the names used are as follows:

Teacher from Chestnut Hill: Mr.C

Teacher from Kenmore: Mr.K

Teacher from Riverside: Ms.R

Appendix M (i): Interview Question to Students: "How do you find mathematics this year?"

Extract from Chestnut Hill

Interviewer: How do you find maths this year? What do you think of them?

Oscar: It's pretty much the same as last year, he Mr.C just goes a bit faster this year. Because of Higher Level probably. It's a bit of pressure with this Higher Level maths, compared to other subjects., maths is, like, a lot harder than other subjects.

All: Agree

Alan: Mr C, he's a better teacher than the one I had last year. I find it very hard this year, and I have to keep on reading over and over again. And look back at examples and try to do it. I find maths difficult this year. I'm doing Higher Maths this year. I'm thinking of dropping out of it. I'd be most nervous about maths.

Ben: Yes. Me too I'd be nervous of maths. Because, maths is more difficult, it's more likely that you're not going to get it right. In other, subjects, you have a fair idea; you know what you're doing. It's like, maths is a lot harder than, you know, you might have to think about it a lot more than everything else and sometimes, it's just more awkward. Last year it was hard enough, well, it wasn't that hard but, the teacher wasn't as good as Mr. C, Mr. C, helps you a lot if you're stuck on a question, making sure you understand it.

Betty: I think I have got better at maths this year. I've a good teacher and I like maths.

Kate: Yeah, I think I've got better. I'm starting to understand them more and, eh, yeah. I had a different teacher last year, I have a better teacher this year.

Extract from Kenmore

Interviewer: How do you find maths this year? What do you think of them?

Zara: I learnt more this year. Because last year you had to get to know the teacher and stuff and then, mostly, this year you got to keep the same teacher. we had Mr. K last year as well.

Ken: I was no good at maths last year, rubbish. I'm a lot better at maths this year? Because Mr. K is a good teacher. Last year the teacher , she showed them differently, she'd do it on the board to show everybody instead of showing it individually. She wouldn't, check the copy and all, to see if it had been done or anything. And I wouldn't ask for help. Just couldn't be bothered. I don't think she would have helped. She'd get annoyed because you won't stop asking her, if you don't understand.

Cormac: I'm a lot better at maths this year too, because, I was in higher level last year and now I was put down to Foundation because I couldn't do maths. The frustration, like, I can't find the root or fractions or multiply. I didn't have Mr.K last year. The teacher last year just gave us more homework than Mr. K does. She always put the sum on the board and she wouldn't explain it that good, she'd just say 'do this'. She'd say 'do the sum' and she would she give you loads like that to do.

Dorothy: Yeah, my grades went up this year.

Roisin: I think I've come on a little bit. Because, last year I didn't understand them.

Daniel: Yeah. Before I came to Kenmore I wasn't very good at maths. I could only do plus and minus, I didn't know how to divide or multiply.

Zara: Sometimes I don't understand it and I have to get help from my mam because my dad's useless at maths.

Extract from Riverside

Interviewer: How do you find maths this year? What do you think of them?

Kathy: I had a different teacher last year and her teaching methods were different. Well, with Miss X last year, we used to learn songs and things, I remember, like, plus and minuses and stuff like that, like negative numbers and positive numbers and with Miss R this year it's just kind of more straightforward, yeah. She never rushes through anything, if you don't understand; you can say 'I don't understand'.

Ida: Yes, Mss X last year she'd sing songs and poems and had, pictures on the walls. You had to, remember what happens when you multiply a minus and plus and all that stuff, and we didn't have notes. If you want to study, we'd look at our copies and it was very hard to follow, like, it was just memory last year, and if you forgot it, that's our problem. This year it's clearer. I'm more nervous this year because you're in higher level and you have to be really good at maths. Last year you were mixed (mixed ability), and that's much easier, you know?

Appendix M (ii): Interview Question to Students: "What is a good mathematics teacher"?

Extract from Chestnut Hill

Interviewer: What makes a good mathematics teacher?

Alan: One that, if you don't know you can ask a question. Someone who explains it well.

Ben: Mr.C makes sure that everybody in the class knows what they're doing and, if he doesn't, he'll come down to you individually and sort it out.

Alan: He goes very fast though but if you ask him to slow down, he will and if you have a problem, he'll be able to tell you, he'll go down and go through it step by step. And that's a good method that he has.

Ben: Well, what Alan said really. He does it very fast but, he'll slow down if you wanted him to and he'll just take it step by step on the board just to make sure everyone has a feel for it; that they know what they're at. That's good.

Oscar: Sometimes he'll take an example from everyday life and he'll kind of explain it to you that way, and that's really, really good.

Kate: When he's writing on the board, he breaks it down. Makes sure you understand the key bits so that you'll get the whole question. Like once you get to understand the basics of it then you get to learn it, and understand the whole question.

Extract from Riverside

Interviewer: What makes a good maths teacher?

Polly: Our teacher explains it well and has a good relationship, with the students. She can talk to the students and you can talk to the teacher, if you have problems.

Deirdre: Yeah, well, she explains everything, she doesn't just say, "this is how you do it and learn it". She explains why you should do it this way and she makes everything really clear and it's not complicated at all. I had the same teacher last year but, in Primary School, I didn't learn anything. I was bottom of the class in Primary School and now, I'm in Higher Level, because of the teacher.

Kathy: Oh, she's friendly and she'll explain something to you if you want and she doesn't go too fast and she doesn't just say 'this is what it is, learn it'. She explains and gives examples and we have our notes copies which are really handy. I think the notes really work, the notebook, not just a load of examples from the book.

Ida: I think she's very organised, very easy to follow, I think she probably plans her lessons, she is very thorough.

Deirdre: She always has examples there, ready and she doesn't really get that distracted and go away from the point. So, we don't spend three lessons trying to get one thing, we do it all in one lesson and then we have enough time to try some examples ourselves in the same lesson which is good.

Deirdre: It's a really good atmosphere in our class, because we all get on really well, there's no, fighting and Ms R, she doesn't have, like, any favourites, she asks everyone equally.

Kathy: Ms R., like, she gets a bit frustrated sometimes but she'd never shout or lose the head, you can't really imagine that with her (laughter). She wouldn't … yeah, she wouldn't really get angry.

Extract from Kenmore

Interviewer: What makes a good maths teacher?

Zara: Mr. K. just comes down and helps you: like, "we'll do it, slower and in more detail". Other maths teachers fly through it and get as much done in as short a space of time as possible. He shows you how to do it and he goes over it and over it and over it until you can understand and he explains it really well.

Dorothy: Yeah, other teachers would be two days there and where we'd be a week going over it. He goes over it and just shows you how to do them and that.

Ken: He shows us how to do them. Explains them and all that.

Cormac: He goes over them until you get it, like he helps you until you finally know what to do.

Roisin: He breaks it down, like, as far as it can go and then explains it all.

Daniel: Mr. K takes it step by step.

APPENDIX M (iii) Interview Question to Students: "Do you ask the teacher questions in class if you don't understand"?

Extract from Chestnut Hill

Alan: I'd be a little bit afraid to ask the teacher. I, just worry that someone else in my class was going to start laughing or something.. I'd definitely ask the person beside me rather than the teacher.

Ben: I'd ask the teacher because the student probably wouldn't know exactly and the teacher is supposed to know what he's doing, so, it's right to ask the teacher because the teacher will say 'right' and he'll say the easy way.

Oscar: Yeah, I'd probably ask the person beside me. You kind of know that person a bit better than you would the teacher. I mean, you're with them more and, sure, if they didn't know it then, you'd probably ask the teacher.

Linda: I 'd ask a student for help. Just to make sure if the answer's right, I prefer to ask the student than ask your teacher. That's in case I was wrong in front of the class. If the student didn't understand it, I'd ask the teacher then, like, I wouldn't be afraid to ask the teacher.

Extract from Kenmore

Daniel: No, Because I (pause), I don't think, I, I don't think I would need help.

Roisin: I'd ask the teacher

Zara: I might ask someone beside me if the teacher was with another student and was busy.

Ken: I'd ask the teacher but I've been in class and didn't ask the teacher and didn't understand because sometimes I just couldn't be bothered .I just rather sit there, not do anything. I'm just not interested really.

Zoe: I don't ask, I probably just sit there and, like, hope for the best.

Extract from Riverside

Kathy: Not always, you don't want to be scared that if you ask a question, the teacher is going to get mad because, that's probably the worst thing in a class.

Interviewer: Okay, And has that ever happened to you in a maths class?

Voices: Yeah.

Ida: Even with this class, like, maybe it's just me, I'm just afraid she might get a bit angry like, she might explain the whole thing, I might still not get it, you know?

Dana: I worry about maths, you feel you always need to work a bit harder in it.

Deirdre: If it was very complicated and I kind of thought the person beside me mightn't understand it,even if you felt kind of stupid, you might ask the teacher. I ask Ms R but, sometimes I'd ask the person beside me, it depends. If it was just something wasn't working then it might be just be a simple mistake that I made but if it was the method that wasn't working then I'd have to ask the teacher.

Ida: Well, I do worry that she might get, a bit frustrated with me, after she explained the whole thing and I mightn't get it or I did something wrong, I didn't get the right answer or something. I just don't want her to get angry or frustrated.

APPENDIX M (iv) Interview Question to Students: I want you to think about a time when you felt happy or anxious in your maths class.

Extract form Chestnut Hill

Alan: I'm anxious about Maths the whole time. I don't wanna go into class. I don't like it at all. I say I'm going to drop out of it but it's just maths, they're really hard. When I'm not able to do the maths, I would say to myself 'what am I going to do with the Junior Cert when I'm not able to do them I'm barely ever able to do them and then I get the results back, I just get really upset with them.

Ben: When, when I first went into Mr. C's class and when we got the Christmas test, when I first looked at it, it was way different than the other tests I'd done, so, that kind of gave me a kind of worry so, I was happy enough when I got 53% out of it, like, I thought that was a good achievement because I passed it and I did not really know how to do them. It's just kind of worrying when you get the maths test and you're after working hard and you get the maths test, it just feels like everything you know is just gone, so when you look at it, you could spend ten minutes staring at it until it eventually comes back to you.

Oscar: At the Christmas test, I studied really hard and everything and then when the test day came along, the paper was completely different than I thought it would be and, I got 53%. I know I passed, but it was disappointing for the amount of work I put in. I feel worried about them ever since that. I was really confident, like, after getting 84% in the Summer test. I was really happy with that. And then at the Christmas test just 53%. Well I have kinda lost confidence.

Betty: Coordinate geometry I couldn't get it, it took me ages to get it, you know, that was when I was worried, and then transformations and all that, I couldn't understand that at all. You feel like you're the only one who doesn't understand and you feel like everyone is going to think I'm stupid and I'm not stupid but, I worry I'm going to have to move back down to Ordinary.

Kate: You worry when you don't understand and you can't grasp it as quickly as the others.

Linda: It feels like I'm not able to do it and everybody is able to do it and what am I doing here anyway?. Am I wasting my time here? I can't do it at all and why can't I figure it out? Everyone else seems to be writing away and all the answers are right and I'm just not getting it.

Extract from Kenmore

Zara: I've never felt happy in a maths class. Never, because I used to keep getting lost in primary school. The rest of the class'd be gone on to, say, question 12 and I'd still be trying to do question 10.

Cormac: Mid-term maths test I felt nervous, because I was afraid that I wouldn't remember the sums.

Zara: In maths exams, some of the questions are seven parts long and they are really confusing and I start getting really worried that I'm going to fail. Yeah, it's like churning in the bottom of my stomach, horrible.

Roisin: Last year's Summer maths exams. I didn't really study for it. Even if I had studied, it wouldn't have made a difference I think.

Zara: The more I study, the more confused I get. During the tests I just have to leave it. It's scary, don't you think? Because sometimes you just get really confused and you feel like no one's going to be able to help you. And it gets really, really scary.

Dorothy: Last year's Summer maths tests, and I hadn't a clue. I just didn't know and then I moved into Foundation and I felt much better.

Extract from Riverside

Deirdre: Before our November maths exams, about a week or two before, we were revising stuff and I was just having a panic attack every day. I don't know, there were some things I didn't understand even if I did study. There were some little bits I didn't get and then, there were some bits I did get but I kind of thought, I didn't understand them so I was just having a panic attack every day and it was horrible.

Ida: The November exams I started studying two weeks before the exams started and seeing it all go blurry at the exam, I was so nervous.

Appendix A for Chapter 7 Table 1: Content of mathematics lessons

School	Lesson	Topic	Specific	Level
Chestnut Hill	1	Algebra	Rearrangement of formulae	Mostly New
Chestnut Hill	2	Trigonometry	Solution of right-angled triangles and triangles requiring use of application of the sine rule. Use of formulae $\frac{1}{2ab}SinC$ for finding area.	Mostly Review
Kenmore	1	Statistics and data handling	Mean and mode. Interpreting bar - charts	Mostly Review
Kenmore	2	Number Systems. Statistics and data handling	Squares and square roots. Estimation leading to approximate answers. Mean and mode. Interpreting bar - charts	Mostly Review
Riverside	1	Statistics	Drawing histograms	Mostly New
Riverside	2	Applied Arithmetic	Tax	Mostly New

Vignettes from Videotaped Lessons Year 3

Appendix B for Chapter 7: Illustrative Vignette – Practising Procedures for Pre Junior Certificate Examination Questions (From Chestnut Hill and Kenmore)

(i) Vignette – Practising Procedures for Pre Junior Certificate Examination Questions (From Chestnut Hill).

This extract is from Chestnut Hill. It involves an experienced teacher teaching a Higher Level class of boys and girls. After having corrected a Sample Junior Certificate question the teacher now introduces another sample question which essentially requires the same procedures except for the numerical values. As can be seen from the extract that follows the concepts are merely presented without further explanation and the aim is to practise questions similar to what would appear on future examination papers.

Time since start of Lesson	Activity	Text of Lesson
10.81		*Teacher:* Let's go to page 65 and there's a question in there that's very very similar to the question you just did. Which question is it?
11.04		*Student:* Part (c)
11.06 11.23 11.72		*Teacher:* Part (c) You can see why it's a part (c) of a question because it's not the easiest question in the world but it's doable. It's like everything else if you know what you are doing it's doable. Look at question 5 (c). Does the structure of that question look very similar? OK before you do it the last thing is this: if they give you Cosine θ and they ask you to work out Sine and Tan it's a right angled triangle. If you're given Cosine you are automatically given Sine and Tan.. That's the way you should be thinking. So if you look there they've given you Cosine haven't they? Cosine $\theta = 2/3$ so you should be automatically thinking I know if they ask me to work out Sine I can get it, if they ask me to work out Tan I can get it easily. Can anyone tell us the link there between them, Ronan, the link between part (i) and part (ii).
11.81		*Ronan:* Cosine θ=2/3 and Cosine xyz=2/3.
11.87		*Teacher:* Very good and they ask you to work out the area of the triangle. To work out the area of the triangle you need Sine and they've given you Sine disguised as what?.... Cosine and you just use a right-angled triangle and do it. So what I want you to do for the next five say ten minutes is to do 5(c) and to finish off that then I just want to give you a question on the board

		which you might see coming up in your mocks maybe, maybe not. Alright after this a little tip. Will you all try that for five minutes. See if that question seems a lot easier to get your head around now.
12.55	**Teacher rubs out work on board**	
12.60		That question is from the Sample Papers for that new Junior Certificate.
12.71		
12.73		
	Private with student	
12.96		
	Calls roll	
	Private with student	
13.10	**Private with student**	
13.58	**Teacher moves to front of room**	
13.77		*Teacher:* Two or three minutes left alright.
15.00	**Private with student**	That's the time you would have in the exam, ten minutes. I've given you seven.
	Private with student	

(ii) Vignette – Practising Procedures for Pre/Junior Certificate Examination Questions (From Kenmore).

This extract is from Kenmore. It involves an experienced teacher teaching a Foundation class of boys and girls. The class starts with the teacher reviewing certain buttons ($\sqrt{x}, x^2, x^3, y^x$) on the calculator. The teacher then asks the students to start a part (a) and a part(b) sample Junior Certificate question which essentially requires the same buttons to be used, the only difference is the numerical values. As can be seen from the extract that follows the concepts are explained by the teacher. After correcting these two parts the teacher then reviews estimation which is required for part (c) of the question and the students then practice part (c) which is similar to what the teacher has just reviewed apart from the numerical values.

Time since start of Lesson	Activity	Text of Lesson
0.17	**Teacher writes on board:** $\sqrt{64}$	*Teacher:* Most of the keys on the calculator we've met already so today we're going to look at the square root key. OK so if you want to get the square root of sixty four. Emmett, where do you find that on the calculator.
0.45		
0.47		*Emmett:* Over here Sir.
0.49		*Teacher:* OK so you have a square root button and you can

		find it on it. Good lad. So what's the answer?
0.59		*Emmett:* Eight
0.61 **0.67** **0.77** **0.82**	**Teacher writes on board:** $\sqrt{64}=8$ **Teacher writes on board:** $(8\ )^2$	*Teacher:* OK What about this Emma? Eight squared. How do you do that on your calculator? What's the answer?
0.91	**Teacher writes on board:** $(8\ )^2=64$	*Emma:* Sixty four
0.96 **1.03** **1.09** **1.21**		*Teacher:* OK. Do you notice anything happening from these two questions? Here do you see the difference between square root and square (pointing to board)? They are opposites square root and you get eight and eight squared you get back to sixty four. They are opposite, do you understand?
1.25		*A boy:* Yes
1.28	**Teacher writes on board:** $(2)^3$	*Teacher:* OK. Enda you have the number two to the power of three. What does that mean?
1.45		*Enda:* Multiply three by two.
1.50	**Teacher writes on board:** 2×3	*Teacher:* No not multiply three by two. If you want to write that down Enda you go 2×3 that means two multiply by three but to the power of three what do you think that means?
1.71		*Enda:* two by two
1.73		*Teacher:* Go on
1.75		*Enda:* by two
1.78	**Teacher writes on board:** $(2)^3=2\times2\times2$	*Teacher:* Three times two by two by two and you can do it like that two by two by two. Is there another button you can use there Emmett, do you know?
1.97		*Emmett:* Well there is another way of doing it Sir.
1.99 **2.02**	**A boy enters the classroom and sits down** **Teacher walks down to Emmett who shows the teacher the calculator button.**	*Teacher:* What is it?
2.15	**Teacher writes on board:** $2\times2\times2=8$ **Teacher writes on board:** $2[x]^3=8$	*Teacher:* OK on some calculators that'll give me eight or you can go on some of the calculators if you have an x cubed button two and the x cubed button it will give you eight alright. And some of them don't have that x cubed button at all so they may have a y to the power of x button, OK you can see it over on the left hand side or a y to the power of x and then three equals. If you have that button on the calculator most of you have I think try it out to make sure you can use it OK.
2.82 **2.95**	**Teacher writes on board:** $2[y^x]3=8$ **Private with student**	Alright you have a sheet with questions. I want you to do part (a) and (b) please. Question 1 a and b.

3.04	**Teacher writes on board: Q1 (a)** **(b)**	
3.06		*Amy:* What page?
3.09 **3.34** **3.40** **3.42** **Teacher walks around room** **Students working at their desks.** **3.89**	**Girl hands out sheets.**	*Teacher:* It's on a sheet, I'm going to hand to you. Just on your sheet answer (a) and (b) Do you need to show your work for this question.
3.92		*Amy:* Yea
3.94		*Teacher:* How do you know that Amy?
3.97		*Amy:* Because there's a hand.
4.00		*Teacher:* Because there's a hand correct and right. Just remember on your exam paper they'll show you a little pencil in the hand , if they want you to show your work other than that you can use your calculators and go ahead with it. You've got to make your numbers clear on the paper so that everyone can read them.
4.99		*Emmett:* Will we do (c) as well Sir.
5.00 **5.11** **5.30** **Teacher walks around room** **Private with student** **5.57**		*Teacher:* No just (a) and (b) for the moment and we're going to see (c) in a second. Good man. *Teacher:* Have you all got it finished.
5.61		*Student:* No
5.62 **6.24**	**Private with student**	*Teacher:* No
6.51		*Teacher:* Alright Amy will you do the first one on the board for me please.
6.58		*Amy:* OK
6.71 **6.60**	**Amy goes to board**	*Teacher:* When you are ready. *Amy:* Can I bring this sheet up?
6.75 **7.01** **7.06** **7.22**	**Amy writes on board: Q1 (a) =** $9 \times 8 = 72$ **Kim writes on board:** $3146 \times 7 = 23912$	*Teacher:* Yes you certainly can. The others just check your answers as you go. There are five marks for each answer. You mark it yourselves as you go. Nine by eight equals seventy two. Thanks very much. And Kim the next one. If you got it right give yourselves five marks.
7.48		*Teacher:* Is that a number in front of the three or not? (Kim points to three in 23.912) No, over on the left (referring to 3 in 3.146) Is that not a

		number ? No It's just three four one six is it?
7.64		*Kim:* Yea
7.66		*Teacher:* That's perfect. Thank you so two three nine one two. Did you all get that? Is there a decimal in it?
7.76		*A boy:* No
7.78 **8.11** **8.24**	 **Emmett goes to board:** **A boy leaves the room with a nosebleed** **Emmett writes on board: (b)** **$9835 \div 5 = 1967$**	*Teacher:* No, there's no decimal in the question and there's no decimal in the answer. OK so again five marks if you got it right. OK next one please then Emmett b(i)
8.76 **8.81** **8.84** **8.90**	 **David goes to board:**	*Teacher:* One nine six seven Did you all get that? Yes or no. OK David part (ii) Again five marks.
8.99 **9.37** **9.53**	 **David writes on board:** $5^3 = 5 \times 5 \times 5 = 125$	*Teacher:* Most of the questions are ten marks for (a) then twenty for b and twenty for c. There are four parts to this so that will be five marks each. OK so five cubed is five by five by five which is one two five OK. The usual mistake there is what people think five by three it's not five times three. OK Gavin (hands marker to Gavin) Part (iii)
9.61		*Girl:* Sir, is that five marks again.
9.64 **9.84** **1.23** **10.31** **10.49** **10.59** **2.1**	 **Gavin writes on board:** $(iii)\sqrt{36} = 6$ **Emma writes on board:** $999 + 88 = 1087$ **Teacher writes on board: The nearest whole number**	*Teacher:* Yea, It's four fives for part b, ten for part a, twenty for part b and twenty for part c. The square root of 36 is 6 perfect. Again five marks. And the last one Emma. So 999 plus 88 gives you one thousand and eighty seven. Correct Emma. Perfect. Well done. Five marks again. Just be careful watch out for the signs you get in your question .OK The next question will deal with rounding up a number or giving an estimate to the nearest whole number. So Emma two point one. What is the nearest whole number to that is it two or three?
10.94		*Emma:* Two
11.01		*Teacher:* Two, how did you decide that?
11.02		*Emma:* Anything under five.
11.08	**Boy who had left with nosebleed comes back into the room.**	*Teacher:* Yea so this is the number we look at We look at this one (points to the one) If it's a one a two a three or a four you stick with the two.

11.36		If it's a five a six a seven an eight or a nine then you go up to three. So if it's two and a half or more you go up to three. The number here you decide on. So if it's a 1 2 3 or a 4 it goes to 2 but if it's a 5 6 7 8 or a 9 it goes to 3.
11.46	**Teacher writes on board: 2.2** 1 2 3 4 → 2	
11.58	5 6 7 8 9 → 3	So on that basis then Derek Three point six, three or four.
11.69	**Teacher writes on board: 3.6=4**	*Derek:* Four
11.77		*Teacher:* OK and yourself Declan five point eight?
11.82		*Declan:* Six
11.84	**Teacher writes on board: 5.8=6**	*Teacher:* yea six OK. The question is usually asked in two ways it asks you first of all to estimate or to round to the whole number. The first part and……
12.07	**Private with student.**	*Teacher:* So if you could go onto part c do the four pieces to it. Do the nearest whole number, then your estimate and then the actual answer.
12.54	**Teacher writes on board: 17.8 × 7**	
12.67	**Teacher rubs out blackboard.**	
13.13	**Private with student**	
13.40	**Private with student**	
13.48	**Private with student**	
13.69	**Private with student**	
13.95	**Private with student**	
14.11	**Private with student**	*Teacher:* So the first one c part (i), (hands marker to Danny). Off you go. To the nearest whole number is eighteen, OK. Do part (ii) while you're there.
14.62	**Danny writes on board: 17.8 = 18** **Danny writes on board: 7.3=7**	*Teacher:* OK thank you very much. And Emmet do part (iii) please.
14.75	**Teacher writes on board: (iii) and hands marker to Emmett.**	
14.92		*Teacher:* OK so for the estimate you are going to use those estimated figures or the nearest whole number figures OK? So what's the question. What are we being asked to do?
15.02		
15.27	**Emmett writes on board: 17.8**	*Teacher:* For the estimate Emmett are we going to use 17.8 or the eighteen?
15.37		
15.42		*Emmett:* Eighteen
15.44	**Emmett writes on board: 18**	*Teacher:* Right
15.54		*Teacher:* Multiplied by?
15.56		*Emmett:* Multiplied by

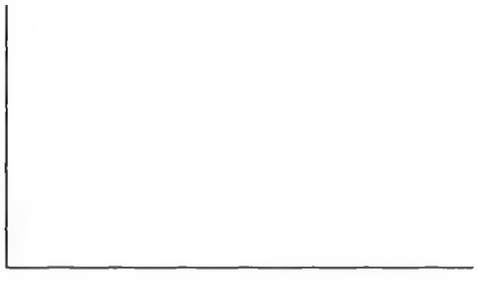
15.60		*Teacher:* For 7.3 what are you going to use?
15.62	**Emmett writes on board: 18 × 7**	*Emmett:* Seven
15.67	**Emmett writes on board: 18**	*Teacher:* OK, use your calculator to work it out.
15.84	**× 7=126**	OK so the last part. So for the estimate remember to use the figures that that you made up or that you got from rounding off or the nearest whole number.
16.02	**Teacher hands marker to girl.** **Girl comes to board.**	
		Teacher: Now the exact value you use the exact ones they gave you.
	Girl writes on board: 17.8 × 7.3	So for part (iv) you are going to use 17.8
16.20	**= 129.94**	Very good. Which is one two nine point nine four. Very good. And again there were four parts to that for five marks. You should now have a mark out of fifty for that question.
16.42		OK. Anyone get fifty out of fifty? Well done.
16.50		So remember that's the way the question will be in your mock exam as well and the Junior Cert.
	One boy puts his hand up	So you should take your time and with your calculator you should be able to get fifty out of fifty in the first question.. OK so we'll look for that in the mocks and see how you get on.

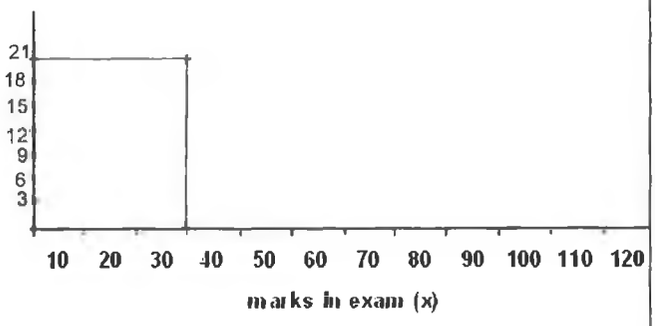
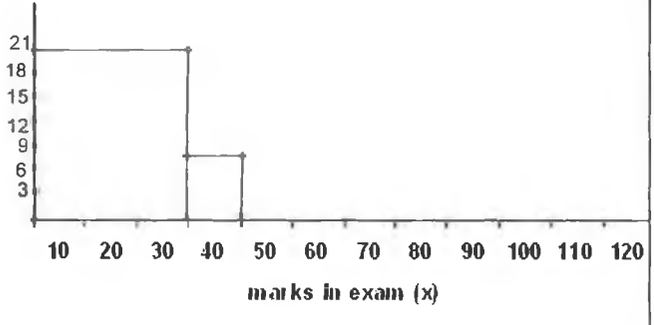
Appendix C for Chapter 7: Illustrative Vignette - Concept Developed (From Riverside)

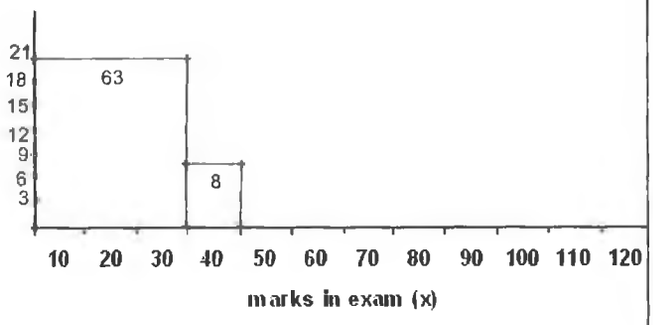
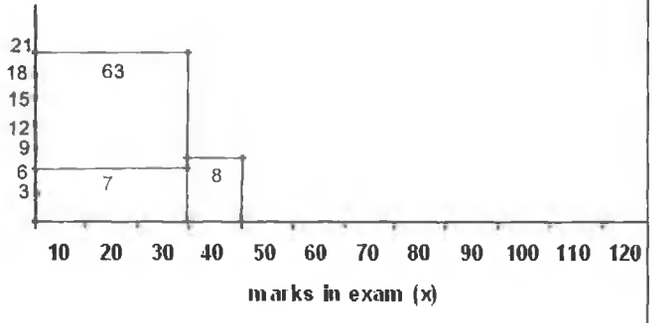
This extract is from Riverside. It involves a very experienced teacher teaching an all girls class. After using a given frequency table, the students with the teacher have worked out the proper scale to use for the x-axis and have drawn this in their copies. The teacher now moves on to introduce the concept that it is the area of the rectangle that represents the frequency not the number in the frequency table. As can be seen from the extract that follows the students are involved publicly in developing this concept.

Note: Time is measured not in minutes and seconds but in minutes and decimal minutes.

Time since start of Lesson	Activity	Text of Lesson
2.56		*Class:* Yea
4.77 4.98 5.15	<table><tr><td>x</td><td>Marks in exam</td><td>0-30</td><td>30-40</td><td>40-60</td><td>60-100</td><td>100-120</td></tr><tr><td>f</td><td>No. of s students</td><td>21</td><td>8</td><td>12</td><td>20</td><td>8</td></tr></table> **Teacher writes on board:**	*Teacher:* I think it might be a little harder to read. I'm not sure about drawing, I think it might be the same level of difficulty to draw, usually it's easier to read particularly the old bar charts when the height was what was relevant to us. So the big news from yesterday was that in this histogram which is the new bar chart it's not the height of the rectangles it's the area of the rectangles which represents the frequency. OK the area of the rectangle. So could you all get a frequency axis drawn and you can just use your hardbacks. You don't have to do this one on graph paper but we would always ordinarily draw these on graph paper.
5.50		*Student:* How long should we draw that line?
5.52		*Teacher:* I don't mind. Have you drawn he table on the top of the

		page?
5.59		*Student:* Yea
5.60		*Teacher:* So use up the rest of the page. Just nothing postage stamp size. Draw decent sized and (to a student) do you think you need twenty one boxes?
5.75		*Student:* Do we?
5.77	**Teacher writes on board:** 	*Teacher:* I don't know what we need yet, that's what we're trying to figure out. So don't be going numbering anything , just draw a frequency axis and also your variable axis it's called, the thing we talk about the x in the question, the marks in the exam, the goals scored in the match, or whatever it is.
9.29		Now yesterday I finally got to the stage I want to be at. I asked everybody to draw this thing bearing in mind it's not the height but the area represents the frequency. Etain, I know this is a lot to take in and listen to but How many students got between 0 and thirty?
9.63		*Etain:* Twenty one
9.65	**Teacher writes on board:**	*Teacher:* So if I were to go up, I don't want you to write anything down for a moment 3,6,9,12,15,18,21, let's just say and the number

		of people getting from 0 to 30, twenty one. Let's call each of these base units one (pointing to 0-10 etc.) OK, so what's the length of the base ?
1..15		*Class:* Three
10.17		*Teacher:* Three, and what's the height of the rectangle?
10.23		*Student:* Seven
10.27		*Teacher:* No the height
10.29		*Student:* 21, these guys are only one unit, the height of the rectangle?
10.33		*Class:* 21
10.35		*Teacher:* And what's three times twenty one?
10.38		*Class:* Sixty three
10.40		*Teacher:* Sixty three. Is that the area we're talking about. Is that the frequency we have up in the table?
10.52		*Class:* No
10.54		*Teacher:* No and that's the problem. It's almost like… Well what's the next one?
		How many people got between 30 and 40?
10.60		*Class:* Eight
10.63	**Teacher writes on board:** 	*Teacher:* 8, OK. So 8 is about there(pointing to graph). And what's this? (pointing to base) If this is one unit and the height is eight units what's the area of the second rectangle?
10.80		*Class:* 8
10.82		*Teacher:* 8 That seems OK. But it seems a little

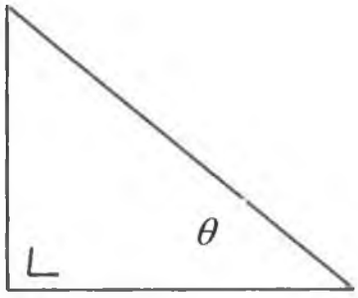
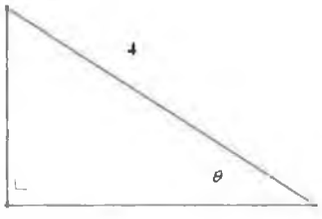
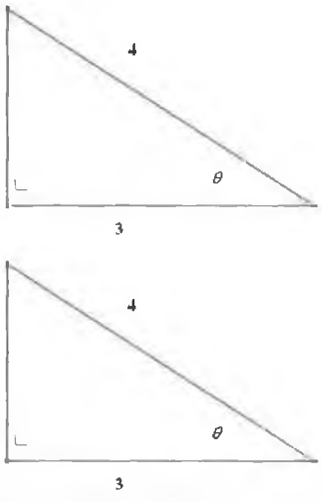
10.96 **11.13**	**Teacher writes on board:**  	unfair if this only has a base of one this one has a huge base length of three (points to graph). Don't you think it's a little unfair to be drawing them the heights from the table. This is going to increase by three times (pointing to graph) this is very unfair. 3 by 21 is 63 1 by 8 is 8 So our 8 seems OK but our 21 seems enormous. Can you see that
11.29		*Class:* Yea
11.30		*Teacher:* So what I'm trying to find out can anyone suggest what we would have to do to make this a fair representation. Makela and Anastasia are not allowed to say anything because they figured it out yesterday.
11.72		*Etain:* Divide 21 by 3
11.75		*Teacher:* Divide 21 by 3, how come?
11.77		*Etain:* To get the right area
11.79		*Teacher:* To get the right area Yea. To get the right area Yea. If you divide 21 by 3 what do we get?
11.86		*Class:* 7
11.88	**Teacher writes on board:**  	*Teacher:* So in fact from 0 to 30, on our actual diagram we should only go up to 7 and 3 by 7 is 21. Is that a fair representation of what we have above?
12.07		*Class:* Yea

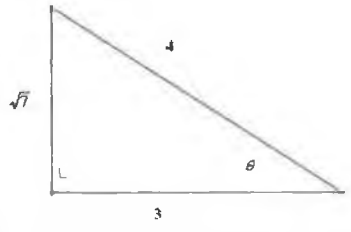
Appendix D for Chapter 7: Illustrative Vignettes-Homework Correction

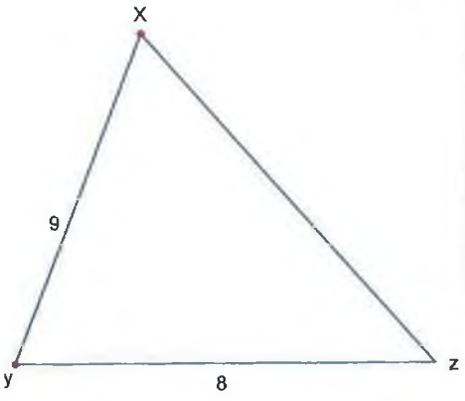
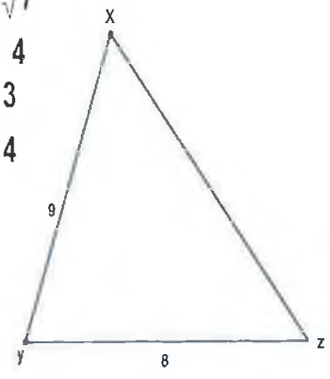
(i) From Chestnut Hill

This extract is from Chestnut Hill. It involved correcting a homework question completed by students at home. The correction is by a mature teacher to a Higher Level Third Year class. The question was in two parts, the first part involved finding the Sine of an angle given the Cosine of the angle. The second part of the question linked with the first part and required finding the area of a triangle. In the correction of the homework the teacher is intent on students giving the correct answer to each stage of the solution and getting it corrected as quickly as possible.

Time since start of Lesson	Activity	Text of Lesson
1.96 2.25 2.45 2.86 3.00	**Teacher writes on board: F Paper II Q 5 (c)** **(i)** $Cos\theta = \frac{3}{4}$ FIND $Sin\theta$ INSURDFORM.	*Teacher:* OK so what I'm going to do now is look at the question there on page 102 we're going to look at 5 (c) part 1 and II. Everyone said part 1 is fine that was the one thing I asked you to concentrate on and part 2 was how you used that. That's the hard bit right so this is F Paper 2 and you're doing part (ii) to 5 (c). So part (i) we'll go through briefly and explain it The thing said that the Cosine of φ is $\frac{3}{4}$ and the question said find $\sin\theta$, we'll change it to θ in surd form. Now there's a few things about that question that should alert you to what you have to do. Shauna would you, what is there in that question that tells you not to go for the calculator.
3.09		*Shauna:* Surd form
3.15		*Teacher:* Surd form. So when it says in surd form it means you can't use the calculator so John what do you have to do?
3.24		*John:* Pythagoras' Theorem
3.36 3.57		*Teacher:* So when they say find $\sin\theta$ in surd form what they mean is you are not to use the calculator. In other words you are not to go θ = the inverse cos of thre quarters ($\theta = \cos^{-1}\frac{3}{4}$)to get your value for θ and then get the sin of it. You are not to do that OK. What you have to do is what that means for you is draw a right angled triangle and put in your θ here. Generally you draw the triangle the same way each time.

3.74 **3.85** **3.94**	**Teacher writes on board:** 	Remember I explained this to you yesterday because when you came to do the construction you are consistent then. Now in terms of Cosine here you know from Silly Old Harry. What's the definition for Cosine? Adjacent over hypotenuse. So put adjacent over hypotenuse So Brian can you tell in terms of θ , how do I handle the three and the four?
4.09		*Brian:* Put four on the first side.
4.24		*Teacher:* Where, opposite which angle
4.26	**Teacher writes on board:** 	*Brian:* Ninety degrees
4.30		*Teacher:* Right, and where does the three go?
4.32		*Brian:* Ah, opposite θ
4.37		*Teacher:* Opposite θ, did everyone get that?
4.41		*Class:* No
4.43	**Teacher writes on board:** 	*Teacher:* It's adjacent so it has to go there. Now does that explain it to you, why your one was upside down for the second part?
4.57		*Brian:* Yea
4.60		*Teacher:* Now you know the reason at least we've sorted that out and you're then to work out what x is which is the opposite and the best way of doing that Sinead is what?
4.75		*Sinead:* Use Py…

4.79 **5.06**	**Teacher writes on board:** $H^2 = O^2 + A^2$ $(4)^2 = x^2 + (3)^2$ $16 - 9 = x^2$ $7 = x^2$	*Teacher:* OK so let's try that now. OK so if you fill that in then. Four squared equals x squared plus three squared. So now we've got sixteen minus nine equals x squared. So in other words x equals seven. The question wants it in surd form. Peter what's the last step?
5.25		*Peter:* Square root of seven.
5.53	**Teacher writes on board:** $x = \sqrt{7}$  	*Teacher:* So then x is the square root of seven. And as usual when you get the answer you put it into the diagram and you can work out the *Sin of* θ or tan *of* θ or whatever they ask you to work out. So then Carol what is the definition of $Sin\theta$?
5.56		*Carol:* O over H
5.59	**Teacher writes on board:** $Sin\theta = \frac{O}{H}$	*Teacher:* $Sin\theta$ eauals O over H What's the answer?
5.70	**Teacher writes on board:** $Sin\theta = \frac{O}{H} = \frac{\sqrt{7}}{4}$	*Carol:* Root 7 over 4
5.72 **5.83** **6.09** **6.54**	$\|xy\| = 9 \quad \|yz\| = 8 \quad LINK$	*Teacher:* The square root of seven over four and there's the first part and you know most of the class could do that and there's no harm going over it because a few people made a few mistakes, a few people were out. Now to look at part (ii) and how to use that question, to use that method for the following part of the question. If you look at it there it says in triangle xyz, xy is nine, yz is eight and the Cos of xyz is equal to three over four. Alright so can you see the link between part (ii) and part (i). So what they tell us is the length of xy equals 9 and the length of yz equals eight and here is the link between part (ii) and part (i) the cosine of angle xyz is equal to three quarters. So what's the link John C What's the link between that q and this q even before we draw the triangle.
6.64		*John C:* $Cos\theta = \frac{3}{4}$ and $Cos\ xyz = \frac{3}{4}$
6.80	**Teacher writes on board:** $\|xy\| = 9 \quad \|yz\| = 8 \quad LINK \quad Cos < xyz = \frac{3}{4}$	*Teacher:* Perfect so if $Cos\ xyz = \frac{3}{4}$ If you had just to say, let's pretend you didn't know what the question was really asking right? Let's pretend you didn't and they told me that Cos of that angle equals three quarters (points to Part (i)) but in part (i) they asked me to work out Sin of it and Sin is root seven over four. So what if I wrote down here Sin of the angle xyz has to be equal to what?

7.28	**Teacher writes on board:** $Sin\ xyz = \frac{\sqrt{7}}{4}$	*Class and Teacher:* Root seven over four.
7.33		And just leave it like that and see if using the result from part (i) will help us with part (ii) when we come to it.
7.43		So let's draw the triangle xyz.
		It doesn't matter what way you draw it as long as you put in the information correctly.
		So xy is seven , yz is eight.
		And the angle xyz is this angle in here (points to angle) but you don't know what it is.
7.73		Now what some people did yesterday was get the inverse Cos of three quarters and put the angle in and they worked out from there and that's fine, you'll only loose a few marks for that.
7.91		Right if there was ten going for that you'd probably get seven of the marks, right?
7.96	$\text{Sin y} = \frac{\sqrt{7}}{4}$ 	So that's not too bad at least you can do it but let's answer the question the way they're trying to get you to answer it right, which is kind of higher level thinking.
8.09	$\text{Cos y} = \frac{3}{4}$	Now you know that this angle in here , you don't know the value of it but you do know the Cosine of this angle , let's call it y is equal to three quarters.
8.27		But just as important is possibly that the Sin of the angle is equal to root seven over four.
		Now even if you don't know exactly how to use it, there's no harm in writing it down to see if it's useful.
8.54		What does the question ask us to do?
8.57		Work out what?
8.60		*Class:* The area
8.62		*Teacher:* The area, now the formula for area, Michelle.
8.64		*Michelle:* Mmm
8.66		*Teacher:* For trigonometry the area of a triangle?
8.73		*Michelle:* Half ab Sine C
8.75	**Teacher writes on board:** $\frac{1}{2}abSinC$	*Teacher:* Sine C and just remember SAS in congruent triangles, it's side angle side, it's the angle in between, it's ab Sin C, it's two sides and the angle in between them. Now if we were to work that out the area of the triangle equals half a is nine, b is eight by the Sin of this angle y isn't it?
9.13	**Area=** $\frac{1}{2}(9)(8)Sin\ y$	And we do have an expression for the Sin of y, Cathal?
		What is Sin y?
9.25		*Cathal:* Root seven over four
9.29		*Teacher:* Correct and that's where it comes in. Did everyone see the link between part (ii) and part(i).
		Do you see it now Ashling?

9.33		*Ashling:* Yea
9.35 **9.64** **10.10**	$Area\,\Delta = \frac{1}{2}(9)(8)Sin\,y$ $Area\,\Delta = \frac{1}{2}36\left(\frac{\sqrt{7}}{4}\right)$ $Area\,\Delta = 9\sqrt{7}$	*Teacher:* All right and that's where it comes in. Now the other method of working out Cosine inverse and Sin inverse is ok and you'll get most of the marks and if you find this complicated use the other method and you'll get most of the marks anyway, Right? But this is the one you need for the higher level thinking, right? So area of the triangle is equal to half of that, what is it? Thirty six times root seven over four and look what happens they want you to get the answer in the form they want the area of the triangle in the form $a\sqrt{b}$, isn't that right? So the four happens to divide into thirty six to give us the area of the triangle is equal to what nine root seven. Was there units in those things centimetres or anything like that?
10.12		*Class:* Centimetres
10.15 **10.42** **10.46**	**Teacher writes on board:** $Area\,\Delta = 9\sqrt{7}cm^2$	*Teacher:* Centimetres is it? Make sure you put in centimetres squared. If you haven't got that just fit it in here. They've got very finicky now about units in the Junior Certificate, right! Any questions on that? Are you (to a student)finding trigonometry better now?
10.48		*Student:* Yea I am.
10.51		*Teacher:* That's good. OK is there any questions on any of that or anything yesterday that you did on your own in class. Everything OK? Now in the next class today we'll be doing the constructions we'll revise them very briefly, just very briefly do the constructions again but before we do that let's go to page 65 and there's a question in there a very very similar similar to the question you just did.

Appendix D (ii): Illustrative Vignette-Homework Correction (From Kenmore)

This extract is from Kenmore. It involved correcting a homework question completed by students at home. The correction is by a mature teacher to a Foundation Level Third Year class. The question deals with finding the mean. In this homework correction episode, homework is corrected in the public domain at a brisk pace with little explanation when a student gave an incorrect answer to a particular step in the solution. The emphasis by the teachers seemed to be on getting the correct response each time in order to get to the final correct answer. The correction lasts for approximately less than one and a half minutes.

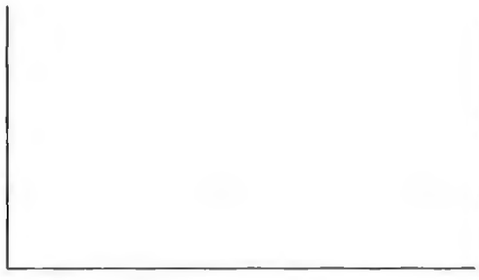
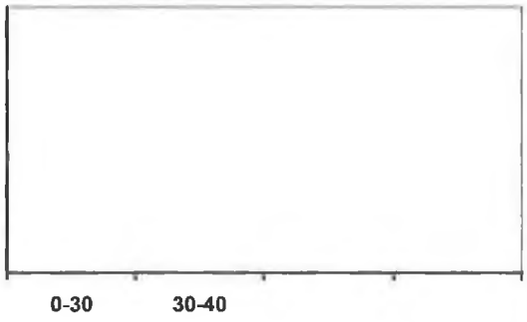
Time since start of Lesson	Activity	Text of Lesson
16.71 **16.94**	**Teacher writes on board: Mean**	*Teacher:* Yesterday we also looked at the word mean. Now what do you understand by the word mean, Emma?
16.96		*Emma:* Mm
16.99		*Teacher:* What does the mean mean, Emma?
17.07		*Emma:* Can't remember
17.13		*Teacher:* Does anyone know?
17.15		*Daniel:* The average
17.17 **17.26**	**Teacher writes on board: Mean (Average)**	*Teacher:* Very good, the word mean is average. OK so how Amy do we find the mean or average of a group of numbers?
17.34		*Amy:* You add them all up and divide by the number of numbers.
17.41		*Teacher:* OK so we add them up and divide by the number of numbers. I think we had one for homework last night is that right?
17.54		*Daniel:* What's the difference between the mean and the mode?
17.59		*Teacher:* The one that comes up the most often, that occurs most often or has the highest frequency. So if you had a list of numbers the mode is the one that turns up the most often in there. OK?
17.74		*Daniel:* Yea.
17.79		*Teacher:* Emmett do you have the numbers for the mean last night?
17.84		*Emmett:* Yea
17.86		*Teacher:* I think it had to do with the heights of people, have it?
17.88		*Emmett:* Yea
17.91		*Teacher:* Will you call them out?
17.96	**Teacher writes on board: 1.4 1.3 1.7 1.55 1.45**	*Emmett:* The height of six students are 1.4 metres and 1.3 metres, 1.7 metres, 1.55 metres, and 1.45 metres.
18.17		*Teacher:* They're all in metres so when you want

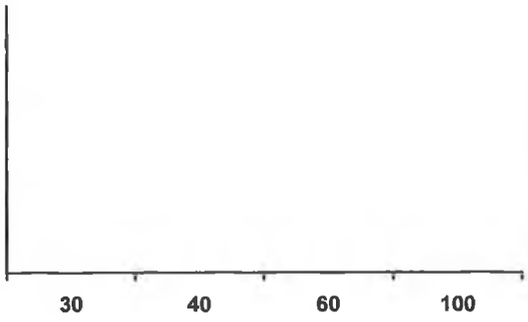
		to find the mean or average Emmett what do you do?
18.26		*Emmett:* Add them up
18.28		*Teacher:* Yea so, is it five or six?
18.32		*Emmett:* Five sorry
18.38	**Teacher writes on board:** $\underline{1.4+1.3+1.7+1.55+1.45}$	*Teacher:* OK so 1.4 Emmett plus 1.3 plus 1.7 plus 1.55 plus 1.45 What are we dividing by Emmett?
18.55		*Emmett:* One point
18.59		*Teacher:* No we're adding them all up and how many of them are there?
18.64	**Teacher writes on board:** $\frac{1.4+1.3+1.7+1.55+1.45}{5}$	*Emmett:* Five
18.66		*Teacher:* OK so when you added them , what did you get the top numbers?
18.72	$\frac{1.4+1.3+1.7+1.55+1.45}{5}=\frac{7.4}{5}$	*Emmett:* Let's see seven point four
18.74		*Teacher:* Seven point four
18.77		*Emmett:* Divided by 5
18.79		*Teacher:* Yea
18.81	**Teacher writes on board:** $\frac{1.4+1.3+1.7+1.55+1.45}{5}=\frac{7.4}{5}=1.48$	*Emmett:* Equals one point four eight.
18.85 **19.01** **19.10**	 **Teachers rubs out right hand side of blackboard** **Hands out sheets**	*Teacher:* 1.48, one metre and forty eight centimetres OK So that was the homework. We have a question like that on a sheet here.

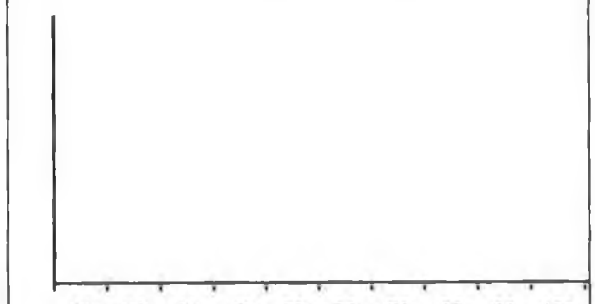
Appendix E: Illustrative Vignettes-Types of Questioning

(i) From Riverside.

This extract is from Riverside. It involves a very experienced teacher teaching an all girls class. After giving the students a given frequency table on the blackboard, the teacher with her students prepare to work out the proper scale to use for the x-axis. The teacher questions a particular student who answers incorrectly but the teacher does not evaluate her answers as right or wrong. Instead she uses wait time and gives the students time to re-evaluate her answer, abandon it and adopt the correct answer. This takes approximately two minutes.

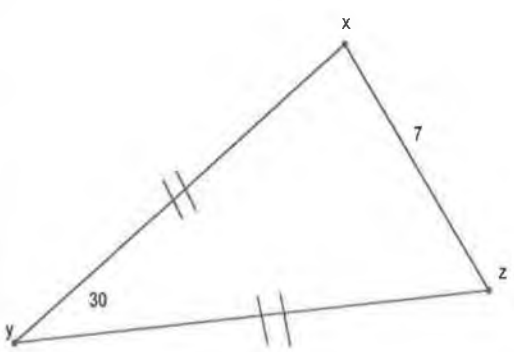
5.77	**Teacher writes on board:** 	*Teacher:* I don't know what we need yet, that's what we're trying to figure out. So don't be going numbering anything , just draw a frequency axis and also your variable axis it's called, the thing we talk about the x in the question, the marks in the exam, the goals scored in the match, or whatever it is.
6.17		*Teacher:* Now how far out on the x-axis do we have to go?
6.24		*Class:* One hundred and twenty
6.25	**Teacher writes on board:** 	*Teacher:* 120, Yesterday I noticed from the people who were here working in pairs, lots of you did things like this: Zero to thirty, yet over here thirty to forty and all sorts of bits and pieces like that. I noticed that a lot and I guess that's because in primary school, you used to have the days of the week, Monday Tuesday Wednesday and that's what you would do (points to board) but the change this year is that those lengths along the bottom those base lengths are really important. So could you suggest another way of doing ?
6.77		*Class:* Calling out answers
6.82		*Teacher:* Emma
6.84		*Emma:* Zero to thirty, forty to sixty, one hundred to one hundred and twenty

		(which is in correct)
6.93	**Teacher writes on board:**  	*Teacher:* OK, so you are suggesting for example I go 0, 30, 40, 60, 199 and so on like that?
7.17		*Emma:* Yes
7.20		*Teacher:* What's the problem, does anyone see, or indeed Emma do you see a problem with this?
7.25		*Emma:(Says nothing)*
7.39 **7.46**		*Teacher:* What's the gap there? (points to zero to thirty) What's the distance between this point and this point?
7.51		*Emma:* Thirty
7.52		*Teacher:* Yes. What's the distance or the gap or the interval between this point and this point (pointing to 30 to 40)
7.63		*Emma:* 30
7.65		*Teacher:* Do you think that?
7.73		*Emma:* Ten
7.75		*Teacher:* Ten, exactly. And what's the gap between this one and this one (pointing to forty to sixty)
7.86		*Emma:* Twenty
7.88 **8.02** **8.18** **8.57**	**Teacher writes on board:**	*Teacher:* so suddenly we have a 30 a 10 and a 20 but all looking the same. So that's a bit of a problem. What we need to do is in tens work our way out to 120. Will you do that? Is that OK? We need those to be the same. So that's quite a lot to get out to 120 that's you'll need 12 different You're in your copies that's alright

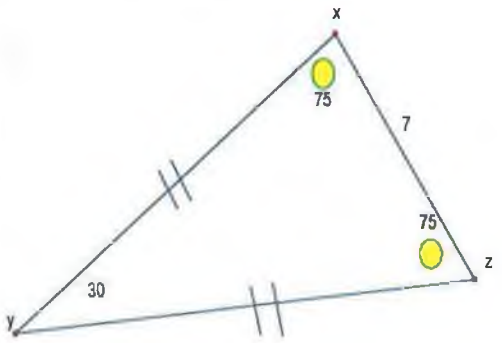


(ii) Chestnut Hill

The students in this lesson have been revising trigonometry by practising sample Junior Certificate Higher Level questions. In this extract the teacher has placed another sample question on the board and asks the students to think about it for a while. He gives the class approx. three minutes and then starts to question them. The questioning moves at a brisk pace, students' response are relatively short and the purpose seems to be on getting the correct answer.

Time since start of Lesson	Activity	Text of Lesson
16.71 **16.85** **16.99** **17.47** **17.67**	**Teacher writes on board:**  **Private with student**	*Teacher:* Two or three minutes left alright. That's the time you would have in the exam, ten minutes. I've given you seven. *Teacher:* Alright those people who are finished you can see from this problem.. This will link into your mocks for the Junior Certificate and then I'll give you one from the Leaving Certificate Ordinary Level. I'll give you one of the questions they have. Alright.
17.91 **18.37**	**Teacher writes on board: Find** $\lvert xy \rvert$	*Teacher:* Right I want you to think about this problem. This could be very handy for you next week. Alright. If you are still doing the question we set you keep doing it, if you're finished think about this problem: find the length of xy Away you go. That's it. Just think about it, what kind of questions it

18.53 **18.62** **18.74** **18.97** **19.07** **19.18** **19.21** **19.39** **19.93** **20.44** **20.68** **20.89**	**Private with student** **Private with student** **Teacher sits down** **Private with student** **Private with student** **Private with student** **Private with student**	makes in your head What are the questions you need to ask yourself when you're doing a question like this. You can't expect to get the answers right all the time, it's checking when you've got it wrong is the key to it. Right, so have a look at the question there when you've finished , the one we were doing a minute ago. Most people are finished. Have a think about that. What are the questions you need to ask yourself. Talk to the person next to you.
21.23 **21.36**		*Teacher:* Can I just ask you there before you get into the question most people are nearly finished already. Look at this here look. I'll just ask you what's missing? Just listen for a second Lorna, what's missing there for you to do the question. This is trigonometry, remember.
21.49		*Lorna:* Yea, you need an angle.
21.54		*Teacher:* Very good, You need an angle, yea you are short an angle. Is there a way of doing it with Geometry, Conor?
21.60		*Conor:* Yea
21.61		*Teacher:* So how do you do it?
21.64		*Conor:* one hundred and eighty degrees minus thirty degrees equals one hundred and fifty degrees and then divide that by two to get seventy five degrees.
21.78 **22.04**	**Teacher writes on board:** $180-30=150$ $=\frac{150}{2}=75$	*Teacher:* Did everyone hear that? I you look there those two angles have to be the same because it's isosceles so what you do is one hundred and eighty minus thirty will give you one hundred and fifty and the angles with the dots (puts in dots on diagram) there equal one hundred and fifty divided by two which is seventy five. So when you work out an angle put it in here.

		
22.13		*Teacher:* Now if they asked you to work out a length because it's trigonometry, it's not geometry. They were asking us to work out length do you have enough information there, Peter?
22.28		*Peter:* Use the Sine Rule.
22.30		*Teacher:* What do you need for the Sine Rule?
22.32		*Peter:* Two angles and one side.
22.34		*Teacher:* And what satisfies that?
22.39		*Peter:* Thirty, seven and seventy five.
22.43	**Teacher writes on board:** $\frac{a}{SinA} = \frac{b}{SinB}$	*Teacher:* Perfect. Is everyone OK? A over Sine A equals b over Sine B And once you actually get over that problem of finding missing angles the question is the same as any other Sine Rule question. Paul, did you get an answer?
22.68		*Paul:* Thirteen point five.
22.75		*Teacher:* Thirteen point five which you can round up to fourteen So make a note of that. Thirteen point five is the answer if you haven't finished yet. Alright. Is there any questions on that there? OK the class in the afternoon we'll look at some constructions in Trigonometry and that will be the end of Trigonometry.

Appendix F for Chapter 7: Examples of how teachers responded to incorrect answers from teacher-student questions.

The examples that follow show how the teachers responded to incorrect answers given by students by (i) dismissing it, (ii) pursuing the correct answer by asking another student and (iii) pursuing what the students had in mind.

Example (i) Dismisses incorrect answer

Teacher: Surd form. So when it says in surd form it means you can't use the calculator so Ian what do you have to do?

Ian: Pythagoras' Theorem

Teacher: So when they say find $\sin\theta$ in surd form what they mean is you are not to use the calculator. In other words you are not to go

θ = the inverse cos of thre quarters ($\theta = \cos^{-1}\frac{3}{4}$) to get your value for θ and then get the sin of it.

You are not to do that OK.

What you have to do is what that means for you is draw a right angled triangle and put in your θ here.

Generally you draw the triangle the same way each time.

Remember I explained this to you yesterday because when you came to do the construction you are consistent then.

Now in terms of Cos here you know from Silly Old Harry.

What's the definition for Cos?

Adjacent over hypotenuse. So put adjacent over hypotenuse

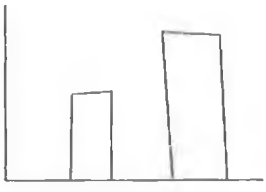
So Brian can you tell in terms of θ , how do I handle the three and the four?

Example (ii) Pursues correct answer by asking another student.

Teacher: If you want to have five and a gap between each one.

Do you understand you're going to have a space, a bar, a space, a bar.

Teacher writes on board a rough diagram:



Five bars, how many gaps do we need the whole across?

Cormac: Two

Derek: Six

Teacher: Do you think?

Draw a sketch at the back of another sheet and work that out first.

Teacher hands out more paper.

Teacher: Amy:

Amy: Ten

Teacher: Why ten?

Amy: Because you need a gap a block at the start, a block a gap, a block a gap, a block a gap…you need five gaps for each block.

Teacher: OK Amy is right, if you leave a gap first and a block for whatever the first one and then a gap you're going to need ten across.

Do you understand that?

So we need ten divisions across the bottom.

So what are you going to pick if you look at your ruler.

What are you going to pick that will fit all the way along across that will give you ten spaces.

Are you going to go inches or centimetres or what?

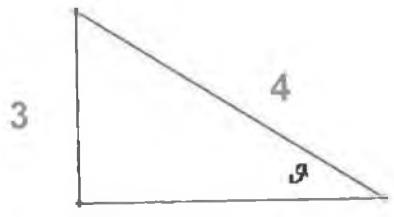
Example (iv) Pursues what student had in mind

Brian: Put four on the first side.

Teacher: Where, opposite which angle

Brian: Ninety degrees

Teacher writes on board:



Teacher: Right, and where does the three go?

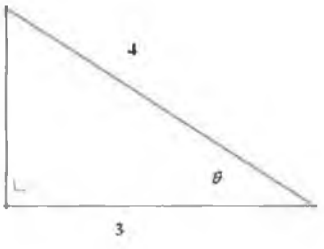
Brian: Ah, opposite θ

Teacher: Opposite θ, did everyone get that?

Class: No

Teacher: It's adjacent so it has to go there. Now does that explain it to you, why your one was upside down for the second part?

Teacher writes on board:



Brian: Yea

Teacher: Now you know the reason at least we've sorted that out and you're then to work out what x is which is the opposite and the best way of doing that Sinead is what?

Appendix G for Chapter 7: Extracts from Interviews with Teachers Year 3

To protect the identity of students the names used are fictitious.

Appendix G (i)

Interview Question to Teachers: When you think of the class you have this year, have any of them fallen back since they came into Third Year, do you think?

(i) Teacher from Riverside

Interviewer: Can you identify any students who appear to have fallen back or made progress since the start of Third Year?

Teacher from Riverside: I think some of them have, yeah. For a variety of reasons, for a couple of students, it is because they are not doing that much work maybe three or four for that reason, I mean for others, this girl, Martha, now she's just left yesterday to try Ordinary Level, she would be weak, she was always going to be borderline. It was her decision to leave, with my advice I suppose. It was post-Mock Exams and I asked them to think about things again and see how they felt. So, she came to me then. And Barbra she is working outside of school, she's deteriorated a lot in the last couple of months. The others are pretty much all doing fine.

Interviewer: Is there any student this year that has really made a lot of progress?

Teacher from Riverside: I find that the rest are working well and doing well as they were doing before, there's nobody that's kind of shot up, surprised me that hadn't done already performed in First or Second Year, if you know what I mean?

(ii) Teacher from Kenmore

Interviewer: Can you identify any students who appear to have fallen back or made progress since the start of Third Year?

Teacher from Kenmore: No, I don't think some of the class have fallen back really, possibly Frank. It's very difficult to get work from him, either written work or, or in class and he's much more intelligent than he presents in the class.

Interviewer: Is there anyone this year that has really made a lot of progress?

Teacher from Kenmore: Yeah, there are some students. I suppose they're that little bit more mature, Denise would have improved enormously she has settled down to her work herself. And, Derek would have improved a lot, particularly since he got a calculator. Now he's more confident. I also think the exam papers have helped them all. They've got to a stage where they kind of understand what they're doing, before that, it was a lot of Maths, they didn't see any point to it, now, I suppose, an exam has given them a reason for doing it, a focus to their work.

(iii) Teacher from Chestnut Hill

Interviewer: Can you identify any students who appear to have fallen back or made progress since the start of Third Year?

Teacher from Chestnut Hill: Right. There's one chap, Alan, he'd already decided before the Summer tests last year to go to Ordinary Level and there's been three other students. I'm not surprised by them because one of them Peter, would have been a bit of a joker. We only got the results back yesterday from the Mocks and another chap left the class for Ordinary Level. I think a lot of it was above him, I mean there were questions on the Mock papers that were close to the type of questions and thinking you require for Ordinary Level which he wasn't even able for them. So, I mean, he wasn't able, he was way off. I mean, he was a very nice young fellow. He just wasn't able, he suddenly realised he wasn't able, the Mocks were a real indicator, you know?

No surprises really, I'd say, I'd still expect one or two more at least from the group to go to Ordinary Level. Again, it's, it's just a lack of work and a lack of awareness of where they're at, of the knowledge you require. I think because they haven't done the work, they're not aware of just how far off the pace they are for Higher Level.

Interviewer: Is there anyone this year who has really made a lot of progress?

Teacher from Chestnut Hill: Oh yes, there's a few students that have made huge progress. There's one particular fellow, Ian, now, he got his results in the Mocks and they were very, very good, he got around 60%. I remember from talking to the parents in the Parent-Teacher Meeting, at the beginning of Second Year, and they said his self-esteem had improved dramatically and it was largely because he never felt he was able for Maths until he started doing the Higher Level course. He's improved immensely, but I can see it in a lot of students, you know, there are a few girls there, Kathy who was always an excellent student, but, for some reason she thought that she wasn't a Higher Level Maths student, for some reason. She's way beyond what's required I mean, she's looking at an A or B anyway, for certain.

Interviewer: Why do you think some students have made progress, you've mentioned self esteem is there anything else?

Teacher from Chestnut Hill: I don't know, I think they're very used to setting up a kind of action plan, based on a kind of traffic light system we use and I think they're very good at thinking about how they're doing themselves, you know. This is a mixed ability Higher Level group and because I've tried different methods with them over the two years. I think what's happened is, the content isn't necessarily, covered in the same detail at the stage of the year that I would normally have but I think what's happened is that they're definitely more receptive on how well they've done or how they do, compared to other students I've taught.

Appendix G (ii) for Chapter 7: Extracts from Interviews with Teachers Year 3

Interview Question to Teachers: Do you think all of the students ask for help if they need it?

(i) Teacher from Riverside

Interviewer: Do you think all of the students ask for help if they need it?

Teacher from Riverside: I'm not convinced about that, no. Zoe, she's a terribly, terribly quiet girl, by nature, she'd never ask anything. Barbra, I know, I think there's a little bit of a language problem there. Again, I would ask her but she wouldn't never really ask me in front of the group. She might ask if I was kind of wandering around. The others would probably all throw in their penny's worth at some stage. The brighter ones would dominate the questioning, I think. So, the, the less able kids wouldn't be as confident, maybe, to ask things but, but they might, okay, I mean Zoe could definitely not, Barbra definitely no and a few others, yeah, quieter, I mean the brighter ones are dominating it I think.

(ii) Teacher from Kenmore

Interviewer: Do you think all of the students ask for help if they need it?

Teacher from Kenmore: The majority, Derek would be very quiet but he's slow to ask. The others would all ask. He's a very shy boy, I would know though and I would watch him, you know that kind of way? I'm at this stage, you know, you pick it up after a while.

(iii) Teacher from Chestnut Hill

Interviewer: Do you think all of the students ask for help if they need it?

Teacher from Chestnut Hill: I think so because they've done quite a bit of group work and because they've been doing the Traffic Light thing and correcting their own tests, I think they

look at themselves a bit more than any class I've had before. So, they would ask me, they've never ...., they've no problem asking me. But they'd have no problem asking each other first.

Appendix G (iii) for Chapter 7: Extracts from Interviews with Teachers Year 3

Interview Question to Teacher: Do you think students are naturally talented, they've a natural ability or is it possible to teach them? Can you, can you get somebody to a level or do they have to have to have that sort of innate ability?

(i) Teacher from Riverside

Interviewer: Do you think students are naturally talented, they've a natural ability or is it possible to teach them? Can you, can you get somebody to a level or do they have to have to have that sort of innate ability?

Teacher from Riverside: I think you can get somebody to a level. Yeah, I do. There are so many factors. One is definitely that they feel comfortable and that they like the subject or that they like what they're doing, they're happy and they're enjoying it and that that's all a big part of it. Two sounds like a broken record here now, but, teaching them to understand what they're doing and Three, I guess, take them along as far as they can go, you know, just take them along. Bring them with you. I do think you can bring the kids somewhere, yeah. The ones with the ability are going anyway.

I think people can have a, a natural leaning and that definitely, yeah, I mean, but you can have flair in a particular subject, for sure and that, and that's going to come out, yeah, but you can also, get there without, you mightn't reach the same heights but you can get to a certain place without that flair.

(ii) Teacher from Kenmore

Interviewer: Do you think students are naturally talented, they've a natural ability or is it possible to teach them? Can you, can you get somebody to a level or do they have to have to have that sort of innate ability?

Teacher from Kenmore: I certainly believe that some students find it easier to do things than others, but I do think that if you find a way to getting to a kid, they'll understand it. And it's a matter of go and look for that. And that's not always easy and I don't always do it but, I think, certainly some kids have difficulty for one reason or another in doing maths for me. But, if I teach in my traditional way, I hit a certain number of kids. If I use different methodologies and I use different approaches, I hit more. You involve them in simple things like working in groups, they learn better from, from their peers, how the exams are actually marked. They give up if they, if they have a problem, but if you show them that they can marks by just doing something, then they don't give up and then suddenly they say 'this is how it works' and they can do that. That's just a couple of examples, I mean, the other things like, like the algebra tiles or even doing stuff, like demonstrating geometry any of those things may help, you know? Eh, not for all kids, but I mean if you have ten out of twenty students who can do it because of the traditional way, there are at least another five of the ten that can pick it up some other way and there will be certainly some people who can't …, who just don't get it.

(iii) Teacher from Chestnut Hill

Interviewer: Do you think students are naturally talented, they've a natural ability or is it possible to teach them? Can you, can you get somebody to a level or do they have to have to have that sort of innate ability?

Teacher from Chestnut Hill: Oh well, yeah, well ability has to be there, ability for the appropriate level. A natural ability, well, it helps a lot, you know? I think Maths is like music, you know, it's innate in everybody, I think. It's just a matter of being able to apply it in this kind of, unnatural environment of, an exam at the end of three years of very unnatural setting, you know? But, it's a question of whether within that setting you can make them realise some potential in Maths, whatever that potential is, whether it's an A in Higher Level or a D in Foundation Level, you know? Even an E in Foundation Level, sometimes is an achievement, you know? I think, yeah, it's innate to everybody, it's just within the confines of the syllabus, can you find the scope in

your classroom and in your teaching to allow the students to reach whatever potential they have, you know? And to enjoy the Maths.

Appendix G (iv) for Chapter 7: Extracts from Interviews with Teachers Year 3

Interview Question to Teachers: Could you describe your own approach to teaching maths in the classroom?

(i) Teacher from Riverside

Interviewer: Could you describe your own approach to teaching maths in the classroom?

Teacher from Riverside: I'm not really sure any more what my approach is. I definitely think that I want the kids to understand, that's definitely the premise on which I work. I don't want them to be able to do ten of the same. I know I want them to understand, that's how I try to teach but I don't really know if that happens. (laughter). I don't know. I think at times I put an example up on the board, work through it, step by step, piece by piece. The children take it down and get time to practice. At times that is my approach. I go in and we do something or whatever, the only thing I could say is that maybe I would talk a little bit more about things than I did or ask a little bit more, try and invite their ideas on it or ask a little bit more, you know, ask them questions on it a little bit more.

(ii) Teacher from Kenmore

Interviewer: Could you describe your own approach to teaching maths in the classroom?

Teacher from Kenmore: I suppose it has changed a bit with TL21 in, in terms of what I'd use, I mean. before that I was basically a text, chalk and talk person and that has changed a lot and also I would have much greater emphasis on geometry, which I didn't have before. Most of your teaching is learnt from somebody else, you don't just wake up one morning and be able to teach something, you follow what you've learnt and what you've known or what you've done in school

to you. In secondary school for me it was "There's an example, take it down, do forty of those". Probably before TL21, 85 to 90% of my teaching would have been to teach maths by doing an example and explaining it to them and then asking them to practise now it would be somewhere about 60% of my teaching.

(iii) Teacher from Chestnut Hill

Interviewer: Could you describe your own approach to teaching maths in the classroom?

Teacher from Chestnut Hill: My approach has changed because of TL21. I experiment now quite a bit. I think my approach would have been much more I suppose more centrally controlled by me of the class, you know. When I say centrally controlled, I don't' mean controlling of the students, I mean controlling of the material. And, I suppose I would have delivered it in a very much expository fashion. You know insisting on certain behaviours in the class which contradicts the behaviours you need for group work for students to be opening up, to be talking, to be, to be working, to be making noise, that type of thing I would have had very little tolerance of in the past. I have to say though I saw that it can work extremely well once you establish a method and once you see that you can explain the stuff very well and it's clear and then, you get them to work themselves and you go round and help them. I found that after, a few months then you have a class that starts to change and starts to gather its own personality and it's been very successful I've found. Extremely successful, you know? I wouldn't be trying to manage it in terms of, like, over-controlling the class but I would be very, very insistent on everybody being given a chance to listen to the material.

I've changed over to group work then, this year increasingly and then getting them to do their own work you need to sort of, eh, let go of a lot of things yourself, in order for that to work. Well, I mean, first of all, you don't know exactly the content of the course that you're covering, necessarily, or that the students are covering, when you cover a certain amount of it and then, you're letting the students off and working at it themselves. Normally, I'd spend fifteen minutes explaining it, getting them to give me examples, getting them to write down their own example. I was very comfortable with that, you know? Like last week I just let them off in groups, just to explain percentages to themselves, you know? So, you don't know, if there's any material lost in the control on the material, but it means that your circulation in the classroom is enhanced greatly with group work.

I suppose, having experimented with the First Years, it kind of gave me the confidence to experiment with the Second Years and I'm doing stuff with them that I would never have done had it not been for the experiment with the First Years. There's no doubt, I wouldn't have done it had I not got involved in TL21 And last year we had an initiative where we all tried to teach geometry the same way, we started with actual geometrical shapes, physical shapes and all the students got their own shapes and we started from there rather than from an abstract diagram, you know? That was a direct result of, of the workshops. I suppose what, what moved it on, for me anyway, considerably then, was, was the people that came in, particularly Michael Fullan and Chris Baker, they were the two, I think that influenced me hugely.

Appendix G (v) for Chapter 7: Extracts from Interviews with Teachers Year 3

Interview Question to Teachers: Has your approach changed over the years, from the time you started teaching?

(i) Teacher from Riverside

Interviewer: Has your approach changed over the years, from the time you started teaching?

Teacher from Riverside: Yes. It has, it definitely has, I think it's changed with my, knowledge, comfort and confidence with the subject matter. I know how I teach things have changed, yeah, sure. When I was doing it at the beginning, I was probably teaching more from my own memory in school which would have been positive and good. But it would have been much more, everything was in isolation whereas now, you see all the connections and I'm trying to piece them together for the students. I know how I'm doing things has changed because how I see things has changed with my involvement in TL21 for sure, definitely. It has made me think a lot more about how the kids learn, apart from how I teach. How they learn and, as a result then, how I might teach, and how the two are connected rather than just how I present stuff to them which has made me try all sorts of little things like wait time and effective questioning, I definitely was not aware of that before. I can tell you that categorically. I think I have slowed down a lot in how I do things and how else? Yeah, just to be open to try new things, which I am, I always was open, I mean, I suppose , I think my personality is open to doing anything, trying anything and trying new things and I'm always interested in new stuff but before I did TL21, I never made it my priority to try new stuff so, TL21, I dunno, put the wheels in motion for me.

(ii) Teacher from Kenmore

Interviewer: Has your approach changed over the years, from the time you started teaching?

Teacher from Kenmore: I suppose it has changed a bit with TL21, in terms of what I'd use, I mean, before that I was basically a textbook, chalk and talk person and that has changed a lot and also I now would place much greater emphasis on geometry, which I didn't before. Most of your teaching is learnt from somebody else, you don't just wake up one morning and be able to teach something, you follow what you've learnt and what you've known or what was done in school to you. In secondary school for me it was "There's an example, take it down, do forty of those".

Probably before TL21, 85% to 90% of my teaching would have been to teach maths by doing an example and explaining it to them and then asking them to practise now it would be somewhere about 60% of my teaching.

(iii) Teacher from Chestnut Hill

Interviewer: Has your approach changed over the years, from the time you started teaching?

Teacher from Chestnut Hill: It has, yeah, yeah, because of TL21 and the math section of that, really, it's changed. Well, I've experimented quite a bit, with classes, like, last week I did something I never did before with First Years and I'm not sure if it was successful. I taught them one particular way and then. let them off to do their own work and then tried to group work with them and then mix up a whole load of things. and I've actually gone right back to what I would have done had I had them in September last year, or the year before just to get another comparison and see how it was, you know? And it was very successful.

Appendix G (vi) for Chapter 7: Extracts from Interviews with Teachers Year 3

Question to Teachers: Would your method of teaching vary in the way you would teach Ordinary Level and Higher Level?

(i) Teacher from Riverside

Interviewer: Would your method of teaching vary in the way you would teach Ordinary Level and Higher Level?

Teacher from Riverside: Yeah, it would, a little. I think that, my teaching for Ordinary Level is not as educational as my teaching for Higher. I think I find myself making sure that they can do the mechanics of it. I don't think I emphasise the understanding, making it possible for them to understand because a lot of the time either I'm not able to do that or we just don't – the understanding doesn't happen as much and so, it's more, here's one and here's ten more. Which, yeah, I'm not happy about, like, I definitely have to think about that when I get an Ordinary Level class next time– because at the moment I have all Higher Levels so, when I am back in an Ordinary Level situation, trying to maybe concretise stuff for them or something but definitely, it's much more the mechanics of things,

(ii) Teacher from Kenmore

Interviewer: Would your method of teaching vary in the way you would teach Ordinary Level and Higher Level?

Teacher from Kenmore: Yeah, probably does, I mean I think I would probably spend more time coming up with new ways of teaching Foundation than I do for the others but I would probably spend more time in preparation for the others. Now, that may sound strange but like, the Honours Leaving Cert class, their work would take me quite a bit of time every evening. I would do their homework every evening, I would prepare the class questions I was going to do with them in class or whatever and this time of year, we're doing a lot of revision as well, I would be

doing exam questions at home in preparation for them, and the solutions, all that sort of stuff, good examples of how work is done and whatever and then, so that takes a while, it takes time.

With the, foundation level kids, because there's less content in, in Foundation Maths, there's not as much stuff to cover but it's just as difficult a problem for them to learn it, so I suppose you're coming up with new ways of looking at it or whatever or trying to, trying to come up with some way that they will get it, you know?

(iii) Teacher from Chestnut Hill

Interviewer: Would your method of teaching vary in the way you would teach Ordinary Level and Higher Level?

Teacher from Chestnut Hill: Oh, yeah, yeah, yeah, immensely. I suppose when its mixed ability, you're aware of the fact that there are weaker students in there. So, you can't go at the pace which would challenge the average to higher level students, you know, so that changes the way you approach it and the pace you approach it at and maybe the examples you'll pick and maybe the, you know, the fact that I'd always be getting them to do a project in First Year and I'd be kind of inclined to not to in Second Year because, particularly if they're going to Higher Level, because it's, well, the real business starts then, you know the way? So there'd be less of, less of the project work, less of the example work and maybe less, a little less of group work, I suppose, as they begin Second Year. With the Second Year group, when they became Higher Level, it was a kind of mixed ability Higher Level class; I wasn't able to go, kind of, full steam ahead with them. I very much believe in top Higher Level students needing a lot of challenges to get them to perform and to work at their highest rate.

Interviewer: When you say, challenges?

Teacher from Chestnut Hill: Well, I think just difficult Maths problems and difficult and Higher Level Maths problems. Throwing examples at them, like, in, in trigonometry and, for example, giving them a triangle and asking them why 'you know, why can't you use the Sine Rule in this particular example, why would it not work?' and getting them to, getting them to give you the reasons why and to think that way. And, so, I find with the real top Higher Level student group, they need that in order to perform at the highest level, I think. You know, whereas with the crew I have now, this kind of mixed ability Higher Level, I haven't got to that stage yet because I know if I move it on there, I'm going to lose a lot more of them, so I'm much more conscious of

trying to retain the numbers as well as trying to challenge them and that's very difficult, you know? So, that's, that's why the approach is different there.

Appendix G (vii) for Chapter 7: Extracts from Interviews with Teachers Year 3

Interview Question to Teachers: What are the main problems you would associate with the teaching of Junior Certificate mathematics?

(i) Teacher from Riverside

Interviewer: What are the main problems you would associate with the teaching of Junior Certificate mathematics?

Teacher from Riverside: I think that, in a lot of cases, that they're coming from a system in Primary School whereby they get 8 out of 10 or 9 out of ten or 10 out of 10, you know, it's all driven by getting this "right" or "wrong", as opposed to how we're getting it, so, I think that when they come to us at twelve and they say that they like Maths or they don't like Maths, they already have the wall built.

I really believe that they're afraid of maths, I believe that that's driven by the system and, and the way that it's presented to them and it's because a lot of the time we're not teaching for understanding. We're just teaching how you do it and you do this to get it right. And, that's really what I believe strongly and the teachers drive that, the system drives that. The knock on effect is that you're afraid to get the wrong answer, that they think the only thing is the right answer, that if you look at something and it's not exactly like something you've seen before, you have no confidence to try it because you don't think you can get the right answer, you know?

We all know how State exams are marked and that marks are given for method and marks are given for attempt. But, I don't know, I find if the kids look at something and already they think 'I can't do that', absolutely they're giving up more easily that they did ten years ago. I don't know what or where that comes from but absolutely they are giving up and I don't know whether that's linked to the fact that they think 'Oh, I can't get it fully out, so I can't get it at all'. I, I don't know why, why they're giving up.

I am frightened by how dependent they are on the teacher. Terrified, it's unbelievable; it is incredible how dependent they are on the teacher, at every level. It's because of the way we teach and because of the way they are institutionalised. Through the way that I have changed the way I teach and so on, they're becoming less dependent by me teaching that way.

(ii) Teacher from Kenmore

Interviewer: What are the main problems you would associate with the teaching of Junior Certificate mathematics?

Teacher from Kenmore: I suppose, I mean, a lot of the students are dependent on the teacher, particularly if they're taught in the time-honoured tradition of, a spoon feeding base: to give the students an example and then we'll do five million of these. I think it makes them very dependent. They don't think at all for themselves, I mean give them the problem but if you change the way the question is asked, they can't do it at all, you know. So, if you're trying to train kids to do Examination questions, it leaves you with a problem.

(iii) Teacher from Chestnut Hill

Interviewer: What are the main problems you would associate with the teaching of Junior Certificate mathematics?

Teacher from Chestnut Hill: I think one, one problem is, you see this a lot with Ordinary Level students and you see it with students who are trying the Higher Level but not maybe confident of doing very well or not able to do very well is the fact that they, they're still caught up in this thing from Primary School, I think, of wanting to get an answer. And when they get an answer, they leave the questions and they go on to the next one instead of actually reflecting on the answer. I think a lot of that comes from Primary School and I think we're guilty of it as well at Secondary Level, it's just this thing of, getting answers and moving on.

I think also there's a trend, particularly amongst Ordinary Level students and weaker Higher Level groups there is this tendency too, to not actually question their answer. You know the way, they, they just simply use the completely wrong methods for a question. e've seen it in the

Mocks now that I've corrected, students, they use a completely inappropriate method for it and I make a comment and I'll ask them about it later and all you get is 'Ah, yeah, yeah, yeah, I And I ask 'why did you use that other method?' and they'll say ' I just couldn't think of anything else'. You know, so there's no thinking going on. Where the responsibility for that lies, I don't know.

Appendix H for Chapter 7: Construction of Attitude scales

Lyons et al., (2002) constructed a number of attitude scales to survey students' attitudes and beliefs. The scales used in this study are the same as the scales used by Lyons et al., and are presented below. These items were issued to all the students in each of the three classes.

(1) Students' attitudes towards mathematics: i.e. students' perceptions of school mathematics, that is how difficult, useful interesting, enjoyable or boring mathematics is perceived to be and whether it was listed as a first or second favourite subject.

Responses to the following 9 items were used in this scale. The scored responses were aggregated in the following way as shown below. To control for non-response, the total score was divided by the number responded to by each student giving the final score with values ranging from 1 (very high liking for maths) to 2 (low liking for maths).

Item	Statement	Response/Score	Response/Score
1	Maths is an easy subject	Very easy/easy = 1	Quite difficult/difficult= 2
2	Maths is useful	Yes = 1	No = 2
3	Maths is interesting	Yes = 1	No = 2
4	Maths is difficult	No = 1	Yes = 2
5	I enjoy maths at school	Always/most of the time/sometimes = 1	Hardly ever/never = 2
6	Maths is important to everyone's life	Strongly agree/agree = 1	Strongly disagree/disagree =1
7	Maths is boring	Strongly agree/agree = 2	Strongly disagree/disagree =1
8	Maths is my 1st or 2^{nd} favourite subject	Yes = 1	No = 2
9	Maths is my 1^{st} or 2^{nd} least favourite subject	Yes = 2	No = 1

(2) Students' academic self image in relation to mathematics self assessed ability in school mathematics in the context of their peer group.

This is a six item scale. It indexes the students' image of his/her own mathematical ability relative to that of his/her peers. The scored responses were aggregated in the following way as shown below. To control for non-response, the total score was divided by the number responded to by each student giving the final score. The values range from 0 (very high maths self-image) to 2 (low maths self-image).

Item	Statement	Response/Score	Response/Score	Response/Score
1	This year so far I understand the maths	Very Often= 0	Often = 1	Few times/never = 2
2	Do you think you are good, bad or okay at the maths you do in school?	Good= 0	Okay = 1	Bad= 2
3	Think of everyone in your maths class this year, where would you place yourself	Top/well above average= 0	Just above average/average = 1	Below average/well below average= 2
4	I'm usually well ahead of others in my class	Strongly agree = 0	Agree =1	Strongly disagree/disagree = 2
5	In maths I can do just about anything I set my mind to	Strongly agree = 0	Agree =1	Strongly disagree/disagree = 2
6	I am as good at my maths school work as most other people my age	Strongly agree = 0	Agree =1	Strongly disagree/disagree = 2

(3) Students' perceptions of a positive classroom interaction with their teacher, perceptions f frequency of interaction with their teacher and the level of reward for achievement in class.

This is a six-item scale. It indexes the students' image of his/her interaction with the maths teacher. The scored responses were aggregated in the following way as shown below. To control for non-response, the total score was divided by the number responded to by each student giving the final score. The values range from 0 (very positive) to 3 (negative interaction).

Item	Statement	Response/Score	Response/Score	Response/Score	Response/Score
1	Over the past 2 weeks in math class I have been told my work is good	Very often = 0	Often = 1	A few times =2	Never =3
2	Over the past 2 weeks in maths class I have been asked questions in class	Very often = 0	Often = 1	A few times =2	Never =3
3	Over the past 2 weeks in maths class I have been praised for answering a difficult question	Very often = 0	Often = 1	A few times =2	Never =3
4	Over the past 2 weeks in maths class I have been praised because my written work is good	Very often = 0	Often = 1	A few times =2	Never =3
5	This year so far, I offer to answer questions without the teacher asking me to do so	Very often = 0	Often = 1	A few times =2	Never =3
6	This year so far, I pay attention and work hard in the class	Very often = 0	Often = 1	A few times =2	Never =3

(4) Students' perceptions of a negative classroom interaction with their teacher, correction/sanctioning for poor work or bad behaviour.

This is five-item scale. It indexes the students' image of his/her interaction with the mathematics teacher. The scored responses were aggregated in the following way as shown below. To control for non-response, the total score was divided by the number responded to by each student giving the final score. The values range from 0 (less negative) to 3 (very negative).

Item	Statement	Response/Score	Response/Score	Response/Score	Response/Score
1	Over the past 2 weeks in maths class I have been given out to because my work is not done on time	Very often = 3	Often = 2	A few times =1	Never =0
2	My maths teacher pays more attention in class to what some students say than to others	Strongly Agree = 3	Agree = 2	Disagree =1	Strongly disagree =0
3	Over the past 2 weeks in maths class I have wanted to ask questions but have been ignored	Very often = 3	Often =2	A few times =1	Never =0
4	Over the past 2 weeks in maths class I have been given out to for misbehaving in class	Very often = 0	Often = 1	A few times =2	Never =3
5	I find my maths teacher is hard to talk to.	Strongly Agree = 3	Agree = 2	Disagree =1	Strongly disagree =0

Appendix I for Chapter 7 Table 2: The mean scores for each class on each of these scales Year 3 of study.

Case Study Schools	Perceptions of Mathematics		Experience with the	Class Teacher	Maths at Third Year Level
	1.Attitude to Mathematics (1-2) 1=High Liking 2=Low Liking	**2.Mathematics Self-Image** (0-2) 0=Very High Self-Image 2=Low Self-Image	**3.Positive interaction** (Rewards) (0-3) 0=Very Positive 3=Negative interaction	**4.Negative Interaction** (Correction) (0-3) 0=Less Negative 3=Very Negative	
	Mean Score	Mean Score	Mean Score	Mean Score	
Kenmore	1.31	1.22	1.41	0.45	Foundation Level
Riverside	1.38	1.10	1.56	0.46	Higher Level
Chestnut Hill	1.42	1.30	1.77	0.41	Higher Level
	Ranking	Of School	Out of 3	(1=most positive)	
Kenmore	1	2	1	2	Foundation Level
Riverside	2	1	2	3	Higher Level
Chestnut Hill	1	3	3	1	Higher Level
Overall Mean	**1.37**	**1.21**	**1.58**	**0.44**	
Overall Mean of schools from Inside Classrooms	**1.29**	**0.96**	**1.45**	**0.61**	

Appendix J for Chapter 7 Table 3 (i) :Ranking of Case study schools (Year 3 of Study) in comparison with ranking of 10 schools from *Inside Classrooms* in relation to Perceptions of Mathematics.

3 Case Study Schools from above Compared with Case Study Schools from *Inside Classrooms* Ranking in Brackets (1=most positive) Year 3	Attitude to Mathematics (1-2) 1=High Liking 2=Low Liking	3 Case study Schools from above Compared with Case Study Schools from *Inside Classrooms* Ranking in Brackets (1=most positive)	Mathematics Self-Image (0-2) 0=Very High Self-Image 2=Low Self-Image
	Mean Score		Mean Score
Case Study School *Inside Classrooms* (1)	1.05	Case Study School *Inside Classrooms* (1)	0.67
Case Study School *Inside Classrooms* (2)	1.14	Case Study School *Inside Classrooms* (2)	0.87
Case Study School *Inside Classrooms* (3)	1.20	Case Study School *Inside Classrooms* (3)	0.90
Case Study School *Inside Classrooms* (4)	1.24	Case Study School *Inside Classrooms* (4)	0.92
Case Study School *Inside Classrooms* (5)	1.28	Case Study School *Inside Classrooms* (5)	0.99
Case Study School *Inside Classrooms* (6)	1.29	Case Study School *Inside Classrooms* (6)	1.02
Kenmore (7)	**1.31**	Case Study School *Inside Classrooms* (7)	1.05
Case Study School *Inside Classrooms* (8)	1.35	Case Study School *Inside Classrooms* (8)	1.08
Riverside (9)	**1.38**	Case Study School *Inside Classrooms* (9)	1.09
Case Study School *Inside Classrooms* (10)	1.40	**Riverside (10)**	**1.10**
Chestnut Hill (11)	**1.42**	**Kenmore (11)**	**1.22**
Case Study School *Inside Classrooms* (12)	1.50	Case Study School *Inside Classrooms* (12)	1.25
Case Study School *Inside Classrooms* (13)	1.56	**Chestnut Hill (13)**	**1.30**

Key to scores on attitude scales: Lyons et al., (2003) recorded the schools that scored 1.05, 1.20 and 1.14 as being positive in their attitude towards mathematics. The schools that recorded a score of 1.40, 1.50, and 1.56 were referred to as being negative in their attitude towards mathematics. The remaining scores occupied an interim place between these two positions.

Appendix J for Chapter 7 Table 3 (ii): Ranking of Case study schools (Year 3 of Study) in comparison with ranking of 10 schools from *Inside Classrooms* in relation to experience in class.

3 Case Study Schools from above Compared with Case Study Schools from *Inside Classrooms* Ranking in Brackets	Positive Interaction Perception of frequency of Interaction with teacher, level of praise for achievements. (0-3) 0=Very Positive 3=Negative Interaction	3 Case study Schools from above Compared with Case Study Schools from *Inside Classrooms* Ranking in Brackets	Negative Interaction (0-3) Sanctioning/correction for work-related and non-work related behaviour. 0=Less negative 3=Very negative
	Mean Score		Mean Score
Case Study School *Inside Classrooms* (1)	0.89	Case Study *School Inside Classrooms* (1)	0.26
Case Study School *Inside Classrooms* (2)	1.14	**Chestnut Hill (2)**	**0.41**
Case Study School *Inside Classrooms* (3)	1.22	Case Study School *Inside Classrooms* (3)	0.43
Case Study School *Inside Classrooms* (4)	1.32	**Kenmore (4)**	**0.45**
Kenmore (5)	**1.41**	**Riverside (5)**	**0.46**
Case Study School *Inside Classrooms* (6)	1.52	Case Study School *Inside Classrooms* (6)	0.49
Riverside (7)	**1.56**	Case Study School *Inside Classrooms* (7)	0.59
Case Study School *Inside Classrooms* (8)	1.58	Case Study School *Inside Classrooms* (8)	0.61
Case Study School *Inside Classrooms* (9)	1.60	Case Study School *Inside Classrooms* (9)	0.64
Case Study School *Inside Classrooms* (10)	1.63	Case Study School *Inside Classrooms* (10)	0.69
Case Study School *Inside Classrooms* (11)	1.70	Case Study School *Inside Classrooms* (11)	0.77
Chestnut Hill	**1.77**	Case Study School *Inside Classrooms* (12)	1.06
Case Study *School Inside Classrooms* (13)	1.93	Case Study School *Inside Classrooms* (13)	2.40

Appendix K for Chapter 7

Extracts from Interviews with Students Year 3

To protect the identity of students the names used are fictitious.

To protect the identity of teachers the names used are as follows:

Teacher from Chestnut Hill: Mr.C

Teacher from Kenmore: Mr.K

Teacher from Riverside: Ms.R

Appendix K (i): Interview Question to Students: "Do you feel you have made progress at mathematics this year?"

Extract from Chestnut Hill

Interviewer: Do you think you have made progress at maths this year? Why do you think you have made progress?

Betty: Yes, a little bit because I'm studying more, working more.

Linda: Better than last year, I have to work harder this year because we're learning more stuff quicker to get the course covered for the Junior Certificate.

Kate: Yes I feel I've made progress this year. I'm definitely, doing a lot more work, we have to revise over what we've done before.

Ben: Yeah, I made a good bit of progress this year, mainly because I was doing a lot of work at home with my mother.

Oscar: Yeah, I'd say I would have made progress because I kind of spent a lot of time on it and put a lot more effort into it this year.

Denis: The same as well for me, because I have been working a lot harder at Maths this year and I upped my grade a lot since last year. It seems to be coming to me a lot more naturally now than it used to. It's not as hard any more. I think it's because, I sort of settled, when we came into Second Year, we were split up from our other classes and so, now we're sort of settled in to our classes, settled in well and we're getting used to the teachers, so, we're able to learn a lot better.

Oscar: For me it's got a lot harder, than previous years, I think the teacher is going at a quicker pace and that makes it a lot harder to keep up. I think – mind you, once you put the effort in, it's okay.

Ben: Aw, the topics are harder all right. You can keep up with the class if you work hard, and if you're not listening in class, you're not going to get anywhere really and that's it.

Extract from Kenmore

Interviewer: Do you think you have made progress at maths this year? Why do you think you have made progress?

Derek: I've made progress. It's easier this year I know how to do the stuff now.

Frank: Yeah, I made a lot of progress. I just understand more things now. I find it hard to understand some stuff like circles, the circumference of the circle.

Cormac: Easier this year.

Dorothy: Yes it's easier than last year my grades are going up a bit because I listen more.

Zoe: It's kind of hard as well. It's kind of better this year because my grades have gone up as well, because we go slower and if I was in a Higher class, I'd get left behind, I wouldn't understand some of the stuff.

Daniel: It's a bit easy and a bit hard. I used to be terrible at multiplication, I didn't do very well during the Second Year, but this year I'm getting better. I do some studying at home with my Da at maths. The old stuff is easy but doing the new stuff, like, Pythagoras' Theorem is a bit hard.

Zoe: It's really hard. I don't understand it.

Extract from Riverside

Interviewer: Do you think you have made progress at maths this year? Why do you think you have made progress?

Deirdre: Yeah, I think so I've been working harder.

Cath: Yes, I think so, I don't know why. I'm just getting better grades this year. I think I just understand the subject better this year maybe I'm paying more attention.

Ida: Yeah, I think I've made progress. It's just kind of easier this year for me for some reason, I don't know why but it is and I tried a bit harder to get my grades better this year. Some of the stuff is based on last year's work, like angles and all that stuff so when we came to it we kind of knew what to do that makes it easier.

Polly: Yeah, I think I've made progress. I think you pay attention,, you put more effort into it because it's your Junior Cert. year, you're not messing with it. Yes it goes into more depth than last year so you can connect things.

Dana: Yeah, it's easier this year. I don't really know but I guess it's just because of the Junior Cert, you're studying more and you're trying harder.

Appendix K (ii): Interview Question to Students: "What is a good mathematics teacher?"

Extract from Chestnut Hill

Interviewer: What makes a good mathematics teacher?

Betty: Someone who can explain things properly and who makes us do homework properly and tells us to study.

Linda: I think Mr. C is a good Maths teacher, he explains everything properly and he's really helpful and very patient.

Denis: They take you there, go at a comfortable pace and they show you absolutely everything you need to know, but they would still do it at regular pace and they'd be very helpful, sort of very friendly with you and they wouldn't snap at you if you didn't know something that you really should know, they'd just be really calm.

Oscar: Someone who has patience with the students and will talk over problems with the student if he has any, and he's happy to answer questions.

Ben: He has to have a lot of patience, as Denis said, doesn't snap at you, take it step by step, slowly but surely but wouldn't want to go too fast, to make sure you know it before he'd go any further, make sure you understood it, because there's a big difference between just knowing it but if you have to understand it as well. Because if you get a difficult question, you won't know how to do it if you hadn't understood it.

Extract from Kenmore

Interviewer: What is a good mathematics teacher?

Derek: Some one who is easy to understand him.

Frank: Mr. K is a good teacher because we get along with him, he's not like other teachers who are snobby they won't get along with you; they look you up and down and think they're better than you. He explains everything to us, he writes it out, does rough work on the board and shows us step by step how to do it. You learn more from a teacher like Mr. K. He comes down and helps you, he shows you what to do not like other maths teachers I've had who'd leave you sitting there without knowing anything.

Dorothy: Yeah, if you're stuck, he will come down and help you. He goes to each one of us individually and helps us. And he's, like, funny as well. The class isn't always boring, like the rest of them. You don't have much fun in the other classes, like having a laugh but with Mr.C you do. He doesn't scream and shout at you.

Zoe: Yeah, because, like, what Dorothy said, it's never boring and he is friends with us, not like other teachers.

Cormac: He gets along with you.

Zoe: Yeah, he gets along with you and he tries to be your friend.

Frank: Not snobby

Zoe: Yeah, basically, yeah.

Dorothy: It's not all the same stuff all the time.

Daniel: I'd say the same as Dorothy. There's more teachers, well, snobby and all and they look down on you even when you try your best. Mr. K is different, because he goes through the Maths, piece by piece and that's very good.

Frank: They treat the brainy ones way different because they probably do their homework and if they're not nice, you won't bother then. They just annoy you.

Extract from Riverside

Interviewer: What is a good mathematics teacher?

Girls (together): Ms R.

Dana: She has a great reputation.

Girls: Yeah. (*together)*

Interviewer Why?

Cath: She actually explains things slowly, properly and goes back over it and she's okay with people asking questions. With Ms R, as long as you try, she doesn't mind. She would only ever get angry if you weren't working.

Dana: She's very patient with us. She doesn't give out.

Polly: Very clear, everything's very clear when she does it. You can talk to her, if you can't do something; she won't be like "Well, why can't you do that?" stuff. She will help you. There are other teachers we know who say about the theorems "They are in the book, learn them". That's it, they don't explain them at all. Sometimes, in the exam you get questions that are related to the theorem, so, if you don't understand the theorem, you can't do those questions.

Ida : Funny, she's funny.

Deirdre: She encourages us.

Appendix K (iii): Interview Question to Students: "Do you spend more time on mathematics at home than on any of your other subjects"?

Extract from Chestnut Hill

Interviewer: Do you spend more time on mathematics at home than on any of your other subjects"?

Kate: It is a lot of work it's one of the hardest subjects but not the most difficult and you do have to try and get your head around it, understand it and that. It would be slightly harder compared to other subjects but, like, there would be other hard subjects like science subjects.

Linda: Maths is not the hardest subject it's doable but it's definitely hard, and I put more work into it than other subjects but I like doing it, I prefer to do that than other subjects.

Betty: Well, maths is the hardest subject for me more than some other subjects, I think. You need to know what a formula is and just all the numbers and it takes a lot of work and studying and to get your head around it, you know.

Ben: Sort of, if I don't understand the question, I can't get it right after spending about ten minutes, maybe twenty, fifteen minutes, more, trying to get it right and if I can't get it right, I'll leave it and go way. And that wouldn't happen in other subjects I'm actually quite happy with other subjects, I know what I'm doing.

Oscar: I'd say so I spend more time too on maths homework. It kind of takes a lot more effort than other subjects, you have to think a lot more about how to solve the problem and you may have to go at it a few different ways. And then something occurs to you and sometimes and you go looking up, looking back over your copy and that.

Denis: I do find I spend a lot more time at that maths because, I had to try a lot harder this year because I knew I was falling behind the rest of the class last year, so, I had to try harder to get a better grade and I've done it, so I'm happy.

Extract from Kenmore

Interviewer: Do you spend more time on mathematics at home than on any of your other subjects?

Derek: No, I don't do homework really.

Frank: I look at the answers in the back of the book.

Cormac: I don't really do maths homework, I find it a hard subject to do.

Zoe: The more I study it, the more confused I get because of the numbers just kind of move around.

Daniel: Well I do a bit, but I tend to do more work with my other studies.

Extract from Riverside

Interviewer: Do you spend more time on mathematics at home than on any of your other subjects?

Girls (together): No

Cath: No.

Deirdre: No, normally you spend a while on it just like any other subject

Dana: Depends on the amount, if you have a test or for an exam, coming up and you do spend more time on it. The same as every other subjects like Irish or English.

Appendix K (iv): Interview Question to Students "Do you ask the teacher questions in class if you don't understand"?

Extract from Chestnut Hill

Interviewer: Do you ask the teacher questions in class if you don't understand"?

Betty: I'd ask someone sitting beside me first before I'd ask the teacher because it's much easier just to ask someone beside you.

Linda: Yeah, definitely.

Kate: Yes, it's just easier to ask the person beside you but I wouldn't mind asking the teacher but it's just easier to ask someone beside you.

Denis: Well, sometimes you ask him because it would be something new you're doing and he would explain it. Sometimes when we're sort of revising things and I'm not sure, I think I'd normally don't ask the teacher because I think, I might feel a bit stupid because I should know this thing but I don't. I'd feel stupid in front of the class and in front of the teacher. I wouldn't feel like that in other subjects.

Oscar: I'd nearly go, ask the lad beside me first and if he didn't know or if he didn't get an answer that I was happy with it I'd go and ask the teacher then. The teacher, he has enough to be doing, he has other people to be going around. I think you're sometimes you're better off learning from the person beside you, from someone your own age.

Ben: Well, I think I'd ask the person beside me first, there's a lot of competitiveness in the class you wouldn't want to show your weakness, you know what I mean? So, I just want to ask the student beside me first of all and then you could go up to the teacher. Usually if I'm on another subject at home revising with my mother and if I couldn't get something, I might go in after everyone has gone after the class, then I'd ask 'Sir, how would you manage to do this?' if I couldn't get it at home.

Extract from Kenmore

Interviewer: Do you ask the teacher questions in class if you don't understand"?

Daniel: Yes, because, sometimes, some students don't know the answers to the questions.

Zoe: It depends whether the teacher's busy. If the teacher's busy, I'll ask my friends and if he's not, I'll ask the teacher.

Dorothy: It depends on who's closest, like.

Cormac: I'd ask the teacher, because he's more experienced and wait until the end of the class to ask him.

Frank: I'd ask a student first, in case he's busy.

Derek: I'd ask the teacher.

Extract from Riverside

Interviewer: Do you ask the teacher questions in class if you don't understand"?

Ida: I'd ask the person beside me first because it's easier, it's faster, they've got it done. If they've got it right, they show you and it's easier that way.

Polly: No I wouldn't ask the teacher, I'd ask Coleen the girl beside me because if I got the wrong answer, I'd just ask her because she always has the answer right. I just have to know what I did wrong and she tells me but if it was something major that we both got wrong we would ask the teacher.

Cath: Yeah, if she was explaining something and I didn't understand it, I'd ask her but if it's just like a wrong answer to a question I'd ask the girl beside me.

Deirdre: I ask Dana, most of the time.

Interviewer: And Dana, who do you ask?

Dana : The teacher. *(Girls laughing)*

Zoe: I'd ask the person I sit beside first. It's handier.

Ida: If you ask the teacher she kind of explains everything to you but it might be just a tiny bit you don't understand. The girl beside you might have it right, you might have something wrong like signs or something and you just want to check answers to see if you have the method right just check how your answers differ and see where they are different. The girl beside you tells you what you want to know because you can tell them exactly and you it's easier, because it's more casual.

Cath: It's only a small bit easier, so, like if you don't understand the basics of something it's better to ask the teacher.

Interviewer: Are any of you embarrassed to ask a question?

Cath: A little bit. It depends on the question. Sometimes you think this is a really stupid question, I should know this and you don't.

Dana: Yeah, sometimes you get an answer, when you look at it and the teacher explains it, it's so obvious, you're just completely embarrassed, like you forgot how to do it or something.

Appendix K (v): Interview Question to Students "Do you like mathematics"?

Extract from Chestnut Hill

Interviewer: Do you like mathematics?

Betty: Yes, I do, yes. I don't, why I really like them, I just like maths, I prefer it to other subjects, it's better than other subjects and the teacher is a saint!

Linda: I like Maths but it's not my favourite subject, you have to like the teacher to like the subject as well, I think? I get on well with Mr.C, that's why I like the subject, but it wouldn't be my favourite subject.

Kate: In our classroom, it's not like any other tough environment, it's just like everyone is interested and doing their best. Like, in other classes it's tough, you'd be, counting down the seconds until the bell goes, it's just easier when you have a good teacher and you're interested.

Interviewer: Do you like mathematics?

Ben: Maths is alright, it's not my strong point in any way, shape or form. It's difficult enough in some topics, you have to spend a lot of time trying, you have to spend a lot of time at home, trying, to see how Mr. C's methods come into play with the question or the topic.

Oscar: I like maths. I don't know why I like them, it doesn't bother me to go home and to work out things, I like doing that working out problems,

Denis: Yeah, I do like them, because with Maths it's easier for me to get a work ethic to try really hard. It takes time but I do eventually get everything in maths.

Extract from Kenmore

Interviewer: Do you like mathematics?

Frank: It's alright I didn't like them because I didn't really understand them but now I kind of understand them so it's good.

Derek: Yeah, because it's easy.

Cormac: I hate Maths because it's confusing the numbers.

Zoe: The letters make it worse.

Cormac: Like, they write down words, like Pythagoras and whatever that is,

Frank: And radius, and circumference and C equals the yolk there on the poster in the green box. Yeah, something about "d" and "π".

Dorothy: It depends on what you're doing whether like it or not..

Zoe: Yeah, well, it depends on, what we're doing, if we're doing something that's really hard, like, Pythagoras Theorem, I don't like it because it's too hard and I don't understand it.

Daniel: Well, Maths isn't so bad, I mean, it never hurt anyone, did it? I mean, Maths helps you in everyday life, it helps you out with the shopping, for everything.

Extract from Riverside

Interviewer: Do you like mathematics?

Girls: Yeah, different parts. *(enthusiastically)*

Ida: I like the angles and stuff.

Cath: I like area and volume.

Dana: I like the angles too.

Cath: I find functions hard.

Girls: *(All commenting on functions inaudible)*

Ida: You've got to get your head around the "r" and "p" and all that stuff. Once you get it, once you know that $f(x)$ is equal to y then it's kind of easy but it takes a little while to get used to that.

Polly: I find them fine no, I find problems very hard. I always have problems with them. I don't know, I think it's just I get bored with them. I just have problems with them. You know the kind of ones you put the problems into algebra. We'd be writing that down and I'm going "What the hell are we doing"? I just find it very hard.

Zoe: I don't like area and volume but, eh, Miss R said herself like that was, you know, very much still in the summer holidays, at that stage. We just came back from the summer holidays when we did it.

Cath: I think algebra is hard. I think it's because I missed the first few days in Second Year when she started algebra and I then went straight into, like, half way through it. So, I never really understood the basics of it.

Appendix K (vi): Interview Question to Students "Do you get praised often in mathematics class"?

Extract from Chestnut Hill

Interviewer: Do you get praised often in mathematics class?

Betty: Sometimes. If I get a question right that's all.

Linda: Not particularly, sometimes if he asks you a question and you got it out right, nothing major though, everyone is treated the same.

Kate: Yeah, he wouldn't go over the top.

Denis: Yeah, we do, if we do well with any homework, we get praised for getting things right and knowing stuff.

Ben: Yeah, sort of. Not as much praise as our old teacher did, because we were starting off on Maths in Secondary School. Mr. C wants to try and make sure that you don't get too overconfident or else you might think no bother, no need to study, I know this, no need to go back over it and then when you see the test, you don't know what to do.

Extract from Kenmore

Interviewer: Do you get praised often in mathematics class?

Cormac: No, sometimes if we do a really good day's work.

Dorothy: Which is never?

Boys: If we're good.

Extract from Riverside

Interviewer: Do you get praised often in mathematics class?

Deirdre: Like we all do there's no favouritism but if you get something right, she'll be, like, 'yeah, well done' or if you're getting something wrong, she'll, like kind of, guide you , she won't, like give out to you yeah, she's good at helping us.

Zoe: She doesn't have any favourites. Like, even if you give a little bit of an answer right, she'll say "that's on the right track".

Appendix Q (vii): Interview Question to Students "What do you need to do well in mathematics at school"?

Extract from Chestnut Hill

Interviewer: What do you need to do well in mathematics at school?

Betty: You need to, like, to study a lot and to say to yourself that you can do it, that you're able to do it.

Linda: You have to be patient, if you don't get it straight away, you don't say straight away 'Oh, I can't do it at all', you have to work at it and you'll get it eventually, be patient, and you'll get it after a bit.

Kate: Yeah, it's exactly that, it's just working at it and putting in the effort.

Denis: You need to work hard. You need to stick at it, don't give up on it at all and, always if you have a problem with Maths, just ask someone about it.

Oscar: Pay attention and just stick with it, you know, you know, if you see a problem and you can't do it don't say 'I can't do this' you know, come at it from a different angle.

Ben: Don't give up, just if you don't get it the first time, seek help off your mother, father, maybe, or older brother or, or a student that you, know that's pretty good at Maths or if you really want to get Mr. C and he will explain it again, you want to just keep working and keep trying hard and you want to learn things over and over again.

Extract from Kenmore

Interviewer: What do you need to do well in mathematics at school?

Frank: Brains, you need to be clever.

Dorothy: Good at listening in class because if you don't listen in Maths you're gone, you don't know what to do. If you miss one little bit, you're gone.

Frank: You're out. If you fail a test, it puts your confidence down.

Extract from Riverside

Interviewer: What do you need to do well in mathematics at school?

Girls (together): Hard work.

Zoe: Hard work, just really concentrate on the study, learn the notes that we did in class.

Dana: I think you need to concentrate and you need to pay attention and understand as well because if you do something and you're not really paying attention, then you look at the notes when you go home and they make so sense at all, you have to really work hard in class to understand the notes.

Polly: You need to listen, like, when she is explaining something, if you miss something you're not going to get it if you don't listen.

Ida: You need to be really good at a subject and work hard. You have to have a bit of both but to be just like good enough you just need to concentrate and work hard.

Cath: You need to study because the thing about Maths is you never know exactly what the questions are going to be, so you have to know everything. Each of the parts of every question and formulas and stuff like that and how you would work this and that because otherwise you just see a question and if you hadn't been paying attention or something in class, you wouldn't know it when you saw it.

Deirdre: I think you need to just concentrate and also do your homework as well because if you don't do the examples you'll never be good at it.

Appendix K (viii): Interview Question to Students: I want you to think of a time when you were happy or anxious in your mathematics class.

Extract from Chestnut Hill

Interviewer: I want you to think of a time when you were happy or anxious in your mathematics class.

Betty: I don't know when I felt happy. I was anxious when we were doing our co-ordinate geometry I don't like any of that co-ordinate geometry and all that, I don't like it, I'm just not very good at that.

Linda: Happy when we're doing the stuff using the projector and the computer. We were doing, theorems and I'm bad at theorems and the teacher used the computer and projector which showed the proofs step by step and it clicked. We had a test and I got a very high result. And, I was just really happy because I had got it. I'm anxious when I don't understand a topic at the beginning and I'm thinking that I'm not going to get it, I feel anxious then, then when he explains it to us I do get it. You know you think that it's going to be tricky for you to get your head around this one, it's going to be a lot of work ahead of you.

Kate: When we went down through trigonometry, I got my head around it fairly quickly so, I was happy with that.

Denis: Happy when I used to have problems learning theorems and then as soon as we had the theorem test and I got a really high score on it, I think I got 80 something in it and I was delighted, I was over the moon. It gave me the confidence to stay working at Maths and I've improved great. I was anxious when we were doing geometry and there was a question came up and it was just really awkward, a triangle or something, and I just could not do it, I looked at it and I worried away at it and I could not get it. I felt like I was letting the teacher down because I didn't know this and I really thought he'd think that I should know it but I didn't. You feel like you're letting everyone down.

Oscar: Well, at the beginning of First Year I was kind of bad at Maths and then, then I came on and put more work into it and I dunno, I got a really good result in a Christmas test or something, and that kind of gave me more confidence to try. Sometimes maybe before a test you'd be anxious.

Ben: Probably when I got a sum right, the really hard ones, we were starting off a new topic, nobody else really knew how to do it and, for some reason, I had it, the gist of it, because I had done it with my mother already so I was kind of happy with that. A time when I was anxious was really when we're doing a bit of geometry and I didn't really know what was going on so, I kind of said to myself 'Oh no, Jesus, I have go home and learn this now'.

Extract from Kenmore

Interviewer: I want you to think of a time when you were happy or anxious in your mathematics class.

Frank: I was happy when we got a really hard question right.

Derek: When I got a good percentage in the tests.

Cormac: The same as Derek, when I did well in a test.

Zoe: I got an 86 in a test and I was really happy because it was hard algebra. I felt anxious in Third Class when I was left behind they were answering all their questions and I got really lost and I felt really anxious and I got given out to by the teacher. That didn't help.

Frank: I got 96 per cent in an algebra test.

Daniel: I got a 93% once in Maths.

Dorothy: I felt anxious coming up to the Mocks. The Mocks were rock hard.

Cormac: Terrible the Mocks.

Frank: Yes, I felt anxious when it was coming up to the Mocks, I didn't know too much about it. I got through it in the end.

Derek: Yes I felt anxious coming up to the Mocks.

Extract from Riverside

Interviewer: I want you to think of a time when you were happy or anxious in your mathematics class.

Ida: I would be happy all of Third Year, all exams I got like As and I think I got B in one of them, so I'd be happy with that because in my first exam. So I'm happy. I was really anxious when in the first term in Second Year and I was doing bad in all my tests but we had one really hard one, it was really a bad test for me and then I tried really hard and then I was happy in the end but just that time because I was doing really bad in my tests.

Polly: I'm happy when you get a hard question and you think you can't do it and then you can do it and you get it right.

Dana: I think I'm happy when I'm doing trigonometry. I just like it; I don't know why I just do. The Mock made me feel anxious. You'd never done an exam like it before and you'd never had a full test on everything you'd done before. There's so much in Maths, I get the questions confused I wonder will I remember when you're supposed to do this, and there is so much in it you get confused. Sometimes the questions can be similar and you have to be able to identify them which gets a bit annoying at times. It's hard to know what the question wants you to do.

Zoe: When you do well in Maths class and also when you get the question right I feel happy. Doing the mocks made me anxious, I didn't know what to expect.

Deirdre: I feel happy in Maths class, I like going to the class there's no pressure, it's like you know that Ms R expects you to do well, but she goes about it that she expects you to do well for yourself not just for her, so, there's no pressure on you to do really well. I was anxious after the mocks, Ms R. was absent for two days and it was before we got our results back. There was a lot on the exam that we hadn't done so, I was quite worried would she be angry at us for not trying it or what if I just failed really badly or what but then, it was okay. I'm not as anxious this year as last year. You expect to be going crazy because it's Third Year but we're kind of moving slower because there's actually less for us to do this year. So, we've been taking our time doing things to make sure that we do really understand them. So, I think, yeah, I'm more relaxed.

Cath: The first few Maths exams we had, I got a D and then the next one I got a B and then the next one after that I got an A, I was happy. The day though before Paper 2 of the mocks we had it the last day of our Mocks and because I hadn't studied properly for it, I was studying for everything else so, I had three hours on Thursday night to study for Paper Two. I sat down and I opened my book and freaked out, because I had so much to do and I knew I couldn't get it all done properly. But I was really worried.

Polly: The Mocks as well made me anxious because you do the papers and everything but you don't really know what questions are going to come up. You're sitting there for two and a half hours, never having done a full paper before wondering "Am I going to do well"?, "Will I be able to do the questions"? or "Will I understand the questions"?.

Appendix K (ix): Interview Question to Students "How do mathematics tests make you feel"?

Extract from Chestnut Hill

Interviewer: How do mathematics tests make you feel?

Betty: Not great, well, if you're prepared fine, but even then if then don't know something you're kind of done.

Linda: Yeah, I suppose, I freak out I see the test in front of me and I just feel sure that the questions will get me stranded and I've no-one to ask. I panic, especially when I don't know what's coming up and even I do I worry right up until then. I worry about math's test more than any other subject.

Kate: Yeah, you'd be worried about it, like, you'd be wondering, am I doing this right?

Ben: Em, Maths tests, hear them two words, I'm not really looking forward to it, you have to go home, study, study, study and when you come in to the Maths exam hall you're like "Oh Lord, I think I've forgotten something or I'm forgetting something there now, when you open up the page, you're looking at it "Oh no!". I wouldn't really feel like that in other subjects because you can, maybe, predict what's coming up but in Maths you have no idea.

Oscar: Yes, it's kind of the same as Ben, you can never know what's going to come up in Maths because there's so much, the course is so big and that. I would be anxious sometimes before a test, but once they're over, it's grand.

Interviewer: More anxious than other subjects?

Oscar: Yes, I think so.

Denis: Well, I just hear about Maths test and I'm just thinking 'What am I going to do now, this is going to be an absolute disaster". I just always think that and no matter how hard I try at home to study, for some reason, at Maths I'm just not able to study and then I came in to do the exam, after overcoming all the problems to study and I think I'm just blank really, I used to be blank but now, it's not as big a problem any more. I am sort of worried about the Junior Cert. but, I wouldn't be as worried because I am told that you don't get both papers on the one day, which is good, which we did in our Mock exams, we got both, Paper One and Paper Two, on the one day so, we had to study everything for that day. So I am, fairly worried, but not as much now since we did the Mocks because I wasn't sure what I was going to get, how it was going to turn out but it, it turned out okay and I'm not as worried but I am still worried about some topics in it. Maths would be my major worry.

Oscar: After the Mocks, I'm not really worried but, sure a week or two beforehand I might be when the pressure builds up and I kind of start to realise that I forgot to do this or forgot to do that.

Ben: I kind of want to get it over it. I'm delighted now because before the Mocks, Mr.C was going through the parts of the exam paper, where the topics are, it's like Question One could be, sometimes, equations or, as Denis said, the two Mocks Papers One and Two were on the same day won't be in the Junior Cert. I was worried about that.

Extract from Kenmore

Interviewer: How do mathematics tests make you feel?

Frank: Don't want to do it because everyone else will get better than you and you end up sitting there with the lowest percentage. I couldn't be bothered. Just, eh, get on with class and learn something else.

Cormac: I feel the same as Frank. You have to study when you don't want to.

Dorothy: Eh, I don't like them. It's not bad all the time.

Zoe: I don't like doing them I kind of confused because the more I study the more confused I get.

Daniel: Oh, I feel I might as well get them over with, I mean you want to get a good grade out of what you know.