1. **Title of Research** "*The Effects of cooperative Learning on a Second Year Junior Certificate Science Class*"

2. **Name of researcher** : Barry Slattery

3. **Date**: 3rd November 2010

4. **Timeframe including details of when the research was carried out:**

This research project was carried out during the academic year 2009-2010. As it was conducted using an action research approach the project was divided into three main stages to allow for a major review of the evidence gathered of the actions implemented during each cycle. The first stage began in mid-October and finished in early November, stage two was reviewed at Christmas and stage three was conducted from January to mid-March 2010.

5. **Brief outline of research idea :**

There are many research studies conducted on the benefits of CL, but using CL involves a repertoire of skills which need time to be developed and nurtured. To develop these skills both the teacher and the student need to engage in reflection. Therefore, the main focus of this project was to monitor how I was using CL and to develop CL as the vehicle to integrate innovative teaching and learning methodologies to improve the teaching and learning of science. In addition, I wanted to help students develop skills in CL.

This focus led to the development of one main research question:

Can I use CL to improve student learning of and engagement with Junior Certificate science?

6. **Summary of research aims:**

- To improve student engagement with and enjoyment of science;
- To become a more skilful facilitator of cooperative learning;
- To produce a CL template that can be used to teach various Junior Certificate science topics;

- To generate a body of practitioner based knowledge which can be used to help colleagues to implement CL strategies in their classes;
- To improve pupil achievement in science and promote the uptake of senior science subjects;
- To encourage the use of CL in other teachers classes.

7. Outline of methodology used including details of how any ethical considerations were addressed:

This research was predicated on an action research model and the project was divided into three main stages/cycles. Evidence was gathered using a mixed methods approach; many qualitative forms of evidence were used, such as student reflective journal, student focus groups, teacher reflective journal, photographic, video and audio recordings. The qualitative analysis was conduct by using a Spot Check instrument for tracking student engagement during lessons and two Shock Tests to measure student's retention of information. At each stage of the project, I tried to use the most appropriate and effective methods of gathering evidence, so that I could provide evidence of both intended and unintended effects of the actions being implemented.

The research population was a mixed ability science class(Class 2a) which were exposed to CL learning teaching and learning strategies for the duration of the project and two other second year mixed ability science class(Class 2b and 2c) which acted as control groups. There was no use of CL strategies in the control classes. Apart from the fact that the students and teachers differ in each group the only other variable is that a CL approach was used Class 2a while traditional instructional methods were deployed in Classes 2b and 2c.

Parents, students and participating teachers were informed in writing as to the purposes of the research and methods of data collection, and written permission was received from all students, participating teachers and parents of students participating in the research (Appendix 5). However, all names of names in this report are pseudo names.

8. Summary of background reading:

There is a vast volume of research conducted on CL, yet in the classroom CL is often perceived by teachers as group work, a strategy that is frequently used. According to Johnson, Johnson and Holubes (1994), CL is much more that simple group work, they have defined cooperative learning (CL) as “the instructional use of small groups so that students work together to maximise their own and each other’s learning”. There are five essential elements which must be incorporated into the lesson. The five essential elements of CL are: positive interdependence, individual and group accountability, face to face-promotive interaction, interpersonal/ small group skills and group processing. (Johnson, Johnson and Holubes, 1994).) This is what distinguishes CL from group work. Every effort must be made to include these five essential elements in order to achieve the benefits of cooperative learning, such as greater effort to achieve, more positive relations among students and greater psychological health (Johnson, Johnson and Holubes, 1994. Similar claims have been made by other educationalist such as Robert Slavin, he claims that cooperative learning produces greater student achievement than traditional learning methodologies (Slavin 1984). Slavin found that 63% of the cooperative learning groups analyzed had an increase in achievement.

The reasons for these improvements are many, however it is the fact that students are afforded opportunity to to work through their course content with their peers in a constructive manner that appears to be central to these positive outcomes. As a result of the greater number of interactions that each student participates in during each lesson, students are constantly challenging their understanding of a topic and being exposed to other student’s points of view on a topic. It is the opinion of the controversy theorist, David W. Johnson and Roger T. Johnson, “that being confronted by opposing points of view creates uncertainty or conceptual conflict, which creates a re-conceptualization and an information search, which results in a more refined and thoughtful conclusion” (Johnson and Johnson, 1994).

The increase in social support (peer support and teacher support) that is perceived by students who are exposed to CL over a prolonged period of time (Johnson and Johnson, 1985) is also instrumental in bring about the positive changes mentioned above.

Any strategy that could bring about such positive changes must be considered worthy of a trail within any science teachers classroom in light of the finding of the Programme for International Student Assessment (PISA) Report 2006 in Science (Eivers, Sheil & Pybus, 2008) which revealed that just under half of Irish 15 year old students enjoyed learning science compared to the Organisation for Economic Co-operation and Development (OECD) average of almost two thirds. Thus, serious reflection must focus on the experience of the student in the day to day classroom life. It is very important that we remember "how students learn is as important as what they are expected to learn" (Wells, 1999). And as teachers we must "never assume that any students lacks a willingness to be fully engaged" (Harmin & Toth 2006, p318) and we must always strive to improve engagement. We must try to develop teaching and learning strategies such as CL that offer students a greater chance of succeeding in school. This presents many challenges for teachers, one of the challenges "facing teachers, is to recognise the importance of learners talking and to set up language opportunities where the exploration and meaning making can happen" (James & Ashcroft 1998).This requires a major shift in opinion from the traditional view that a quiet classroom was a successful classroom.

This change requires time and effort and in order to further gain expertise in CL it cannot be a solitary activity (Johnson and Johnson, 1989), one needs collegial support. However, colleagues cannot simply be expected to use CL, they can only be inspired to teach cooperatively (Johnson and Johnson, 1989). Therefore it is essential to involve fellow teachers in whatever actions as taken. But first, if I was to encourage the use of CL in other science teacher's classes I needed to develop my theoretical rational for encouraging CL in order to have a sound base of theory to draw on to support any future interventions (Corey & Corey, 2006). The best way to begin this process is implement CL strategies in a reflective manner, engaging not only in self-reflection but also including she student as research partners.

9. Overview of research findings and recommendations:

Stage 1: Implementing Pair Work in the Teaching and Learning of Science

The finding below are based on a detailed review of all the comments in the Student Reflective Journals(SRJ) for each lesson and comparing the students comments to the reflections I made for each lesson in my journal .

In general, this strategy was received well by the students in my class. I categorised all student comment under three headings: positive negative and neutral. The weekly results of this tally are shown in Table 1 below.

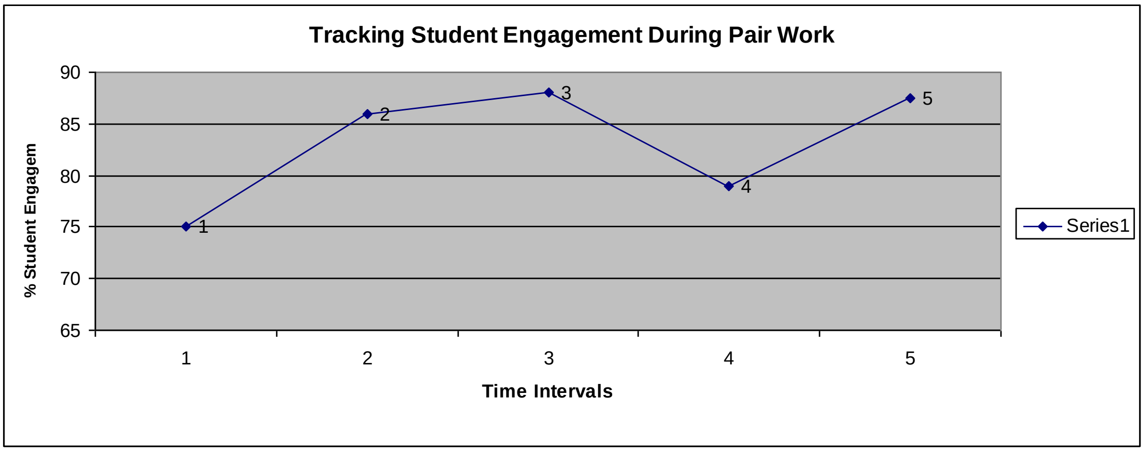
Table 1: Breakdown on students comments in SRJ during pair-work.

	Week 1	Week 2	Week 3	Week 4
Positive	81%	77%	72%	85%
Negative	15%	12%	20%	15%
Neutral	4%	11%	8%	0%

The re-occurring positive comment was the students enjoyed working together, in their opinion they found it a better way to learn. However, not all the positive comment was specifically related to pair-work. Student's positive comments related to the approach we had taken to the teaching and learning of the topic, I will offer an analysis of these comments in the latter part of this section as the negative student comments disclosed more about the use of pair work than the positive comments.

It became apparent to me during the course of working through this topic that sole use of pair work was not going to be a success. I noted in my TRJ that I need to offer pairs the opportunity to double up with other pairs in order to consult on more challenging tasks in order to increase diversity of viewpoints and thus the resources to help the group succeed (Johnson, Johnson & Holubec 1994). This observation was confirmed when the data from the Spot Check (McBeath 2005) survey was collated, it can be seen on table 2 below that students engagement dropped to its lowest value at interval 4. At this point, I had left the students working for too long at composing a rhyme to help them remember learning outcomes they had just achieved. They were showing evidence of frustration with their lack of progress on this task, yet I persisted with leaving the pairs alone for too long. Therefore, it may be that the limited number of interactions which occurs in pair-work compared to bigger sized groups can be an impediment to progress on certain situations.

Table 2: Results of Spot Check Survey of Class 2a using Pair-Work.



In the next lesson, I allowed the pairs to double up to complete tasks after initially working in pairs. A form of: Think/ Pair/ Share. All the comments for this lesson were positive and I noted in my TRJ that students were more engaged in this lesson one student noted that "time seemed to fly" while another student commented "I liked this way of learning because we got into groups".

Another aspect of my use of pair-work that students did not like was the fact that it was used too often and the students did not change partners except to do two experiments. From week 3, I noticed students making comments like "haven't switched partners and its boring", "bored in pairs" and "working together for too long". But as soon as we moved into bigger groups (5) to revise the topic using the game Football Fever the comments changed and students did not report feeling bored. When we were using triads to do the experiments students said "I liked being in a group of three rather than pairs". Therefore, I noted that for my class, the success achieved from using pair-work as a CL strategy is strongly affected by the frequency and format of its use.

<u>Stage Two: Implementing the use of Quads in the Teaching and Learning of Science</u>

After collating the data of the Spot Check surveys conducted during two double class periods during Stage 2 of this research I found that the average student engagement in class 2a during the course of the two double periods, during which no hands on experiments by students were conducted, was 84%. This is an increase of 2% from the levels of student engagement recorded during pair-work, when the average engagement levels from Table 2 are compared to the average engagement levels from Tables 3 & 4 I feel that this supports the observations that I recorded in my TRJ and the opinions of the students in the focus group (DVD Number 1, Clip Number 5) that many correct pre-instructional decisions i.e. group size, were made prior to commencing stage 2.

Table 3: Results of Spot Check Survey I during Stage II for Class 2a.

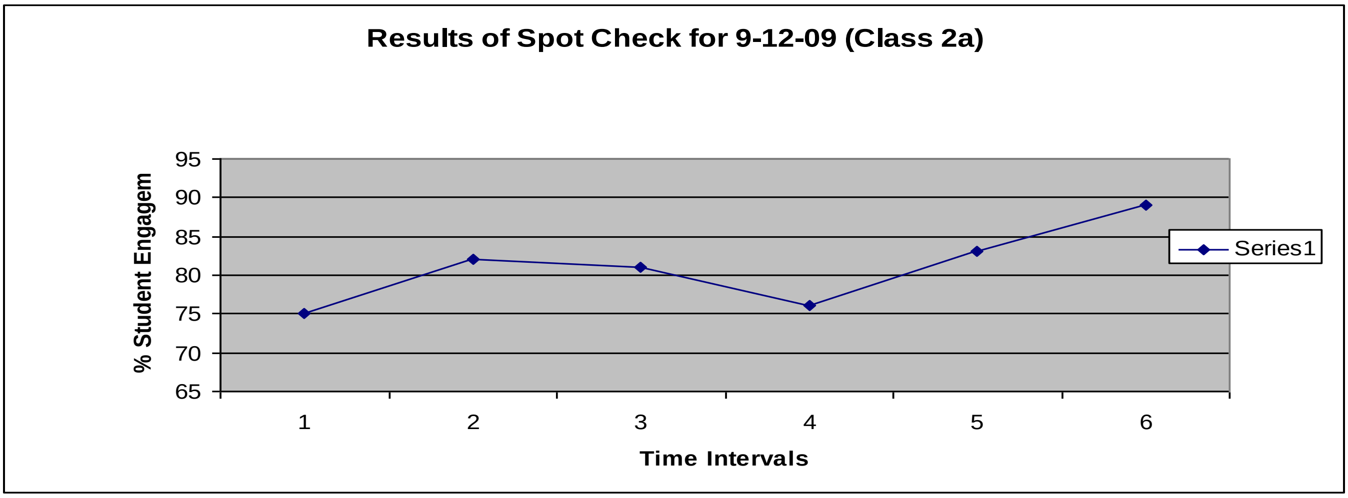
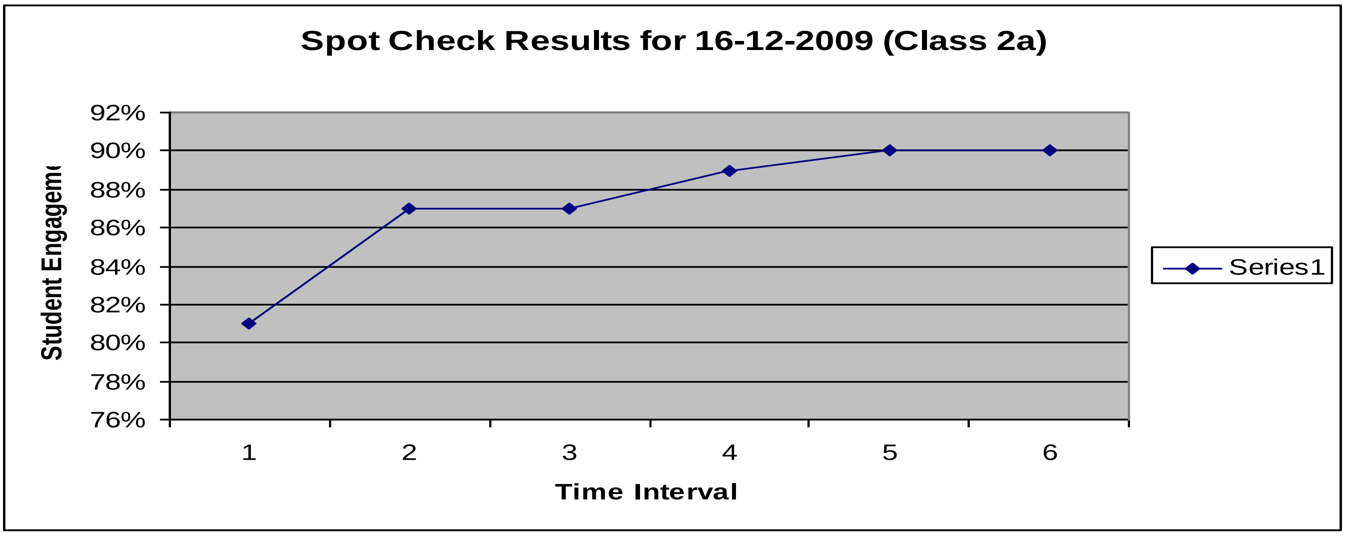


Table 4: Results of Spot Check Survey II during Stage II for Class 2a.



This average of 84% was recorded over the course of the 160 minutes, during which

Student engagement ranged from 75-91%, only dipping below 80% on 2 of the 12 recordings. The benefits of using CL, are further illustrated when these results are compared to those of Class 2b (Table 6 & 7), where students recorded an average of 76% engagement over the same period of time and with Class 2c (Table 7) were student engagement was averaged at 70% over the double class in which the spot check survey was used. The teacher of class 2b was absent on the day that the second Spot Check Survey was conducted.

I acknowledge that there are many variables involved, but they were all second year mixed ability science classes in the same school covering the same topic. Apart from the fact that the students and teachers differ in each group the only other variable is that a CL approach was used Class 2a while traditional instructional methods were deployed in Classes 2b and 2c. It is illustrated on Table 5 and 6 below that CL consistently yields higher levels of student engagement compared to the traditional approach. The importance of student engagement cannot be underestimated especial in the early years of secondary school, according to Osborne & Dillon (2008, p9) " the emphasis in Science education before 14 should be on engaging students with science and science phenomena".

Table 5: Comparing the results of Spot Check Surveys I during Stage II for Classes 2a, 2b and 2c.

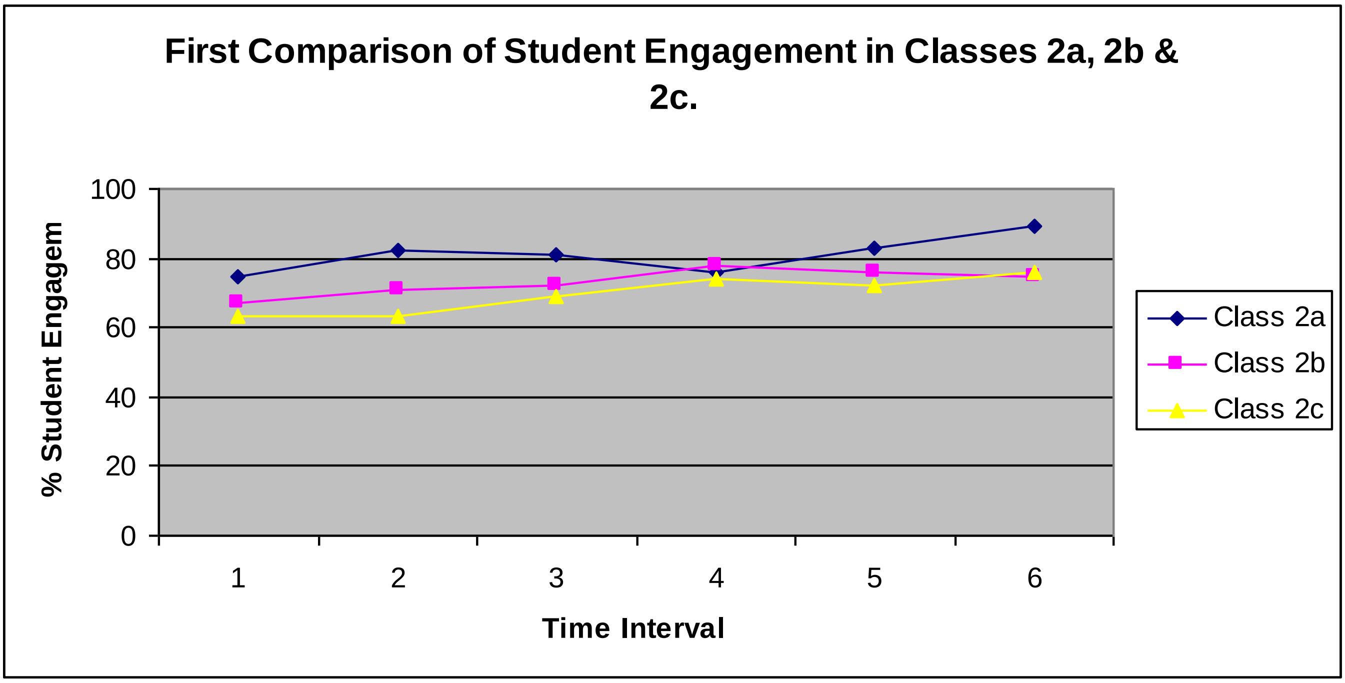
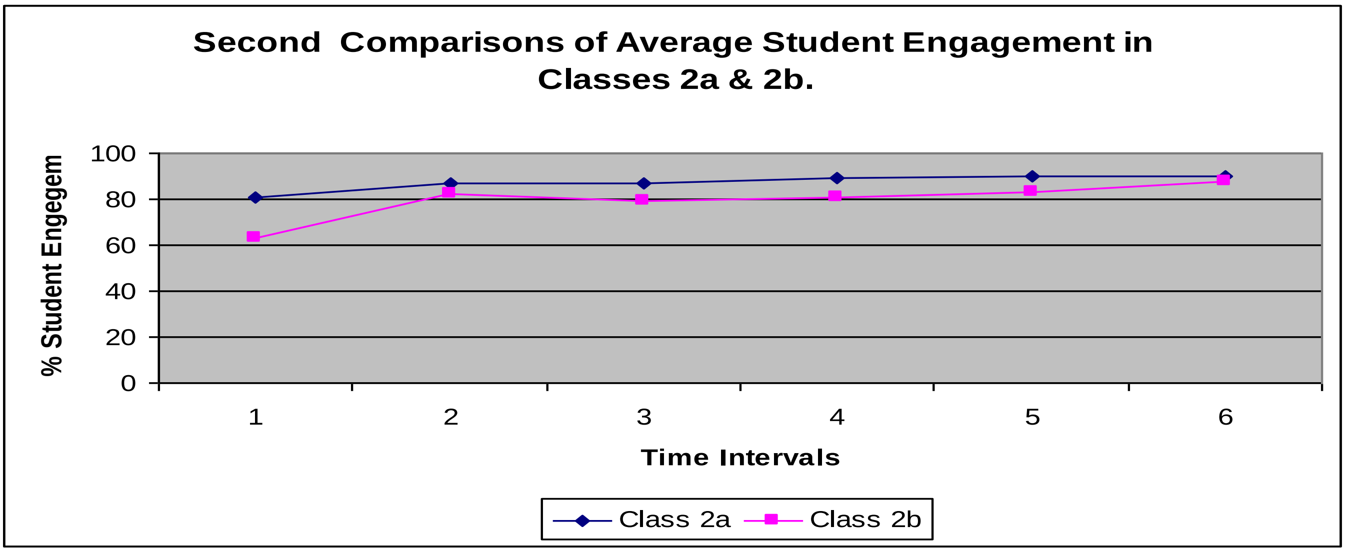


Table 6: **Comparing the results of Spot Check Survey II during Stage II of Classes 2a and 2b.**



Therefore, I think that there was an improvement in the use of CL during this stage. I do not think that this improvement can all be credited to the pre-instructional decisions that were made. These decisions did improve the effectiveness of the strategies which were used during stage 2. What is most apparent as I compare points in the graphs on Tables 2 and 3 to what was happening at each of these intervals as recorded in my TRJ is the wide variety of teaching and learning strategies used during the course of these lessons. Some of these strategies are examples of a direct implementation approach to CL (e.g. the Jigsaw) while others would not have been as effective if the class were used to a CL approach to teaching and leaning. This I feel was vital in achieving high levels of student engagement. This high level of student engagement appears to have improved student motivation, and students are now more switched on to learning and taking more responsibility for their own learning. This was very evident as I reviewed a recorded section (DVD Number 1, Clip 3) of lesson involving the traffic lighting of learning outcomes . I instructed the class to help other group members with learning outcomes highlighted amber. Students can immediately seen to assist each other and one conversation can be heard:

Student 1: Who wants to go first with the orange?

Student 2: Ok, will I?

Then, the students in this group begin to explain and discuss the learning outcomes which are highlighted amber without delay and share markers with each other without hesitation. Towards the end of the recording it became clear that the students though that the video was not recording, thus all footage up to this moment was without doubt uncontrived. It may be the fact that students are more motivated to work with their peers, according to Harmin and Toth (2006) two key factors affecting student motivation are maximizing success experiences and minimizing anxiety. Evidence to support this can be seen in a 10 second clip in DVD 1, Clip1 (5 min 50sec to 6min). At the start of this clip Anna, a student with one of the lowest class test average score, is seen confidently making her contribution to the groups preparation for their class presentation. But more importantly as the camera pans away from Anna and Ruby comes into shot, a student with one of the highest average class test scores, is seen to be actively listening and acknowledging Anna contributions as she repeatedly nods her head to Anna's contributions. This situation offered Anna an opportunity to achieve success and experience a level of recognition for her efforts in a low anxiety setting that she may not get with whole class teaching. The support and recognition that students experience while working in a CL environment appears to increase student confidence as well as student motivation. In this same clip (DVD 1, Clip1, 3 min 25 sec to 3 min 35 sec), Kathleen a normally shy student with slightly below average test score can be seen to be very animated in the group as she explains her share of the information to the group in the Jigsaw class. The peer support offered during stage 2 of the Jigsaw, and the small group setting in stage 3 of the Jigsaw appears to have the effect of increasing student confidence levels of all students. The Big Fish Theory as proposed by Swango & Steward states that:

> "One of the most important needs of young adolescents is that they have a sense of belonging and personal identity within a group. By breaking large groups of students into smaller ones, a student can go from being a small fish in a big pond to a big fish is a small pond. The outcome with teams is that students know

> each other better, feel like their teacher knows them better, and don't fell lost in the crowd" (2003, p92-93)

This offers an explanation as to why student confidence levels increase in small groups.

<u>Stage Three: Monitoring student learning.</u>

I was very interested in examining the effects of CL on student learning, research claims that CL produces greater student achievement than traditional learning methodologies (Slavin 1984). Slavin found that 63% of the cooperative learning groups analyzed had an increase in achievement. Therefore, in mid-February (Appendix 17) and mid-March (Appendix 18) I gave a short 10 minute shock test to classes 2a and 2b on the learning outcomes covered 12 weeks before the date of the tests. Both classes were tested at the same time and neither class had any prior notice about the tests.

In both tests, class 2a scored a significantly higher class average test score (Table 7). The fact that there was only a difference of 14% in the class average in the same Christmas examination paper suggest that the retention of knowledge is better in a the class using a CL approach. I acknowledge that there are many variables to consider. While the classes are matched on the course content being taught and are of similar age and background, all students are obviously different and mature at different rates. In addition, different teaching styles can have different impact on students. However, it is my contention that the main difference between these two classes is that one is being consistently taught using a CL approach.

Table 7: Class average scores in shock tests.

	Class 2a: Average Test Score	Class 2b: Average Test Score
Shock Test 1	64.18%	35.74%
Shock Test 2	72.7%	28.8%

This adds considerable strength to the argument that CL was a significant factor in improving student retention of learning outcomes. In my conclusion I will examine the reasons for this improvement.

Conclusion

In the findings in stage 2 and stage 3 above, I have responded to my initial research question, which was: Can I use cooperative learning (CL) to improve student learning of and engagement with Junior Certificate science? My position is clear; I believe that CL can be used to improve student learning of and engagement with Junior Certificate science. Through out this report I have highlighted how the importance of peer support and working using a variety of activities leads to greater student motivation for learning and greater engagement with learning. These are certainly two major contributory factors to improving student engagement and learning. Now, I would now like to, based on evidence that I have gathered, elaborate on some other contributory factor for these improvements, improvements that I do not believe to be mutually exclusive. Therefore, there are some common reasons for these improvements, such as:

- Students became more responsible for their own learning;
- Increase in class productivity;
- Students learned with a deeper level of understanding.

Students became more responsible for their own learning: This is a natural consequence of using CL, as students gain greater small group skills; they take greater responsibility for their own learning. This was clearly evident as we started to recap on Transpiration and Photosynthesis in late January (DVD 2, Clip 1). This lesson was on the day following the tragedy involving a colleague. Due to the circumstance, I was not as prepared for the lesson as I had intended and had not the required material to carry out the Task 12 as planned. I improvised and provided the groups with the list of prior learning outcomes on the board and poster making materials. The only instruction I gave the class was to link the list of prior learning outcomes (provided on the board) to the list of learning outcomes on Transpiration and Photosynthesis (provided on a handout from a previous task)). I was so impressed with how quickly each group began the task that I recorded the lesson. Each group devised their own division of labour

(1min50sec-1min60sec) and worked cooperatively on the group poster, ensuring that each student in the group understood each connection. I was equally impressed by the quality and variety of their work. As students become more responsible for their learning, they develop a greater sense of ownership and pride in their work and thus become more engaged with learning. This was also a salient moment for me, as I realised that CL had become part of my "theory-in-use" (Argyris & Schon 1974, p10) as I did not resort to whole class teaching.

Increase in class productivity: This became more evident as the year progressed. I was pleasantly surprised on many occasions at the speed at which students successfully completed tasks. I commented in my TRJ that I needed to realise that the class was now working at a faster pace. This was very apparent on two occasions: when we were studying Transpiration in plants and when building series and parallel circuits while studying electricity. On both occasions the class completed a task in the closing 10minutes of class that I would have previously not have allowed the class to start as I would have feared they would have been insufficient time. In fact, on the first occasion it was the students who encouraged me to allow them to do Task 5 as they believed they could get the task completed on time. This increase in productivity ensures that more students stay on task and thus their engagement and learning improves.

Students learned with a deeper level of understanding: throughout the year students were continually afforded the opportunity to discuss the material they were studying with their peers, by allowing students the "opportunity to use the language of science leads to enhanced conceptual understanding" (Osborne & Dillon 2008). This resulted in students constantly challenging their understanding of a topic and being exposed to other student's points of view on a topic.

10. How the research has contributed to your professional development:

As a result of my involvement in this study I have become a much more reflective practitioner and I have a much greater awareness of the wide variety of teaching and learning strategies that are available to teachers as a result of practice based research, which I would very much like to contribute to. I now view professional development in a different light. It is now something that I feel teachers must actively integrate into their practice as opposed to a course that they attend in an n education centre.

11. How this research will benefit the teaching profession and the wider education community:

Firstly, this research confirms many of the benefits outlined in many international studies in the area of CL. However, the fact that this is Irish based research and the focus of research was on student engagement and learning makes it more relevant to Irish educators. Also, I believe that this research presents CL in a new light, as this study evolved CL became not only a vehicle to deliver learning outcomes in student centred manner but also a vehicle to deliver other teaching and learning strategies more effectively, such as peer assessment, traffic lighting of learning outcomes etc.

The nature of this process of implementing a CL approach in a school lends itself to collaborative approach by teachers. The findings of this research has led to the setting up of a cross-curricular Cooperative Learning Team which consists of 4 experimenting teachers who are working with me as project leader to develop the use of CL as a teaching and learning strategy in our school. This is a bottom up approach to change which hopefully will be more effective and sustained.

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