

**Final report on Project R/D 02/04**

**Development of Science in 10 Kerry Schools  
and other Selected Schools.**

**November 2004 –November 2007**

## **Acknowledgements**

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## Chapter 1

### **Background to Project.**

A grant of £50 000 from the Irish American Partnership to 10 schools in Co. Kerry was provided in 2003. The purpose of the funding was to assist the schools in the teaching and learning of science.

St Patrick's College, Drumcondra, was instrumental in advising the schools on the purchase of appropriate equipment, in liaising with the schools and in coordinating visits by a consultant in primary science to all the schools.

Having assessed the outcomes of this funding over one year, the following were identified as being of positive benefit to schools;

- Provision of a science facilitator who would visit schools to help implement the revised science curriculum
- Continued funding on a limited scale for purchase and replacement of scientific equipment and visits to sites of scientific interest,

Based on this analysis, a proposal for the further development of science in selected schools and the estimated funding required was presented to the Partnership.

In order to increase the effectiveness of the project it was suggested that the project might be expanded to 15 rather than 10 schools and that its duration might be extended to three years. As well as providing teaching materials for the participating schools it was proposed that a postgraduate research scholar, who would be a fully qualified and experienced primary teacher, would work as a facilitator with teachers in the schools. Ms Sinead O'Reilly was chosen for this role.

The cost of this three year project was estimated at €74,850 per annum or €224,550 in total. The Partnership undertook to provide half of this funding (€37,425 per annum) with the DES providing the other half. Of the €37,425 provided by the Partnership €30,000

was to be sent directly to the 15 schools, while the remaining balance, €7,425 was to be paid directly to St. Patrick's College.

The Kerry project coincided with the introduction of the revised syllabus for primary schools. Following the introduction of science as a compulsory subject a number of issues arose in schools including

- Teacher confidence
- Teacher knowledge of science subject matter and pedagogy
- Adequate professional support and resources
- New trends in enhancing and developing science teaching

Having examined the literature with regard to these issues and to best practice in developing science in schools, it appeared that positive results could be achieved using a number of different methodologies. This literature is briefly surveyed in Chapter 2.

## Chapter 2

### **Rationale for project.**

The 1971 Social and Environmental Studies curriculum was revolutionary for science education in Ireland with the inclusion of Elementary Science on the syllabus for fifth and sixth class. (Department of Education 1971) However a lack of equipment, materials and in-service resulted in a degree of dissatisfaction with the implementation of the curriculum.

The first official primary science curriculum in Ireland was introduced in 1999, with full implementation from September 2003. (Government of Ireland 1999) This curriculum includes science as a compulsory subject on the syllabus for all primary school pupils. It embraces the development of concepts, skills and attitudes, which are to be developed simultaneously. Scientific concepts are presented in four broad strands, living things, energy and forces, materials and environmental awareness and care. Each of these is subdivided into strand units.

The curriculum encourages the employment of a variety of teaching approaches and methodologies in order to develop positive attitudes towards science. This variety has been to the forefront of our thinking during the development of the project.

The curriculum also places an emphasis on 'Hands-on' classroom science with increased student practical work and a more investigative approach to teaching and learning.

However concerns quickly emerged about teacher confidence in teaching science and also about what support was going to be available to help science teaching.

The Government moved some way towards addressing these issues, through the provision of in-service training (2 days) for teachers and on-going support through the Primary Curriculum Support Programme (PCSP). Schools received grants to purchase science equipment. (DES, 2003, pp.35-36) In addition eight regionally-based Cuiditheoiri have been providing support specifically in science teaching to teachers in

their area. This support is very welcome but there is some suggestion among teachers that it may not be enough.

It can be seen from the literature that teacher confidence in teaching science is a world wide concern. Much of the literature on how to improve teachers' confidence focuses on two areas (a) support and (b) improving teachers' knowledge of science.

#### Support for Primary Teachers.

Research has shown that support is critical for teachers in times of new curriculum implementation. It can, for example, help teachers' views of their own competence and confidence in teaching science. Studies of teacher confidence carried out by Bennett *et al.* (1992), cited by Holroyd and Harlen (1996, p. 323) attribute the increase in confidence by teachers in England and Wales between 1989 and 1991 to 'the investment of resources, both human and material, to support primary teachers in science'. Peers *et al.* (2003) identified factors which support teacher growth during a science curriculum innovation (2003, p.89) as (i) an appropriate programme of professional development (ii) teacher understanding of the elements of the curriculum innovation and (iii) successful experiences in implementing new approaches.

Begg (1993, p.4) reports that training for teachers provided to support the introduction of science as a core curriculum subject in England and Wales, 'Has helped to raise standards of science teaching in our schools' Ongoing support for teachers following introduction of a revised curriculum is also advocated by Begg. The UK Association for Science Education (ASE) Primary Curriculum Task Group, of which she was chair, found that even after initial help by advisers and advisory teachers in introducing teachers to the science curriculum, there was 'still a great need for this support for teachers' (1994, p. 19). It would appear from their experience that help needs to be ongoing, not just once-off.

It seems reasonable therefore to suggest that similar supports would provide help and have a beneficial impact on teaching, planning and delivery of science in Irish primary schools.

### Teacher knowledge of science

Research on teacher subject knowledge shows how primary teachers' understanding of science concepts can impact on confidence and teaching. Harlen and Holroyd (1997, p. 103) found that, in Scotland, 'levels of confidence are influenced by a range of factors, of which science knowledge is a very significant one, whilst confidence in a specific area of content is closely related to knowledge of that content.' When low teacher confidence levels applied, Harlen and Holroyd identified 'coping strategies' used by teachers in the classroom (1997, p. 103). These include teaching as little science as possible; teaching aspects of science with which the teacher feels more comfortable (for example, biology rather than physics); overusing kits, texts and work cards; using demonstration rather than exploration methods and avoiding practical work in science. They conclude (1997, p. 103) that such strategies 'can have a severely limiting effect on pupils' learning'. Appleton (2003) reports similar findings during research on beginning primary teachers in Australia. He states (2003, p. 4) that 'studies that consistently reveal problems with primary science education are a reflection of the science knowledge held by primary school teachers'. His findings show (2003, p. 17) that teachers' limited knowledge results in them utilizing 'activities that work' in the classroom, activities which facilitate process skills development rather than conceptual development (2003, p.17).

### New trends in enhancing science teaching.

New trends in enhancing and developing science teaching are constantly emerging and developing. The literature suggests that Lesson Study could be a useful tool for teacher professional development

In the last 20 years 'lesson study' has become a central component of Japan's major effort at teacher professional development in elementary and middle school.

In lesson study groups of teachers meet regularly over long periods of time to work on the design, implementation, testing and improvement of one or more 'research lessons'.



Lesson study can be quite complex and can involve many parts such as Goal setting and planning, planning the lesson, teaching the lesson (among themselves), evaluating, reflecting and revising, teaching the lesson in the classroom. Lewis cited in Conway and Sloane (2005) provides examples for primary school science.

As pointed out by Conway and Sloane lesson study will not bring quick rewards but it could be important for continuing professional development. They point out that lesson study highlights the importance of teachers' deep knowledge of content and pedagogical content knowledge. They also point out how lesson study can help create contexts for collegial discussions of pedagogical practices.

In rural areas, away from large urban centres, lesson study might be useful for teachers in clusters of schools.

The role of video study in providing archives of teaching that can be used for future research and/or teacher professional development has been documented in the literature. Video offers a promising alternative for studying teaching (Stigler, Gallimore and Hiebert, 2000) cited in Conway and Sloane 2005). Rapid advances in video technology, more user-friendly video technology and declining costs have made the use of video in the classroom more feasible. The advantages of video include the possibility of observing actual events repeatedly; the provision of raw uninterrupted data; the possibility of repeated analysis of the same data from different theoretical angles at a later time. Teachers from other schools can see how lessons worked out – what should be avoided and what should receive more emphasis. Ethical issues however surrounding the use of video would have to be carefully considered.

Bearing in mind the evidence from the literature the project in Year 2 and 3 has concentrated on examining how teachers in the selected Kerry schools could be supported on an ongoing basis. The strategies used will be described in Chapter 3.

## Chapter 3

### **Project Methodology**

The initial ten schools in the programme were chosen to include the catchment area of Kenmare, including the Black Valley. These are schools which, if you travel through the mountains, are close to Killarney.

In choosing the additional schools it was thought best not to include schools very close to or in the town of Killarney as these are larger, more urban schools. In the initial ten, only two are located in the town of Kenmare, all others are rural schools.

Of the five schools that were added to the programme, four were in the Cahersiveen rural area (not the town schools) and one was in Glencar which is close to the Black Valley School. (The schools are listed in Appendix 1).

The work carried out each year is described below.

### **Year 1; Nov 2004 to June 2005**

#### Structure of intervention.

The fifteen schools that had expressed interest in the project were visited in November 2004. In total, fourteen of the fifteen schools were enthusiastic about the proposed project. Aghatubrid N.S. did not wish to participate so Portmagee N.S. was contacted and took the place of Aghatubrid.

An intervention programme for the year was developed that consisted of the provision of fifteen specially designed science lessons that incorporated the theory of Sensory Integration. Sensory Integration is the natural process of organising sensory input so that a person can interact with the environment effectively. Dysfunction of sensory integration, therefore, causes a mismatch of sensory information received and its processing, thus impeding the learning potential. The method promoted is one of

enhancing motivation and inner drive through dedicated science activities that incorporate a 'body-on' component.

The lessons were designed to maximize student participation in learning by providing opportunities for the children to explore materials, engage in hands-on learning, interact with classmates, develop scientific skills, and experience and discuss scientific phenomena. An example of one of these lessons, Stepping Stones, is provided in Appendix 2. The complete set of lessons, *Move and Sense in Science* is provided under separate cover.

Each teacher wishing to participate received a folder of lessons. In addition the schools administered a science attainment test that would be repeated after the science activities were delivered, to determine whether any improvements in scientific conceptual knowledge had occurred. This was also to generate data with respect to a research project involving empirical measures of learning and development in the science lessons designed and implemented.

It was suggested to the teachers that a meeting be held approximately every six weeks, at a central location, in order to provide face-to-face instruction to the participating teachers, which would help to implement and develop the science lessons programme. This would provide opportunities for social interaction between the teachers who carry out the lessons, and would promote mutual sharing of ideas and possibly resources in some cases. The teachers agreed to this format. Teachers were also informed that further information regarding the lessons would be available to them on the website mentioned below.

Approximately thirty teachers agreed to be involved in the project. Representatives of each school were again met in January and March 2005 at two locations in Kerry, the Brooklane Hotel in Kenmare, and the Daniel O' Connell in Cahersiveen. The teachers were given prepared lessons in batches of five to a total of fifteen. Resources and equipment that were required to implement the lessons were procured and sent directly to

schools or sent to a pick-up point at an appointed school. Some resources were given out at the meetings. Training in the use of the lesson plans and resources were provided at these meetings. Refreshments were provided after the meetings.

A final visit to each school occurred in June. Feedback and input based on their experiences throughout the year was provided by the teachers. The outcome of the programme was evaluated at pupil level using a science attainment test. (See Appendix 4) and at teacher level using lesson evaluation sheets for each of the fifteen lessons taught. (Appendices 5 and 6)

During the summer, work commenced on the preparation of a manual of the lesson plans for publication. Discussions were held to inform methods of support in the following year.

#### Additional support.

As part of providing continued information to the teachers of the project, use was made of the Moodle virtual learning environment. See <http://spd.moodle.com>. This information consists of additional resources on science education, sensory processing, photographs of the activities being done in the classrooms and feedback from the teachers.

#### Research Component

Carrying out such a project in schools requires evaluation of the efficacy of learning. Thus, assessment instruments were compiled from the international TIMSS (1999) standardized science tests. Three tests were compiled to cover three age-groups and the first issue was carried out in December 2004. The results for all three age groups are presented in Appendix 4. Children's behaviours and performance in relation to sensory processing, were also measured to assess the effect on some of the multi-sensory, active science lessons. (See Appendix 11)

## **Year 2. Sept 2005 to June 2006**

The emphasis for intervention during this year was on the Strand Energy and Forces. This was at the request of the teachers.

### October 2005

The fifteen schools were contacted and the programme for the year was outlined. Materials/equipment required for workshops on the Strand units Electricity and magnetism and also on Sound were ordered from science suppliers. Background information on these two strand units were uploaded to Moodle.

### November / December 2005

A workshop / meeting with teachers in the East Cluster group of schools took place in the Brooklane Hotel in Kenmare.

First this consisted of a power point presentation outlining details of the project.

The topics covered in this workshop were 1. Electricity, 2 Magnetism and 3 Sound.

The teachers were given ideas on how to introduce the topics. Sets of resource packs (1 per school) containing equipment for electricity and magnetism were prepared and distributed. Also prepared was a selection of related worksheets and books on these topics, which were also distributed. A display of some games that can be made using circuits e.g. the Steady Hand Game, and a Quiz Board game was prepared. Instructions on how to make these were also provided. Examples of homemade Dimmer switches, Tilt switches, Pressure switches and Paperclip switches were provided, with pictures and details of equipment needed to make them.

The hands-on aspect of these topics was presented as a circus of activities. (See Appendix 8 for a sample of these activities) The complete set of activities is presented under separate cover.

Eight hands-on activity packs were prepared. Teachers worked in pairs on the task based activities. The tasks were presented on A4 cards as questions / problems. Each pair

completed 3-4 of the activities. Results and problems that might arise in the classroom were discussed.

This workshop was followed by a similar one for teachers in the West Cluster group of schools in the Ring of Kerry Hotel in Cahersiveen.

#### January 2006.

Visits to each of the fifteen schools were undertaken to meet teachers, discuss the workshops, and to hear how science lessons are progressing. It was decided to cover only one topic in detail at the next workshop and to divide up activities on a class by class basis so the teachers would have more time to spend on the material relevant to their particular needs.

Some teachers expressed an interest in school science trips and possibilities such as The Tralee-Dingle Railway and The Lartigue Monorailway were discussed. Reconstructed engines and carriages allow children to experience a unique mode of transport. The Lartigue Railway runs from Listowel to Ballybunion. It was decided to source information about these and other trips for the next meeting in February.

Information about Primary Science Review was provided and some teachers were keen to subscribe to it as it provides useful articles about various science topics.

#### February 2006 workshops.

The topic of Light was the focus for these workshops. In addition work on finding out children's ideas was carried out. This was felt to be important as there is considerable emphasis on using a constructivist approach in the Revised Primary Curriculum and finding out children's ideas is pivotal to this approach. Concept Cartoons are one method for finding out children's ideas. They are cartoon-style drawings which present a range of viewpoints about the science involved in everyday life. They provoke discussion among children on various scientific topics and stimulate scientific thinking. Teachers were introduced to cartoons related to the topic light. They were also shown books of concept cartoons with details of where to purchase same.

Packs with materials such as equipment, worksheets and assessment ideas were prepared for each of the fifteen schools. Three hands-on activities per class group were prepared and teachers worked in pairs as before, on the relevant activity for their class group. The format for the workshops followed the same pattern as in November with the topics covered this time being

- Themes explored in light in the Primary School
- Key concepts
- Classification of Materials
- Approaches to the topic of light
- Children's misconceptions about light
- How to address specific misconceptions
- Activities to teach about light
- Resources
- Concept cartoons.

#### Logistical problems.

There was a delay in receipt of some of the science equipment ordered from the science suppliers for the Light Workshop. This equipment was eventually posted out in packs to the fifteen schools before the Easter holidays.

The next science workshops were planned for May / June 2006. The topics to be covered were Forces and Simple Machines. However due to the birth of a daughter to the facilitator, this visit had to be postponed until the following academic year, October 2006.

#### **Year 3. Oct 2006 to Nov 2007**

##### October 2006

The fifteen schools were contacted and the programme for the year was outlined.





February 2007

Questioning is one of the skills listed at every level in the science curriculum. The curriculum states that children should be encouraged to ask questions that could form the basis of investigative work. However, often teachers interpret this part of the curriculum as being how they themselves ask questions. In this workshop it was decided therefore to concentrate on developing the children's questioning skills through the use of video.

The meeting began with an introduction to the video project, outlining the objectives of the project, the methodology, and how the video footage itself can be used as an evaluative process. Teachers discussed the project and asked questions to clarify any areas of difficulty.

Following this, a digital video camera was distributed to each school and the teachers spent time familiarizing themselves with the camera and how it is used. A short set of simple instructions on the use of the digital camcorder was compiled to assist the teachers.

The specific objectives of the video project were:

- To develop the science knowledge of senior and junior students through senior students tutoring the younger children.
- To develop the questioning skills of the children
- To measure the effectiveness of the above approach through the medium of digital video.
- To help teachers become more aware of their teaching and the structure of the process.
- To evaluate teaching of science concepts from the Strand 'Forces and Energy'.

Method:

The five topics dealt with in the October 2006 workshop, levers, gears, pulleys, hydraulics/pneumatics, and elasticity, were selected for the project along with light,

sound and electricity. It was decided that two topics should be taught before the next workshop.

The approach was as follows:

1. The teacher teaches a lesson to the senior class *e.g.* Pulleys.
2. Senior students (in groups of 3) discuss the lesson that was taught.
3. Senior students prepare a simple lesson on the same topic to deliver to a junior class.
4. A sample lesson on forces to assist the students in structuring the lesson and to guide their preparation was provided. (Submitted with lesson plans under separate cover)
5. A lesson plan template for the senior students to fill in was also provided. (Submitted with lesson plans under separate cover)
6. Best lesson' taught to a group of junior students.

Each lesson involved three parts:

- 'chat time',
- teaching the lesson,
- using the camera

The children took turns in each of these roles.

'*Chat time*'. This is the part of the lesson that is **videotaped**. The lesson topic is presented. Seniors pose a type of open discussion/question or problem in which the juniors participate by asking questions). The discussion/question could be drawn from a number of sources *e.g.* video, photographs, newspaper articles etc.

#### Video Analysis as a tool for Evaluation.

The purpose of using video analysis was to evaluate and analyse junior students' questioning prior to and following a lesson. The analysis will then hopefully provide pointers as to how to develop questioning skills. This in turn is a measure of how the

seniors developed the lesson and how effectively they were initially taught the same topic. Video analysis such as that described above could link with the idea of both lesson study and video study mentioned in Chapter 2, p.6.

#### June Meeting 2007

Although the video project was in itself an evaluative process, it was considered important that the teachers would provide direct feedback on the project themselves so this meeting began with a discussion based on the following guidelines and the teachers recorded their responses, which can be seen in Chapter 4, p.26 of this report.

The questions posed were:

- What did you think was the purpose of the lessons?
- Were the objectives achieved?
- What were the difficulties/problems with this method of assessment?
- How could you overcome these difficulties?
- What did you learn from the experience?

The teachers had noted previously the difficulty of eliciting questions from young children so it was decided to focus on children's questioning, how to create question-rich environments and how to model good questioning in the classroom. Articles on questioning skills by Wardle (2004) and Rutledge (2004) were sourced and provided to the teachers. Discussion centered round whether they, the teachers, considered that children's questioning is important in science. Different types of questions were considered such as explanation seeking questions and questions leading to investigations. The teachers were asked to post the recorded tapes to the facilitator for analysis.

#### October 2007

Analysis of the tapes received indicated that the teachers had not fully taken on board the issue of using children's questioning as a means of assessment. They found the idea of eliciting students' questions rather than answers as counter-intuitive and they expressed difficulty in coming to terms with the theory behind this idea. The difficulty became explicit in the way that they conducted the video-recorded activities. Therefore it was

decided to re-visit the issue of children’s questioning as an important aid to learning science, and the teachers agreed to video-record further lessons focusing especially on the junior students’ questions.

A teaching sequence was developed based on the work of Watts et al., (1997) for helping younger children ask questions. The sequence is based on grouping children (and so utilizes class organization as part of the learning environment) in a number of ways that allows children build their confidence with their peers and so aids the social construction of ideas. This sequence was presented to the teachers as follows:

<i>Organisation of students</i>	<i>Prompt by teacher / senior student</i>
Class group	Senior pupil ask opening question. “Can you all try to think of...”
Pair work	Share thoughts with a partner.
Fours	Find another pair. “Tell each other about...”
Class circle	Talk to each other about your ideas
Pair work	Now try to think of a question – something you might like to find out about. How might you answer your own question?
Individual:	Write down your question using words such as what, how and why to start the question. Share the question with the class.

More ideas on eliciting questions from young children were presented to the teachers involved in the project. These included the ‘Large question book’ by Watts et al., (1997), time for observation followed by ‘The Minute Game’ (Macro and McFall. 2004). Other suggestions included providing stimuli for questions such as photographs, pictures or real objects and creating a question-rich environment and helping to reframe questions that then could be investigated.

The teachers were also again given very specific instructions on the use of video recording as an aid to evaluating teaching and learning of science in the primary classroom. These instructions can be summarized as follows:

- Choose a topic for video lesson from the lessons you have taught the senior pupils.
- Senior pupils prepare lesson plan-focus on ways to elicit questions from junior pupils before lesson is taught.
- RECORD this Question Time. (3-5mins).
- Seniors teach the lesson.
- Repeat similar question time at the end as comparison. Also RECORD this Question Time.

The teachers were requested to post the tapes to the facilitator in a provided stamped addressed envelope before Nov 10<sup>th</sup> 2007.

## Chapter 4

### Evaluation and analysis

This is presented in three parts.

Year 1 -2004-2005

Year 2 –2005-2006

Year 3 – 2006-2007

### Year 1 -2004-2005

The Evaluation of Year 1 was two-fold:

(a) Evaluation of pupil learning.

(i) Attainment in science for first/second classes was measured using a 30-item objective-reasoning test. This science test was devised by collating individual questions from various topic-based tests from the Right2Learn™ website (<http://www.right2learn.co.uk>) devised for 7-8years. The test was repeated after the science activities were delivered, to determine whether any improvements in scientific conceptual knowledge had occurred.

(ii) An attainment in science for third/fourth/fifth/sixth classes was developed by selecting relevant items that were published by the TIMSS (Trends in Mathematics and Science Studies) (1999) assessment programme. These tests were also repeated after the science activities were delivered.

A number of control schools (Appendix 1) from various parts of the country were chosen. Children from these schools were tested to determine their science attainment also using a 30-item objective-reasoning test (1<sup>st</sup>/2<sup>nd</sup> class) and items from the TIMSS assessment programme (3<sup>rd</sup>-6<sup>th</sup> class). They followed the normal science curriculum over the course of the study and the attainment test was repeated at the same time as the experimental group post-test.

An innovative learning environment was developed that aimed to improve science attainment and the neurological process of sensory integration. The children followed a programme of fifteen sensory-based lessons, juxtaposed between a pre-test and post-test, that took place within the mainstream classroom and was cognisant of the Irish national curriculum. The first stage of the study was the sensory screening of all children, prior to the implementation of a programme of sensory-based science lessons. The instrument used was a shortened Sensory Profile (3SSP).(Dunn 1999). The sensory profile post-test results indicate that most students performed without difficulty in this area at a level typical for children and thus would not show an increase in their scores. However the results show a significant improvement in the sensory processing in three areas, touch processing, vestibular processing which relates to balance and modulation relating to body position and movement. This would indicate that sensory science lessons contributed to this improved performance. Full details of methodology and analysis of results can be seen in the paper *–Improving science through the senses of movement, touch and balance* (Appendix 11)

The statistical analysis of the science scores (a) paired two-tailed Student's t test assuming unequal variances and (b) mixed within between ANOVA showed a significant improvement in some of the groupings had occurred as had been hypothesized.

Figure 1 below shows the results obtained for 1<sup>st</sup> and 2<sup>nd</sup> class experimental and control schools.

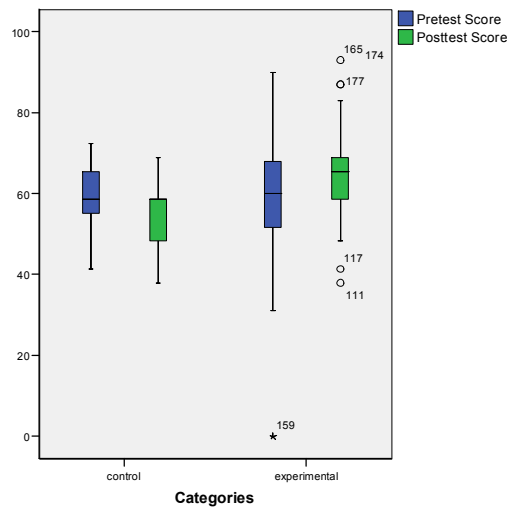


Figure 1. Clustered boxplot of 1<sup>st</sup> / 2<sup>nd</sup> results.

## Conclusion

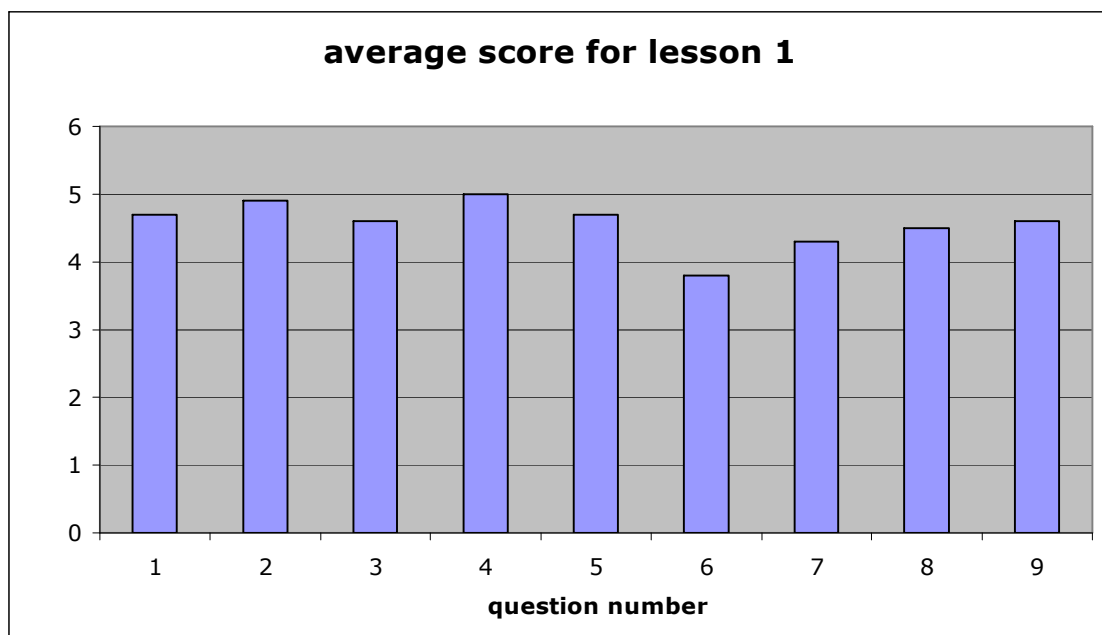
Whereas the pilot study showed a significant difference in the score of the experimental group over the control group and a significant effect for time (between the two administrations) – thus, attainment in the experimental group was improved – the population involved in the main study only showed a significant difference between the two groups and not over time i.e., pre-test to post-test. This may be explained by the fact that the control group was small and this affects the reliability of the statistic; also there may have been administrative issues such as teachers being rushed to complete the post-test (two classes of control groups failed to produce post-test data). It is however, worth noting that the intervention of sensory science lessons was the factor that separated the control from the experimental groups. The average score did improve for the experimental group, whereas it dis-improved for the control group. Naturally, a dis-improvement cannot be attributed to a lack of the intervention, but rather other factors including the issues mentioned already. The analysis of the results for classes 3/4 and 5/6 are presented in Appendix 4.



### **(b) Teacher Evaluation of the fifteen Sensory Science Lessons**

The teachers engaged in teaching the lessons were asked to complete evaluation sheets consisting of nine Likert scale questions plus one open-ended question. (See appendix 3). They were asked to complete one per lesson with the completion rate ranging from 6/15 to 15/15. The data was collated in an EXCEL spreadsheet.

Fifteen graphs were drawn by plotting the question number against the average score achieved as follows:



**Figure 2: Teacher evaluation for lesson 1.**

The response in Fig. 2 was typical of all the lessons with scores rarely falling below 3.5 for any of the questions. The graphs of scores for the remaining 14 lessons are presented in Appendix 5.

The open-ended question at the end of the questionnaire gave teachers an opportunity to write a comment on negative or positive aspects of the particular lesson. The following response for Lesson 1, Push me pull me, is typical of the responses of all fifteen lessons. The written responses for the remaining fourteen lessons are in Appendix 6.

### *Lesson 1-Push me pull me.*

A lot of the children come from farming, motor mechanic background so there was great interest in the lesson content and a very common sense and knowledgable feedback.(3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

Very exciting start. 3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

The children really enjoyed the games at the end of the lesson.

(junior/senior/1<sup>st</sup>/2<sup>nd</sup>/3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

The children loved this activity and some said it was their favourite one. (2<sup>nd</sup>/3<sup>rd</sup> )

The lesson took up too much time. Maybe it could be divided into two lessons. (4<sup>th</sup>/5<sup>th</sup> )

### Overall comment for year one.

All of the fifteen schools fully embraced the project and worked well in it. The participating teachers were hard-working, enthusiastic and committed. The attendance at meetings was very encouraging and continuous feedback to the programme was positive and informative.

The facilitator was very pleased that the resource teacher from one school attended the meetings and provided valuable feedback as to the efficacy of the programme for children with varied special needs whom she teaches.

### Children's learning

The sensory profile post-test results indicate that a number of students performed at a level typical for children without difficulty in this area and thus would not show an increase in their scores. The results show increases for approximately a fifth of the students. This would indicate that sensory science lessons contributed to this improved performance. The statistical analysis of the science scores showed a significant improvement had occurred as had been hypothesised. The science test scores improved for the experimental group significantly over the control group indicating that a marked improvement in children's conceptual knowledge had occurred. This could be due in part to heightened motivation. By adapting the existing science curriculum to allow for children's' desire to move and participate in activities that provide appropriate stimulation for the senses, sensory difficulties that create barriers to functional

performance can be redressed and learning enhanced for all the children. Full details of the statistical analysis are presented in Appendix 11.

Areas that teachers were especially pleased with during the year included language development particularly for infants. Development of questions and thinking skills were also mentioned by several teachers while many teachers remarked on how much science they themselves had learned. One of the resource teachers thought that the lessons were particularly good for children with special needs. She said they have become more confident, are able to ask more questions, have become more involved and that it is great for them. Another teacher thought the lessons would be very suitable for a child with ADHD.

On the negative side restriction in space in some schools was a problem but overall the teachers were very happy with the lessons.

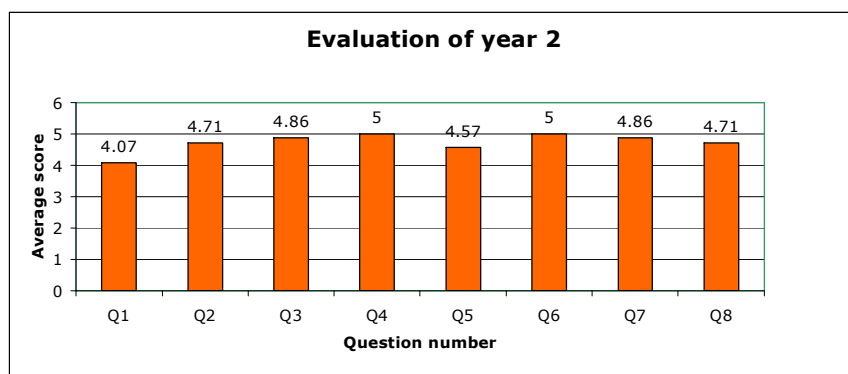
## **Year 2 –2005-2006**

Science Programme (Electricity, Light, Sound and Forces).

Results from Year 1 indicated that intervention in the form of dedicated science lessons contributed to the improvement of children's learning in science. It was decided therefore, in year 2, to concentrate on specific support for the teacher and to assess their opinion of this support.

To gather this information at the end of year workshop the teachers were asked to complete evaluation sheets. (See appendix 7). These consisted of eight Likert scale questions plus one open-ended question. There was one evaluation sheet relating to issues such as confidence levels in teaching science, provision of resources, usability of science handouts. Thirteen sheets were collected and the data once again collated in an EXCEL spreadsheet.

Graphs plotting the question number were plotted against the score achieved.



**Figure 3. Evaluation of lessons Year 2.**

The open-ended question at the end of the evaluation sheet gave teachers an opportunity to write a comment on negative or positive aspects of the programme as follows:

- This programme has been most helpful to me, and the variety of resources has been most beneficial-we are very grateful.
- The demonstrations during the science meetings are invaluable.
- Excellent initiative. Keep it going.
- Excellent, but a long drive after school.
- Delighted with all the resources/ materials made available. Thank you Sinead.
- The pressure of time and finding time for the lessons is the only negative factor.
- Project has been a very important element of teachers' preparation and experience-enhancement. Adds to teachers' professional development. Supply of resources vital and much appreciated.
- I found this programme informative, motivating, and helpful.

#### Overall comment for year 2

Traditionally one of the perceived areas of difficulty for teachers engaging with science is their lack of background knowledge of the physical sciences and their lack of confidence in teaching topics relating to physics in particular. As can be seen from the evaluation graph and the comments above, the year's intervention has greatly assisted the teachers.

However it is interesting to note that the score for question 1, how they rate their confidence in teaching light, electricity and sound, is the lowest of all the scores..

### **Year 3 – 2006-2007**

In October 2006 a workshop was held on the Strand Unit Forces. This had been held over from the previous academic year. It was envisaged that this strand unit would be used as part of the work on video analysis. This was selected as the method of assessment and evaluation of the science programme for year 3.

It was decided to focus on children's questioning and to use senior pupils to tutor junior pupils. In the analysis of the S2JT (senior to junior tutoring) phases, there could potentially be a number of types of questions, but the one that was felt most important was the type of question posed by junior students. This was with a view to probing their understanding of a science topic. The evaluation therefore consisted of the analysis of the junior students' questioning. This in turn was a measure of how the senior students developed the lessons and consolidated their learning and also how effectively they initially were taught the topic. (See Appendix 10 for full details, analysis and results)

#### **Informal evaluation of the video project by the teachers.**

- Sixth class enjoyed being the teacher and helping the younger ones with difficult concepts! The purpose was to find out what the senior pupils knew and the benefit of video as an educational tool. All the children wanted to use the video camera. It was good to see how helpful and encouraging the senior pupils were.
- The teacher of the senior pupils had to have input in the lesson / lesson plan.
- Some children are camera shy. A novel situation-the video camera on the children. A small audience involved and limited audience response. Good way of testing senior pupils' teaching skills. The objectives set by the teacher were achieved. There is a further need to develop questioning skills.

- Teachers spent a lot of time preparing the lesson with senior children. The purpose of the lessons was to see the seniors' understanding of concepts and then being able to share knowledge/ experience. We thought our objectives were achieved but need to develop questioning skills. There are huge organizational implications and difficult learning to use the video. Regular use would overcome these difficulties. It was a great learning experience. Children very imaginative and keen to explore subject further.
- Time consuming. Like anything the approach suited some and not others. Some of the senior boys enjoyed it, others didn't. Some initial confusion-teachers not exactly sure what was required. We learned a bit about the camera which was great. It became a bit difficult to keep the lesson fresh and spontaneous.
- The sixth class students were really interested in the video camera and couldn't wait to use it. They were enthusiastic about teaching the lesson. The purpose of the lesson was to see the effectiveness of the video as an educational tool. The difficulties were that the sixth class students weren't familiar with video cameras. They practiced with the video camera before the lesson. I felt that they were self conscious when teaching the lesson. It was of benefit to both senior infants and sixth class.
- Senior students enjoyed it though a certain amount was false. It was a good way to find out what they know. The seniors tended to be self conscious on camera which hindered their performance.

### Overall comment for year 3

The teachers were introduced to the idea of utilizing the children's questions as a means of enriching the learning situation. This proved challenging as traditionally, children are asked questions and their own questions tend to be procedural or seeking clarification. An innovative approach involving different age-groups had the added dividend of being applicable to the multi-phase classroom. Both children and teachers enjoyed this approach and found it an effective method of evaluating both teaching and learning.

## Chapter 5

### **Conclusions and future directions**

The recent McKinsey report by Barber and Mourshed (2007) on how the world's best-performing school systems come out on top, suggests that these systems consistently do three things well: (1) They get the right people to become teachers; (2) They develop these people into effective instructors; (3) They put in place systems and targeted support to ensure that every child is able to benefit from excellent instruction. Bearing these pointers in mind how do we fare with regards to the teaching of science in Irish primary school?

1. Irish primary school teachers are of a consistently high standard so it is probably safe to conjecture that the right people are becoming teachers.
2. Do we develop these people into effective instructors particularly in science? The present system, in Colleges, where students study to become primary school teachers, provides very little instruction in science, either content or pedagogy. At best students receive about 48 hours instruction in science to cover both content and pedagogy. It is no wonder therefore that the majority of teachers do not feel confident about teaching science in the classroom which makes an intervention like the one in Kerry of paramount importance.
3. Putting in place systems and targeted support to ensure that every child is able to benefit from excellent instruction in science is probably not a priority in many schools. Intervention such as that delivered in Kerry over the last three years and particularly in the first year, with the sensory integration lessons, is one method by which this might be achieved.

### Disadvantages to this method of working.

While visits to each of the fifteen schools is a meaningful and effective form of contact, particularly at the initial stages of a project, it is a more effective use of facilitator time

for teachers to travel to a central location. This cuts down on travelling time and cost and reduces disruption of classes.

This method of promoting science in schools involves commitment on the part of the teachers where they are requested to drive to central locations after a school day. Some were travelling approximately 40 miles to get to the sessions. This is the reason that the number of workshops in the year was limited in number and each workshop lasted only two hours. Furthermore only a finite number of topics could be covered given these time constraints.

Some teachers seem to have poor IT skills, as only one teacher availed of email to communicate, therefore a whole avenue of communication was lost. Communication depended on sending letters, or phoning teachers in the schools, which is an inefficient method of communication.

Because science resources were ordered in large quantities (for 15 schools), it proved difficult to transport resources by car due to the sheer size and weight of the boxes. It often took a number of weeks for the orders to be filled. Outstanding equipment then had to be sent on to schools under separate cover.

#### Will teachers need ongoing help in science?

Confidence levels of teachers in their ability to teach science vary considerably so in terms of intervention in the future “one size does not fit all”. Many teachers have increased confidence levels post intervention, as evidenced by their comments, and realize that that it is not just a question of having scientific factual knowledge to teach well. However others still feel inadequate due to a lack of content knowledge in the subject matter and look for an “expert” in the field of science to come in from outside. This idea would have to be approached with caution as such ‘experts’ would need to have classroom experience and a sound pedagogical background.



The Primary Curriculum Support Programme (PCSP) has completed the national inservice programme in science and currently is considering what subjects should be the focus of future professional development for teachers. A reduction in the provision of cuiditheoirí is expected through the grouping of subjects and this may not provide adequate support in science.

Overall it would seem that teacher confidence in science needs on-going development as evidenced by the score for Year 2 evaluation (p 24).

#### How might this be achieved?

This might be achieved through the provision of short evening courses on particular areas of difficulty. Although some teachers need help at a basic level, it should also be noted that others are teaching science to a high standard.

If links to other schools were established, teachers of similar type classes would have opportunities to share science experiences and pool ideas. Clustering of schools, particularly in rural areas, could be important here. However it would be important that IT skills were improved and IT facilities were available. This is not the case in all schools as yet.

The positive response of the senior pupils to their role as teachers of junior pupils in the video project suggests that this might be an area for development. The teaching of junior pupils by senior pupils is sometimes referred to as peer tutoring or a Buddy system. There have been a limited number of studies in this area and some of the studies suggest that it increases the amount of science being taught in a school. A study by Duffy (2007) also showed that peer tutoring improved children's attitudes to science.

A more fundamental development which might have long term benefits would be the provision of more science education in the colleges of education. The development of a three year science education course would facilitate this.

### **In Summary**

The research project described here was undertaken to identify whether science intervention in primary schools could help children improve their science learning and could help teachers improve their science teaching skills.

The results were positive in both cases. In addition many teachers now feel more confident and enthusiastic about teaching science as reflected by the fact that ten of the teachers wish to continue studying science in order to gain a certificate in science education.

We would recommend similar interventions in other schools particularly in rural areas where access to education centres is difficult and where schools may be isolated.

Methods such as video study, peer tutoring and clustering of schools should be investigated further to examine their effectiveness.

We would also recommend increasing the amount of science education in colleges of education. A three-year science education course would go some way to ensuring that future teachers are effective and confident teachers of science in the primary school.

**Paula Kilfeather**

**Sinéad O'Reilly**

**St. Patrick's College**

**December 2007**

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## Appendix 1.

### List of schools

SCHOOL	PRINCIPAL
Tulloho Bonane Kenmare	Cáit Ní Néill 064-41977
Lauragh NS Tuosist Killarney	Mary O'Shea 064-83578
Scoil Realt na Mara Tuosist Killarney	Cian O' Siochru 064-84504
Kilgarvan NS Kilgarvan Killarney	Sean O' Doherty 064-85428
Scoil an Fháill Mór Foilmore Cahersiveen	Mary Murphy 066-9472646
S.N Phroinnsias Naofa Kenmare BNS, Kenmare.	Mary O' Sullivan 064-42300
St Clare's NS Kenmare	Dennis Courtney 064-42598
Cahir NS Cahir Kenmare	Noreen Hanly 064-42244

Gap Of Dunloe NS Beaufort Killarney	Mairín Finnegan 064-34716
Scoil Naomh Michael An t-Snaidhm Killarney	Tim O' Sullivan 064-45000
Scoil Eoin XX111 Tahilla Sneem	Johanna Galvin 064-45561
Boheeshill MXD NS Glencar Killarney	Eileen Magann 066-9760996
SN Muire Gan Smál Coars Cahersiveen	Marian Murphy 066-9472647
SN Cillín Liath Maistir Gaoithe Cahersiveen	Dennis Fenton 066-9474474
Portmagee NS Portmagee Cahersiveen	Kathleen Lynch 066-9477211

### **Location of the workshops.**

The workshops were conducted at two central locations:

(a) The Brooklane Hotel, Kenmare for the following schools:

East Cluster Group

S.N.Phroinnsias Naofa.

St. Clare's N.S.

Cahir N.S.

Tulloho N.S.

Lauragh N.S.

Scoil Realt na Mara.

Kilgarvan Central School.

Gap of Dunloe N.S.

Scoil Naomh Michael.

Scoil Eoin XX111

(b) The Daniel O'Connell Hotel, Cahersiveen for the following schools:

West Cluster Group

S.N. Cillín Liath.

S.N. Muire Gan Smál.

Scoil an Fhail Mór.

Boheeshill N.S.

Portmagee N.S.

### **Control schools**

School	Principal / Teacher	Classes
Glasnevin NS., Dublin 9	Heather Evans	1 <sup>st</sup> class 2 <sup>nd</sup> class
St. Phelim's School, Cavan town	Maura Maguire	2 <sup>nd</sup> class
Stratford-on- Slaney N.S., Co. Wicklow	Mary o'Keeffe	2 <sup>nd</sup> 3 <sup>rd</sup> 4 <sup>th</sup>
Coole N.S. Co. Westmeath.	Proinnsias o Fearghail	3 <sup>rd</sup> /4 <sup>th</sup> classes 5 <sup>th</sup> /6 <sup>th</sup> classes



St Patrick's BNS Portrane Rd., Donabate. Co. Dublin.	Anne marie Hennigan 01-8436168 Fax as above Miss Hughes  Mr Hyland  Mr Ryan	1 <sup>st</sup> class  3 <sup>rd</sup> /4 <sup>th</sup> class  5 <sup>th</sup> class
Drumcondra NS. Church Avenue, Drumcondra D9	Beryl Healy	3 <sup>rd</sup> /4 <sup>th</sup> classes 5 <sup>th</sup> /6 <sup>th</sup> classes
Queen of Ireland N.S. Toberburr St. Margaret's Co Dublin	Joseph Crowe Phone 01 8404629	3 <sup>rd</sup> /4 <sup>th</sup> classes 5 <sup>th</sup> /6 <sup>th</sup> classes
St. Nicholas of Myra N.S., Kinsealy, Co. Dublin.	Mairead ní Dhoctartaigh Phone 01 8464033	5 <sup>th</sup> /6 <sup>th</sup> classes
Collinstown N.S., Co Westmeath.		3 <sup>rd</sup> /4 <sup>th</sup> classes 5 <sup>th</sup> /6 <sup>th</sup> classes

## Appendix 2

### Sample Lesson Plan

<b>ACTIVITY: 3</b>	<b><i>Stepping Stones.</i></b>
<b>SCIENCE STRAND:</b>	<b>Materials</b>
<b>STRAND UNIT:</b>	<b>Properties &amp; Characteristics of Materials</b>
<b>CURRICULUM OBJECTIVES</b>	
<ul style="list-style-type: none"><li>• identify and investigate a range of common materials used in the immediate environment.</li><li>• describe and compare materials, noting the differences in colour, shape and texture.</li></ul>	
<b>SCIENCE SKILLS</b>	
<ul style="list-style-type: none"><li>• Questioning</li><li>• Observing</li><li>• Planning</li><li>• Communicating</li></ul>	
<b>SENSORY INTEGRATION ASPECTS OF THE ACTIVITY</b>	
<ul style="list-style-type: none"><li>• Pressing the hands, bare feet, and body on different textured materials develops tactile awareness and discrimination</li><li>• Judging the distance between one material and the next improves attention and visual-spatial perception.</li><li>• Travelling from one material to another involves balance, movement, proprioception and motor planning.</li></ul>	
<b>EQUIPMENT</b>	
A variety of materials of various colour, shape and texture:	
<ul style="list-style-type: none"><li>• Carpet squares.</li><li>• Large swatches of velvet, corduroy, satin, chiffon.</li><li>• Sheepskin or fake fur.</li><li>• Foam Packaging.</li><li>• Chenille bedspread.</li><li>• Pillowcases filled with beans or other substances.</li><li>• Foam pieces.</li><li>• Large sheets of bubble wrap.</li><li>• Corrugated cardboard or sandpaper.</li><li>• Wooden blocks</li><li>• Plastic sheets.</li><li>• Large storage box.</li><li>• Whistle</li></ul>	

13

## ORGANISATION

Groupwork.

## WARM UP

### The Shakes and Wiggles.

Put wiggles up each arm – touching arm with fingers.

Wiggle arms-up then down.

Shake out the wiggles.

Repeat with legs-place wiggles from below with hand.

Repeat with mouth.

## VON SENSE ACTIVITY OUTLINE

↑ T ? N G

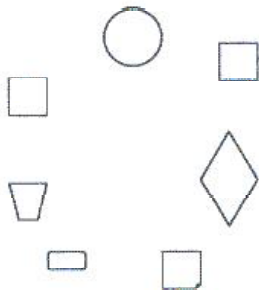


Figure 3.1 Suggested activity layout of materials



Figure 3.2 Stepping stones underway with 1<sup>st</sup> class.

Lay the materials in 5 circles close together with approximately 7 items per circle.(see photograph above)

As the children gain confidence, move the materials further apart to encourage stretching and jumping.

Allow children to remove their shoes and socks.

## TASKS.

T

1. **Walk** or **jump**, forward, backward or sideways, from one textured item to another.

When the whistle blows the children must **FREEZE** on one material, answer the questions in relation to the material the child is on.

### **QUESTIONS DURING FREEZE.**

**?**

#### **Jnr Infants – 2<sup>nd</sup> Classes**

Describe the material you are standing on.  
(shape, colour, texture)

#### **3<sup>rd</sup> / 4<sup>th</sup> Classes**

Describe the material you are standing on.  
(Physical properties: colour, texture, 'bendability', 'stretchability', 'squashability')

#### **5<sup>th</sup> / 6<sup>th</sup> Classes**

Describe the material you are standing on.  
(Physical properties: colour, texture, does it bend, stretch, squash, dissolve, insulate. Chemical properties: does it burn, go off, decay, be destroyed in sunlight)

#### **All Classes**

Each child should compare their material with another child's e.g., the one next to them. (noting differences/similarities as listed in the questions above appropriate for specified age-groups)

### **QUESTIONS**

**?**

- Where have you seen this material before?
- What was it being used for?
- Can you think of 2 reasons that it was chosen for that purpose?
- What do you think made it a good choice for this use?
- Can you think of anything better to do that job?

## NEW WAYS TO MOVE

**N**

1. Move on the materials as above using hands **and** feet.
2. Can you find new ways to move using other body parts?
3. Children get down on the floor and roll or crawl over the 'stepping stones'.
4. Could you move looking at the ceiling?
5. Try to walk very quietly over the 'stepping stones' so as not to disturb the sleeping giant.
6. Could you move and concentrate on what you can feel through your fingertips?
7. When the whistle blows children freeze. Choose child to state which material they like/dislike the feel of and why.

## GAME: Material Types

**G**

- Place all materials in a large circle.
- Children move around the 'stepping stones' in whatever way they like.
- Teacher calls out material properties and those standing on named ones have to sit out.
- Teacher can use more complicated properties as appropriate to the age group using the list in the questions above. The game could also be done as a version of 'Simon/O'Grady Says'

e.g.: *All those standing on bendy materials sit out*  
*All standing on hairy materials sit out*  
*All standing on woven material sit out*  
*All standing on bumpy material sit out*

Continue until one child remains.

### Appendix 3

#### Form for evaluation of Year 1

Specific Evaluation of Lessons  
(Please complete for each lesson)

Lesson number:

Class group/s

How long did you take to complete the lesson? (approx)

How suitable was the lesson for your class group/s?

				
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Did you feel that this lesson was a useful component to the overall scheme?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

Were you satisfied with the learning outcomes?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

Did the children enjoy the lesson?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

Would you do this lesson again?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

How difficult was it to organize/manage  
the physical resources for this lesson?

Did the lesson cater for children with  
special needs/learning difficulties?

Did you find learning was enhanced  
as a result of the movement/sensory  
lessons?

Overall were you happy with the lesson?

Comments/ positive/ negative aspects of the lesson:

## Appendix 4

### Class Analysis

Mixed between-within analysis of variance (Mixed ANOVA)

**Table 1. Descriptive Statistics for 1<sup>st</sup>/2<sup>nd</sup> class**

	TYPE	Mean	Std. Deviation	N
PERCENT1	control	58.62	10.229	11
	experimental	59.36	11.529	167
	Total	59.31	11.428	178
PERCENT2	control	53.61	10.037	11
	experimental	64.60	8.623	167
	Total	63.92	9.081	178

(i) Multivariate tests:

(a) The Interaction effect.

Before we looked at the main effects we assessed the interaction effect. Was there the same change in scores over time for the two different groups; (control and experimental)? The value we are interested is Wilks' lambda, sig.of 0.004 (<0.05) and thus the interaction effect is significant. The effect size is moderate (partial eta squared = 0.045).

(b) Main effects

Then we assessed the main effects for the independent variable. The value for Wilks' lambda for score is 1.000, with a probability value of .951 (>.0005) and thus we can conclude that there is not a statistically significant effect for time.

(ii) Between-subjects effect



The sig. value is 0.027 (<0.05), so we can conclude that the main effect for the 'type'(experimental and control) is significant. The effect size is 0.028 (almost 3%), so we can conclude that it is a medium effect.

### (iii) Boxplots

Clustered boxplots were drawn using SPSS

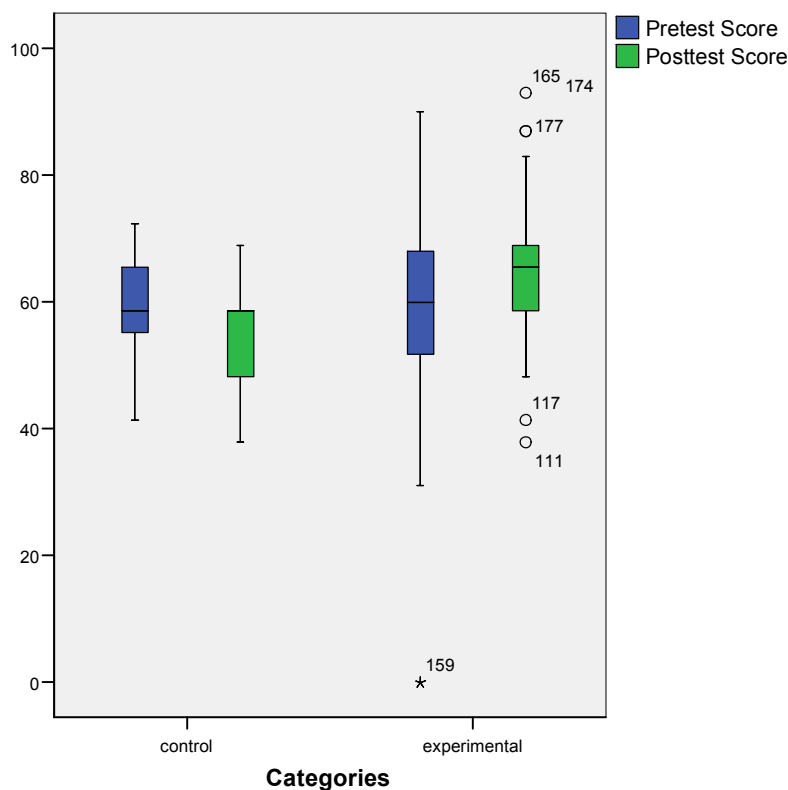


Figure 1. Clustered boxplot of 1<sup>st</sup> / 2<sup>nd</sup> results.

### Conclusion

Whereas the pilot study showed a significant difference in the score of the experimental group over the control group and a significant effect for time (between the two administrations) – thus, attainment in the experimental group was improved – the

population involved in the main study only showed a significant difference between the two groups and not over time i.e., pre-test to post-test. This may be explained by the fact that the control group was small and this affects the reliability of the statistic; also there may have been administrative issues such as teachers being rushed to complete the post-test (two classes of control groups failed to produce post-test data). It is however, worth noting that the intervention of sensory science lessons was the factor that separated the control from the experimental groups. The average score did improve for the experimental group, whereas it disimproved for the control group. Naturally, a disimprovement cannot be attributed to a lack of the intervention, but rather other factors including the issues mentioned already.

Results of 3<sup>rd</sup> / 4<sup>th</sup> class analysis

**Table 2. Descriptive Statistics for 3<sup>rd</sup>/4<sup>th</sup> class**

		Mean	Std. Deviation	N
PERCENT1	control	57.5413	17.36711	101
	experimental	55.0838	18.32314	179
	Total	55.9702	17.99172	280
PERCENT2	control	62.1617	19.36964	101
	experimental	71.8575	16.56024	179
	Total	68.3601	18.19875	280

Mixed between-within analysis of variance (Mixed ANOVA)

(i) Multivariate tests:

(a) The Interaction effect.

Before we look at the main effects we need first to assess the interaction effect. Is there the same change in scores for third and fourth classes over time for the two different groups? (control and experimental). Wilks' lambda, sig.of .000 (<0.05) and thus the interaction effect is statistically significant. The effect size is large (partial eta squared = 0.143).

(b) Main effects

Now we assess the main effects for the independent variable. The value for Wilks' lambda for score is .660, with a probability value of  $<.0005$ ) and thus we can conclude that there is a statistically significant effect for time. Partial Eta Squared is .340 which suggests a very large effect size.

(ii) Between-subjects effect

The sig. value is 0.075 ( $>0.05$ ), so we can conclude that the main effect for the 'type'(experimental and control) is not significant.

(iii) Boxplots

Clustered boxplots were drawn using SPSS

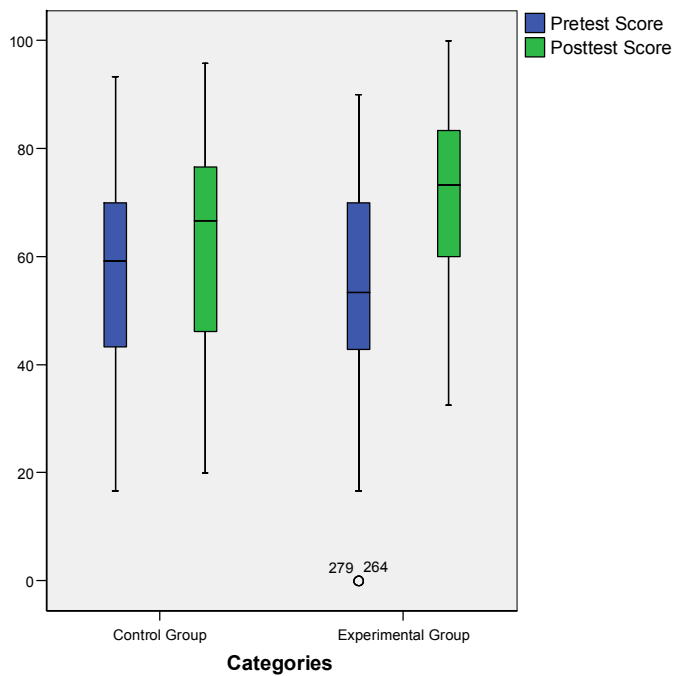


Figure 1. Clustered boxplot of 3<sup>rd</sup>/4<sup>th</sup> results.

Conclusion

The third and fourth class population involved in the main study showed a similar change in scores between the two groups over time i.e., pre-test to post-test. We found a statistically significant effect over the two time periods so we assessed the effect size and found it to be very large so there was a change in scores across the two time periods. It is noteworthy that the control group mean score was higher in the pre-test suggesting that some other factor was at play that has not been identified.

The average score did improve for both groups, though a bigger improvement can be seen in the mean of the experimental group. However this improvement was not statistically significant.

Results of 5<sup>th</sup>/6th class analysis

**Table 2. Descriptive Statistics for 5<sup>th</sup>/6th class**

**Descriptive Statistics**

Type	Mean	Std. Deviation	N
PERCENT1 control	59.7222	14.63396	129
experimental	60.8631	16.83770	84
Total	60.1721	15.51155	213
PERCENT2 control	63.9147	16.65970	129
experimental	72.7282	16.92488	84
Total	67.3905	17.27319	213

Mixed between-within analysis of variance (Mixed ANOVA)

(i) Multivariate tests:

(a) The Interaction effect.

Before we looked at the main effects we needed first to assess the interaction effect. Is there the same change in scores for fifth and sixth classes over time for the two different

groups? (control and experimental). Wilks' lambda is .933 with a sig value of .000 (<0.05) and thus the interaction effect is statistically significant. The effect size is moderate (partial eta squared = 0.067).

(b) Main effects

Now we assess the main effects for the independent variable. The value for Wilks' lambda for time is .761, with a probability value of <.0005 and thus we can conclude that there is a statistically significant effect for time. Partial Eta Squared is .239 which suggests a large effect size.

(ii) Between-subjects effect

The sig. value is .016 (>0.05), so we can conclude that the main effect for the 'type' (experimental and control) is significant. Partial eta-squared value (the effect size) for this result is .027 which is a medium effect.

(iii) Boxplots

Clustered boxplots were drawn using SPSS

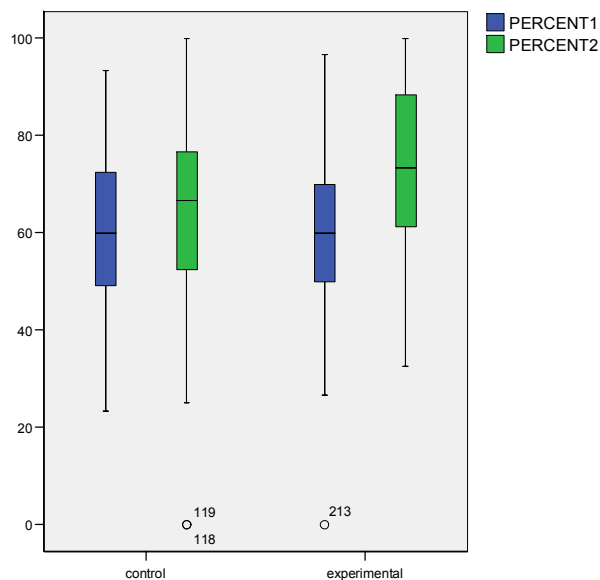


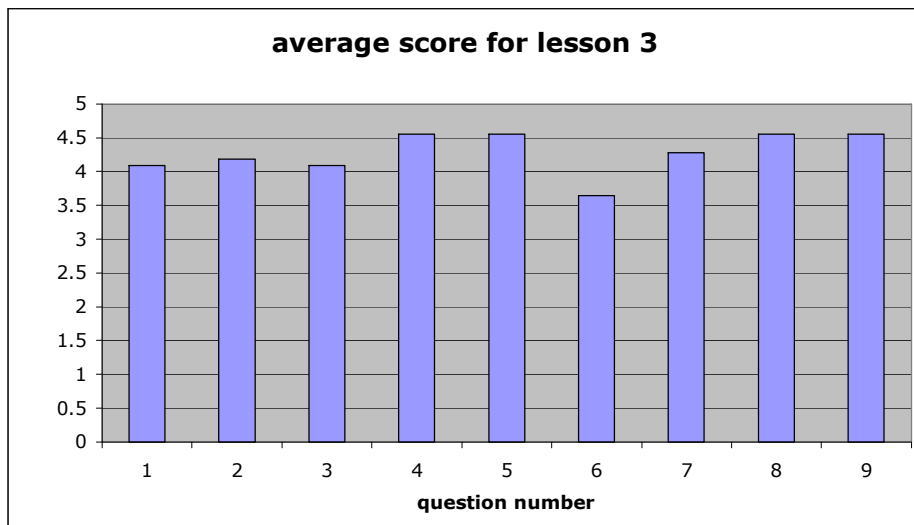
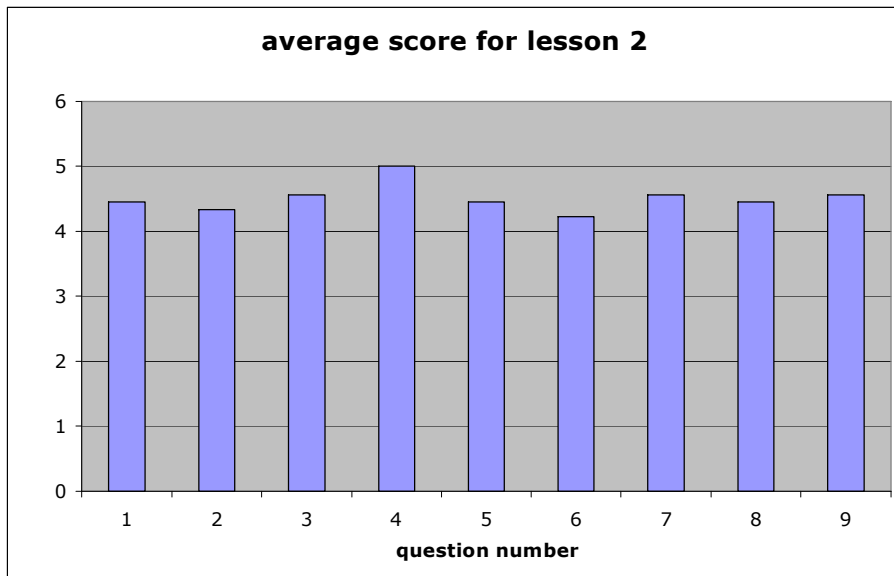
Figure 1. Clustered boxplot of 5<sup>th</sup>/6<sup>th</sup> results.

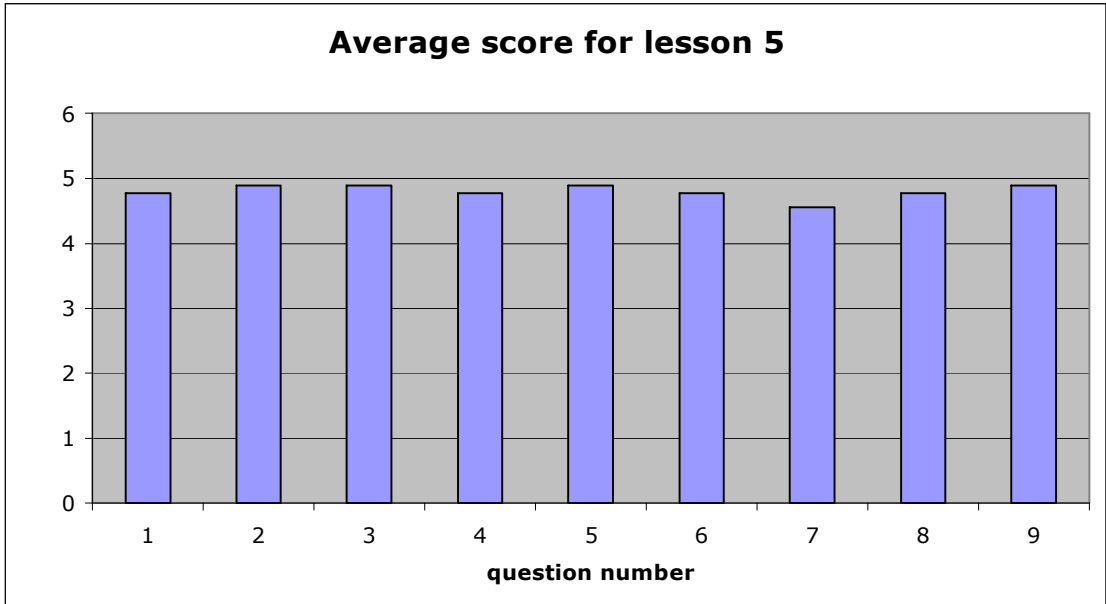
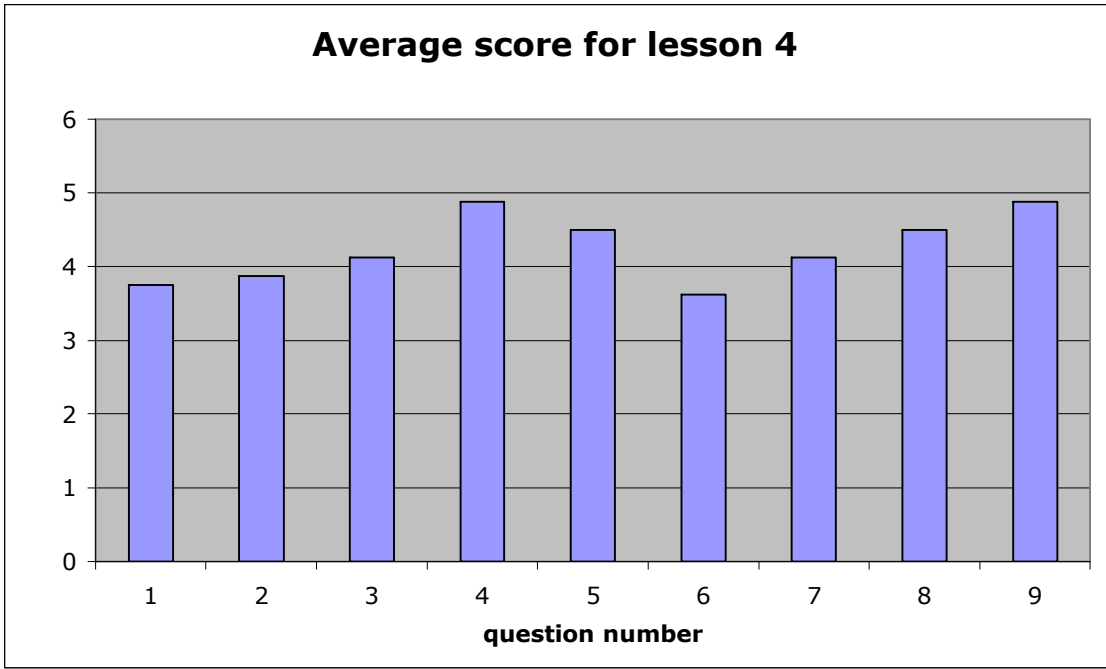
## Conclusion

The results of the study to evaluate the effect of sensory science lessons on scientific attainment in 5<sup>th</sup> and 6<sup>th</sup> class were very encouraging as demonstrated by the statistical test (mixed within -between analysis of variance (Mixed ANOVA). The statistical analysis of the science scores of the two classes showed a significant improvement had occurred in the experimental group compared with the control group. Interestingly the proposed model of sensory science lessons initially had a younger target group in mind but feedback from teachers confirmed that the sensory science model also has potential for improving senior students' conceptual understanding as is borne out by the results here.

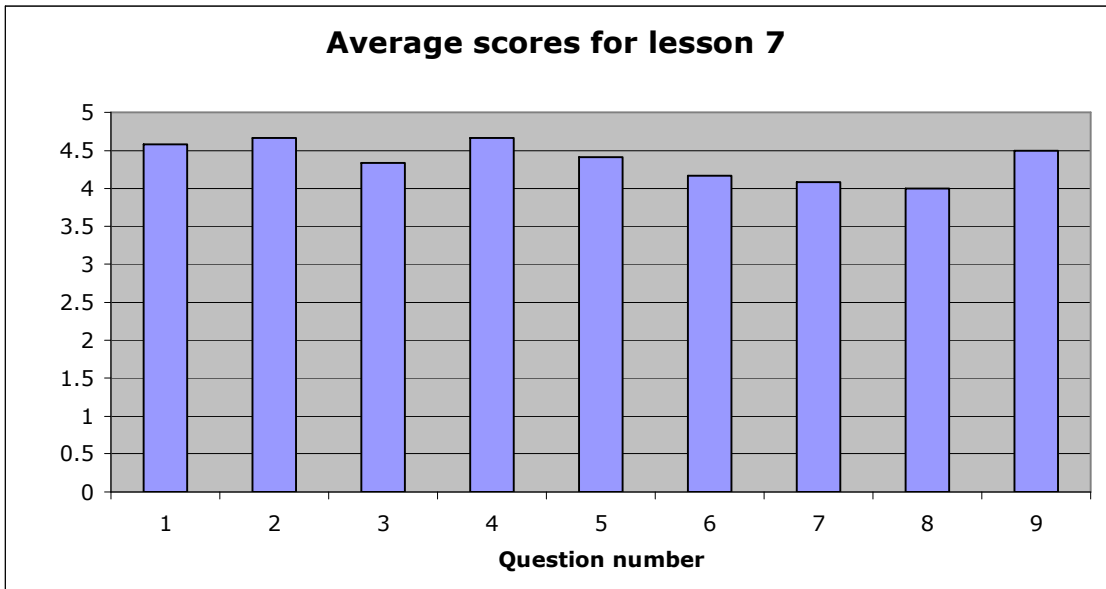
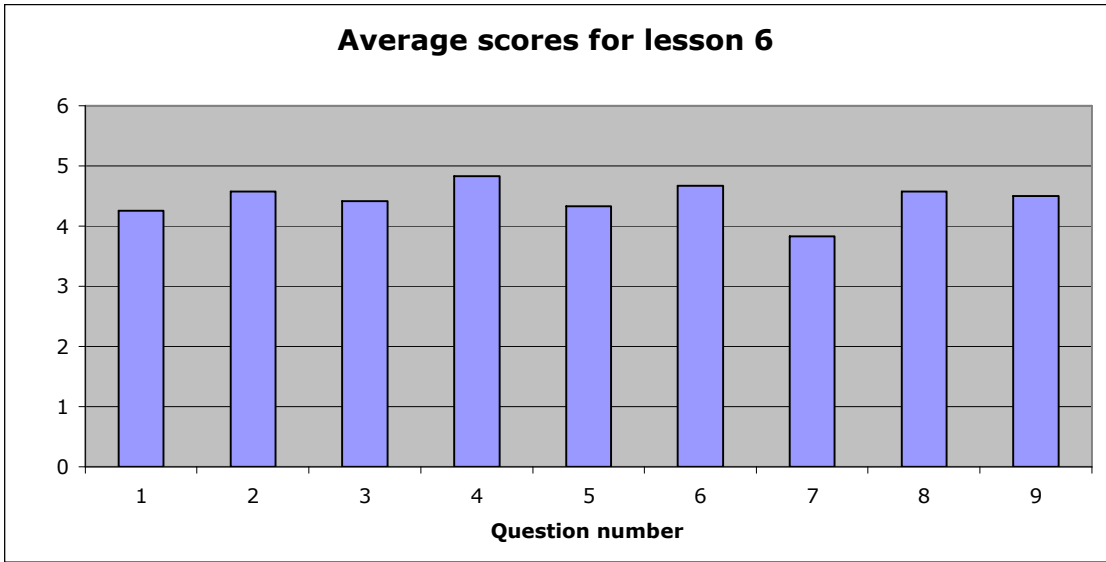
## Appendix 5

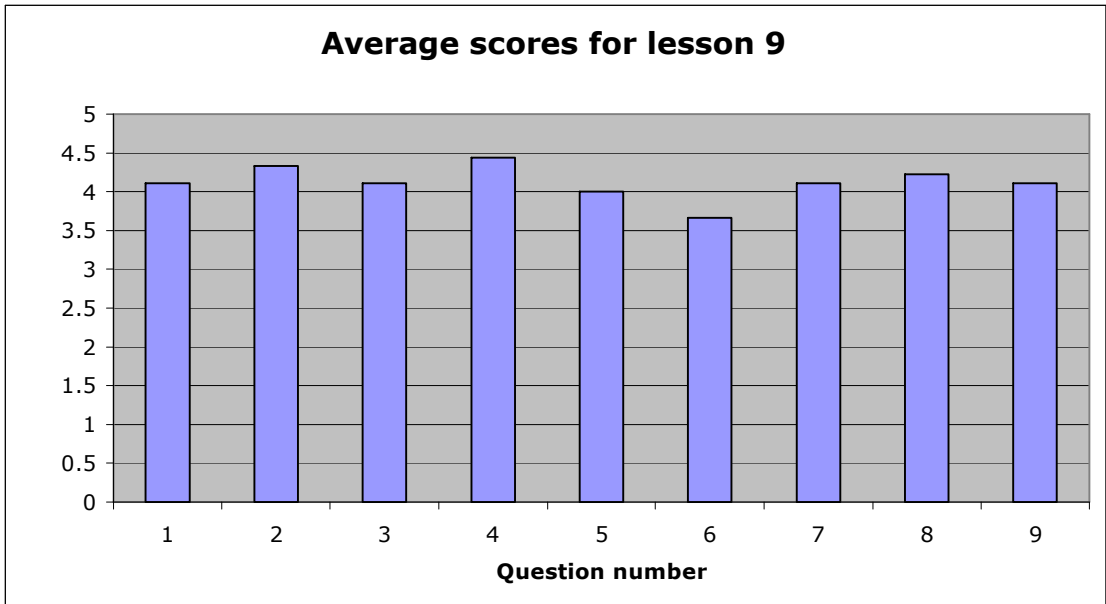
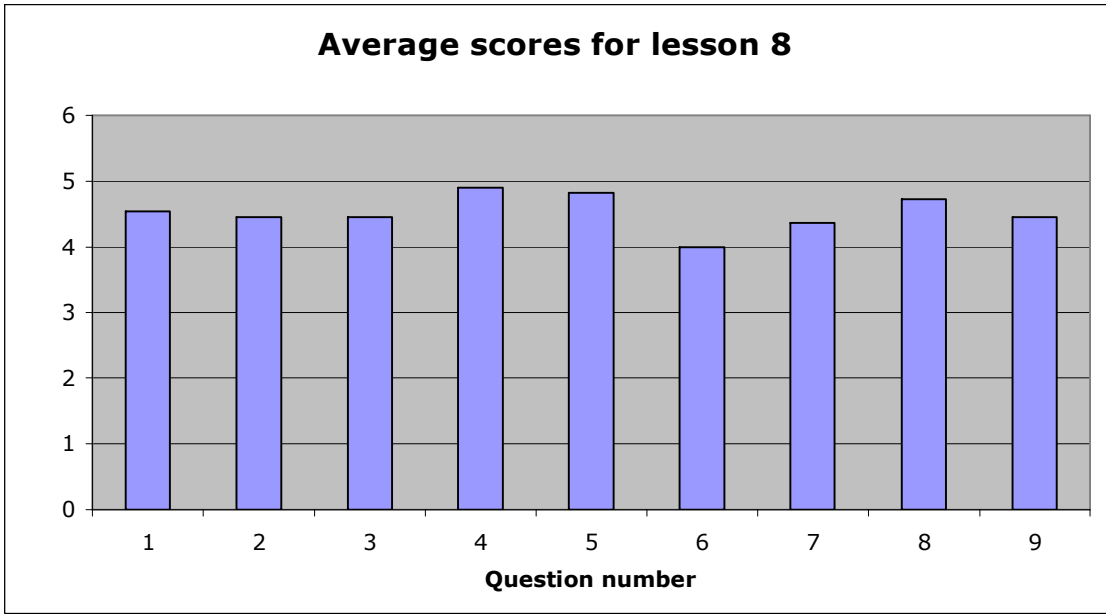
### Teacher Evaluation of the Sensory Science Lessons, numbers 2 to 15.

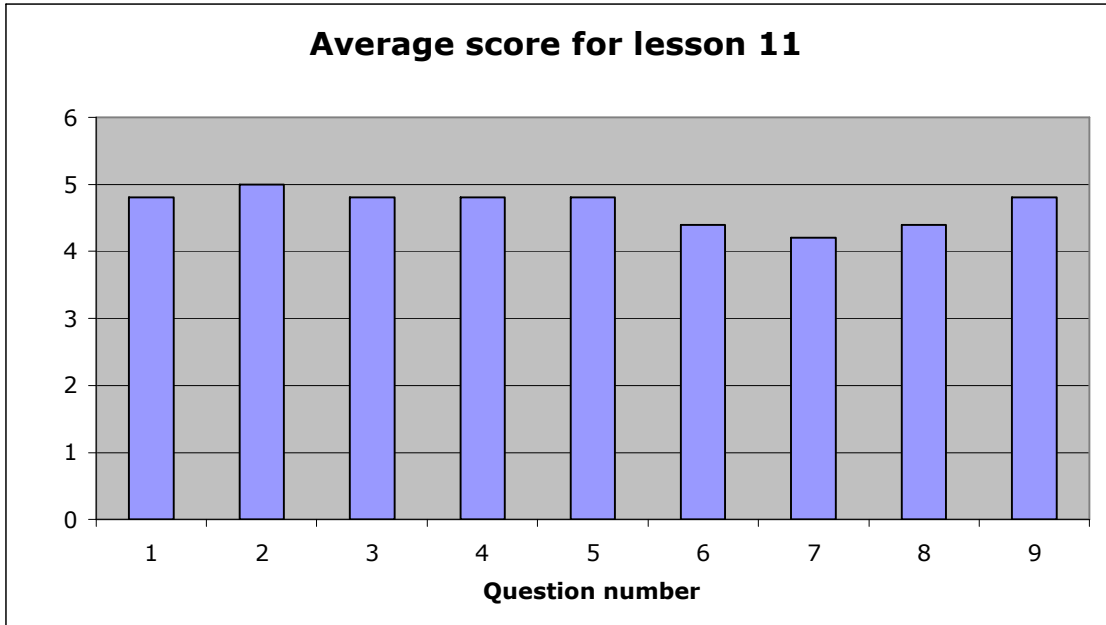
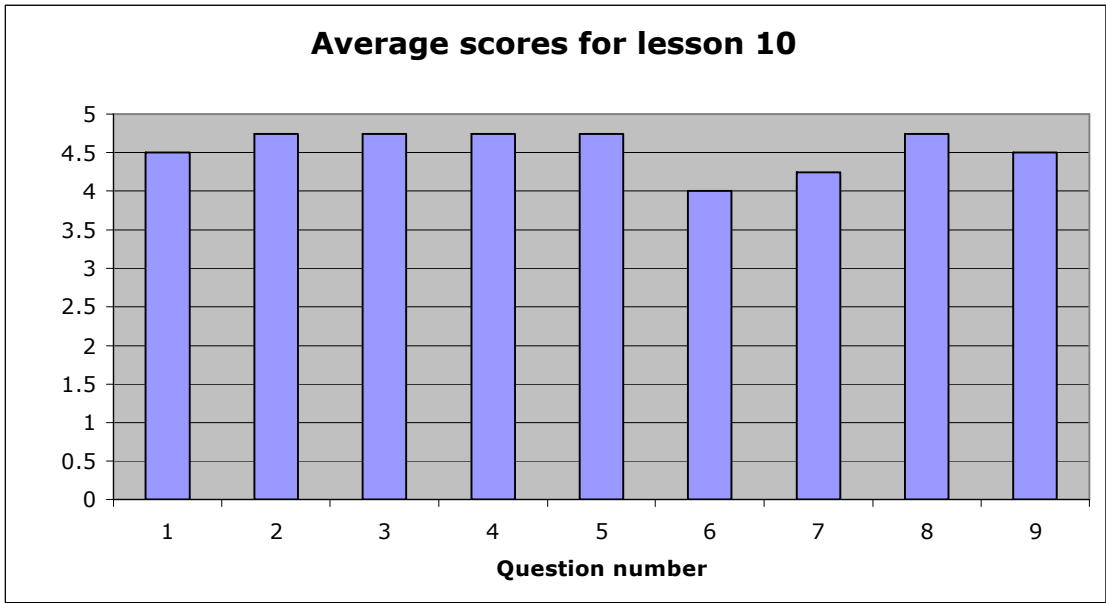


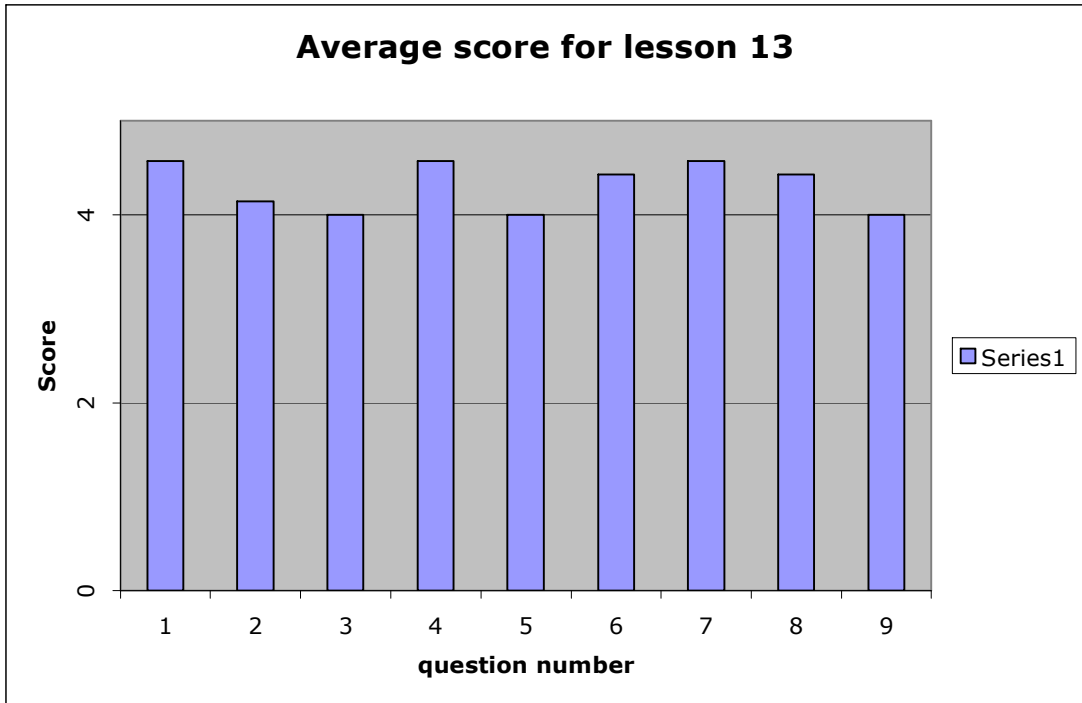
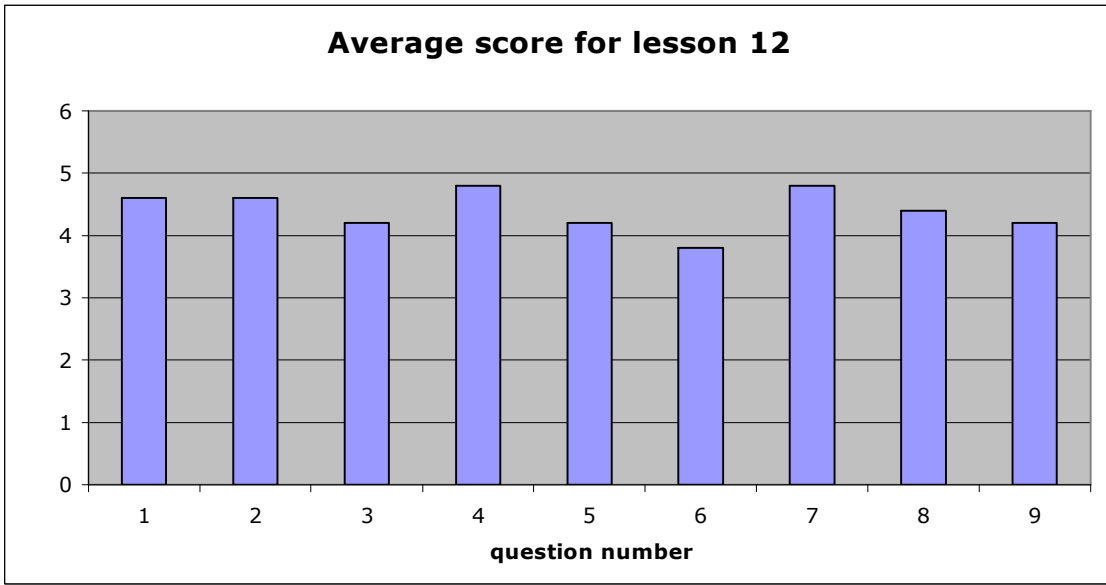




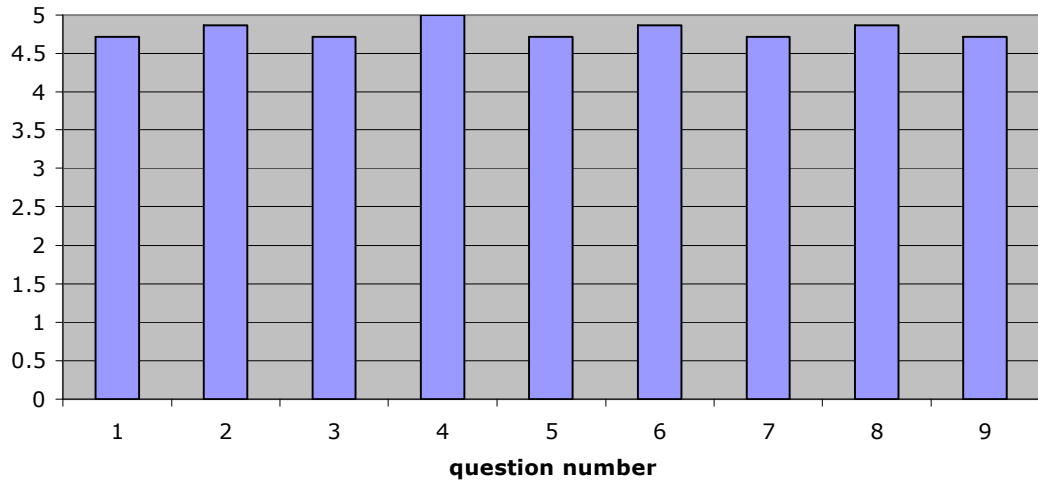




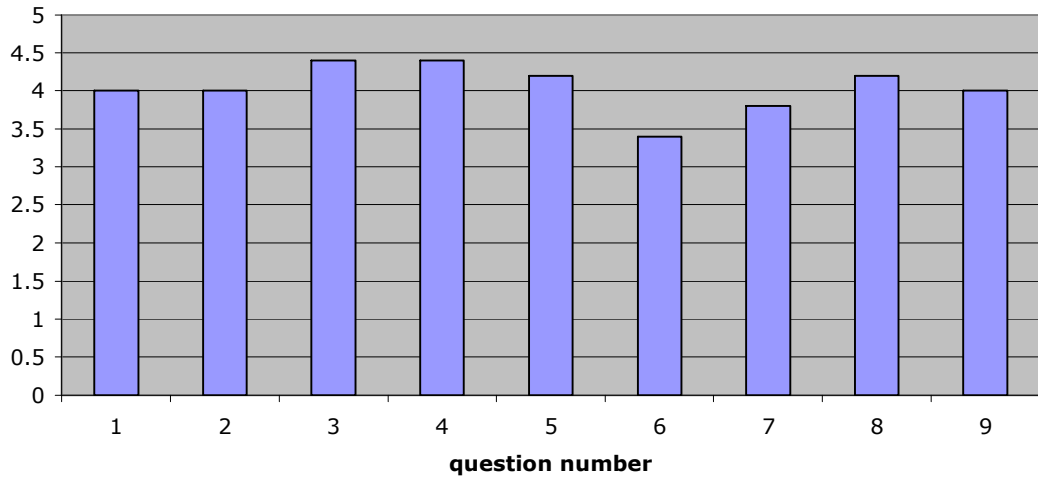




**Average score for lesson 14**



**Average score for lesson 15**



## Appendix 6

### Written Evaluations for year one lessons Nos.2-15

#### *Lesson 2 Hoot on a Scoot*

The children loved the activity part of this lesson. Even children with poor co-ordination.

Though nervous, gave it a go. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

Really good for encouraging co-operation. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

It was difficult to arrange getting skateboards for each pair of pupils. We had to do exercises in groups instead. Game at the end was very enjoyable.

Very enjoyable lesson. Dealt with concepts very well. (junior/senior/1<sup>st</sup>/2<sup>nd</sup> )

Both classes really enjoyed this activity. All comments were positive. (2<sup>nd</sup>/3<sup>rd</sup> )

#### *Lesson 3 Stepping Stones*

Pupils very keen and came up with all sorts of material. Loved the idea of going barefoot on a nice crisp cold day out in the basketball court. Loved the game.(3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

Teacher had to change and make new record sheet as not suitable for my class levels. (junior/senior/1<sup>st</sup>)

We were anxious about floor work and rolling about feeling textures but it all worked brilliantly. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

More suited to younger children. The children were more interested in jumping than the different materials. (3<sup>rd</sup>/4<sup>th</sup>)

#### *Lesson 4 Design a Rig-out*

Extremely enjoyable, children got very involved and put in great thought and effort.

Absolutely a winner! Pupils initially thought "waterproof" would be "boring", but they ultimately came up with the best designs! Bags still on display and treasured by their owners. Great teamwork and learning experience.(3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

We all loved it. Made a great display. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

The hole puncher didn't work very well on material. The activity was too advanced for junior and senior infants. (junior/senior/1<sup>st</sup>/2<sup>nd</sup>/3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

Children found it difficult to use material and to cut it. I felt it was more suited to junior classes. (3<sup>rd</sup>/4<sup>th</sup>)

### *Lesson 5- Funny Bones.*

Simple but effective.

We had covered this already in the science programme so it didn't have the same "novelty" value. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

The children really enjoyed the activity/game part of the lesson.

The lesson was completed over three sessions.

Excellent. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

Making the straw spine was fun and really enhanced the children's understanding of the spine and how it works. (junior/senior/1<sup>st</sup>/2<sup>nd</sup>)

The children really enjoyed the lesson. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

The children really enjoyed this lesson. A very easy lesson to organize. The skeletons were a great help. (3<sup>rd</sup>/4<sup>th</sup>)

Learning was fun. Sensory elements prove a great benefit. Resources were necessary as they lead to great discussion. (4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

### *Lesson 6-Muscle Action.*

Engaged children very well. Made them think about movement and muscles involved.

We only did the arm as time ran out. Good example on how to do a 'fair test'. Interesting results which illustrated well that large/tall does not necessarily mean stronger. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

Rubber band comparison made it easier for children to understand. Children gave plenty of examples of using arm and leg muscles. Picture of arm as lever bit too advanced for this age-group. Practical experiments were better. They loved the weighing scales. All got a bit competitive with pressing hands.

Very enjoyable. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

Excellent extension on from energy and forces from previous lessons in the programme.

(junior/senior/1<sup>st</sup>/2<sup>nd</sup>/3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

The record sheets were not suitable to this age group. (junior/senior/1<sup>st</sup>/2<sup>nd</sup>)

A very enjoyable lesson. Very easy to realize. It took up a lot of time! (3<sup>rd</sup>/4<sup>th</sup>)

Quite an active lesson. Children enjoyed experimenting with movement. Again, hands on approach was excellent to get objectives across. (4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

### *Lesson 7.-Balancing Act*

Very enjoyable and interesting lesson.

Children enjoyed this lesson and learned a lot about balance.

The group activity aspect was very easy for all of the boys, but generated some interesting discussions.(4<sup>th</sup>/5<sup>th</sup>)

The lesson was conducted in the school yard allowing prediction, fair testing, group work etc. It created an active learning situation. No doubt will be remembered since bookwork is forgotten! Special needs children had a little difficulty with balance.(4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

Difficult to find space in the room as it was a wet day! Some pupils found it difficult to 'balance' so I had to explain that it wasn't a competition. I also took part and I explained that I too found it difficult.(3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>).

Total participation. Everyone, even shy students willing as all were having fun.

Resources easy to get. The record sheet assisted step by step procedure. Balloons were the biggest novelty. Children filled them with water for the experiment. Some young children found it difficult to turn on the beam to return to starting point. Balloons/water bottles a little difficult for them to hold. Otherwise proved a very successful lesson and learning experience in gravity/ equilibrium. (junior/senior/1<sup>st</sup>)

The tasks and record sheet could be more challenging for older children. Up to class teacher to adapt content to suit needs of older pupils. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

The children loved this lesson. (junior/senior/1<sup>st</sup>/2<sup>nd</sup>)

Very enjoyable lesson. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>).

A very successful lesson. Needed a lot of guidance from the teacher. The activity sheet was hard to follow. (3<sup>rd</sup>/4<sup>th</sup>)



### *Lesson 8-See-saw*

Some of the initial tasks seemed too easy i.e. more appropriate to a more junior class. The boys enjoyed coming up with new and interesting ways to move on the see-saw.(4<sup>th</sup>/5<sup>th</sup>)

Pupils enjoyed this lesson a lot. Good reasoning, predicting skills. They particularly liked it when the see-saw slowly balanced. All shouted 'equilibrium'! .(3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

Though activities were a little simple they enjoyed themselves. Sensory approach very necessary to teach sense of balance/equilibrium.(4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>).

Children enjoyed shifting their weight from side to side, it helped them understand better.

Pairs on the see-saw integrated with maths concept of heavier/lighter-useful for infants. A little bit dangerous-a few near accidents with infants losing footing and children not waiting and jumping on beam when someone was already on. A lot of safety issues to be discussed in advance. (junior/senior/1<sup>st</sup>)

A great lesson. Children enjoyed the experience and learning about appropriate balances. Body work great fun.

I was very conscious that the children might get splinters from the wood. (3<sup>rd</sup>/4<sup>th</sup>)

### *Lesson 9 Can you feel it?*

Materials and living things linked very well.

Didn't do it as time didn't allow-felt it was a very long detailed lesson and will try it next year when I've more time. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

Not the most stimulating lesson. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

They found it enjoyable and it was an extension from work I have done.

(junior/senior/1<sup>st</sup>/2<sup>nd</sup>/3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

The warm up for the lesson was very good. It made the children really aware of the sense of touch and the importance of their other four senses!

### *Lesson10 – Detectives at work*

Building house took a long time.

### *Lesson 11-Whirligigs.*

Very nice lesson. Some pupils had done similar work in a science workshop and they enjoyed showing what they knew. Others enjoyed the nature aspect and the relevance of the topic in everyday life. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

The children were amazed to see the water tension. They enjoyed the short drama. Perhaps some words too difficult for children e.g. particles, molecules. These words were used but didn't take from the lesson. Will do it again. (junior/senior/1<sup>st</sup>)

A very enjoyable lesson-easy to teach. Excellent illustrations of whirligigs and pondskaters. (3<sup>rd</sup>/4<sup>th</sup>)

### *Lesson 12-Bubbles Galore.*

Had blast! Didn't succeed with making of soap bubbles first go. Had to leave it sit overnight and add more liquid and glycerine. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

Children found it hard to make the loop from the wire. We found it hard to get bubbles from the mixture. So excited when we did get bubbles. Enjoyed getting various shapes from the wire and still ending up with circular bubbles. (junior/senior/1<sup>st</sup>)

Great fun. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

The children enjoyed this lesson very much. (3<sup>rd</sup>/4<sup>th</sup>)

### *Lesson 13-Bendy Bands.*

Very creative ideas when devising a workout and reporting and exchanging of ideas. Very honest about choosing colours to suit levels of energy. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

Room too small. Will go to P.E hall in the village next time. Lesson was great for stretching muscles. Lesson was easy to follow. Children came up with great vocabulary. They enjoyed working in pairs and doing the various movements with the bands. (junior/senior/1<sup>st</sup>)

I felt there wasn't enough content in the lesson. (3<sup>rd</sup>/4<sup>th</sup>)

### *Lesson 14-Watch out Minibeasts...*

Pupils loved this lesson. Got beautiful drawings and detail from them. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

Children enjoyed looking for the minibeasts and loved using the magnifying glasses, nature viewer, insect trap, bug hunters etc..They were very excited about the insects they saw. Will certainly do this lesson again. (junior/senior/1<sup>st</sup>)

An excellent lesson with plenty of room for discussion about insects. (3<sup>rd</sup>/4<sup>th</sup>)

*Lesson 15-Hey ho, down we go!*

We found it difficult to raise the ramp to different heights but it was very enjoyable. The pupils came up with the idea of wearing a hurling helmet for protection as we were doing it on the tarmac. This made them feel safe. Great fun. The graph was a good idea-illustrated the concept well. (3<sup>rd</sup>/4<sup>th</sup>/5<sup>th</sup>/6<sup>th</sup>)

The organization was easy. (3<sup>rd</sup>/4<sup>th</sup> )

## Appendix 7

### Evaluation form for Year 2 of the Science Programme

Electricity, Light, Sound & Forces

How would you rate your confidence  
in teaching the topics presented in this year?

					
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

How would you rate the usability of the  
handouts?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

Did you feel that the capital funding given  
to the school was adequate to finance these  
lessons?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

How important was it to have the science  
meetings?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

How happy were you with the timing of  
the science meetings?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

How helpful was it to have some of  
the resources provided?

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

Were you satisfied with the quantity of resources supplied to you?

How would you rate the year overall?

Comments:

## Appendix 8

### Sample Lesson Plan Year 2

#### Circuits

Try out the following activities. After you complete each activity discuss with your partner some *key questions* you could ask children that could lead to further investigation.

1. Make a bulb light using 1 wire and 1 battery (no bulb holder).

Investigate if there is more than one way to do this?

- Draw a diagram of the circuits you make (record).

2. Make a bulb light using 2 wires, 1 battery and a bulb holder.

- Write one thing you have learned.

3. Use the same equipment as in Task 2. Add a second bulb to the circuit. (use more wire).

- Predict what will happen and test your prediction.

4. Remove one bulb from the holder.

- What happens?

Write a sentence to explain why this happens.

### ELECTRICITY : Design and Make Activity

#### Task

Design and make a model to incorporate an electrical circuit.

**Design-and-Make Criteria:**

1. The model should include a bulb or a motor or a buzzer.
2. The model should include a switch.
3. The circuit components should be hidden from view.
4. The model should be aesthetically appealing
5. Explore materials, plan, make and evaluate. Note time taken for each part of the process.

**Suggested follow-up activities:**

- Wire three bulbs and organize them like Traffic Lights.
  - Steady Hand Game.
  - Make a Quiz board that lights up/buzzes when you get the right answer.
  - Birthday/Christmas Card.
  - Flashing Headband.
  - Model lighthouse.
  - Make a burglar alarm to go under a mat.
  - Clowns face with illuminated nose/ bowtie that spins.
  - Helicopter with spinning blade.
- Dolls house with light fitting operated by a switch.

## Appendix 9

### Sample Lesson Plan Year 3

#### Teaching & learning about Forces

##### *A. Gears: a simple machine*

Curriculum Context: p87  
Strand: Energy & Forces

Strand Unit: Forces

*Identify and explore how objects and materials may be moved*

*By pushing and pulling*

*By machines using rollers, wheels, axles, gear wheels, chains and belts*

Science curriculum linkage:

Design & make a lifting device that uses levers and gears

Curricular integration:

History & Geography: development of transportation – geared vehicles

#### **1. Introduction**

The first question is: “What is a gear? Wheels with teeth!” See picture 1. Where have you seen them? Where have you heard the word mentioned?

Gears are specialised wheels, and a wheel is one of the simple machines of classical antiquity. Teeth were first placed on wheels by the ancient Greeks to prevent slippage whenever it was required to have one wheel turning another.





Picture 1. Gears

## 2. Experiment

You will need:

- 1 beam
- 2 axle studs
- 1 of each type of gear wheel

N.B. Place the studs through the beam first!

You will do:

- Mount a large wheel on the beam
- Mount any other sized wheel on the beam so that it meets the large wheel
- Estimate how many turns it would take to make the big wheel turn once
- Record the wheels by the number of teeth they have – this is written on the wheel
- Carry out the experiment and see if you are correct
- Repeat this with other wheel size combinations
- Record your results in a table and represent the results as ratios, see Table 1.

You will learn:

- That if one gear-wheel represents the force put into the system and the other represents the force exerted by the system (*i.e.*, “coming out”) then there is an

advantage to using gears with wheels of different sizes. This advantage is called “mechanical advantage”. To stress the point you could do the experiment with wheels the same size.

Table 1. A sample set of results from a classroom experiment

Teeth on large wheel	Teeth on small wheel	Ratio of turns (L:S)
50	30	1 to 1.75
50	20	1 to 2.5
40	20	1 to 2
40	10	1 to 4
50	10	1 to 5

### 3. Developing a lesson through questioning:

Observation: When I cycle up a hill, sometimes it is harder than at other times depending on which gear I have selected. What do gears do? [keep this as an open question to be answered in the course of the experiment; but here’s the answer for you: gears are simple machines; simple machines allow more ‘work’ to be done for less ‘effort’]

Questioning: Assume you are using a simple 3-speed gear bicycle. This has one gear wheel at the pedals connected to the others by a chain. There are three gear wheels on the rear axle in this type of bicycle. Can I cycle up-hill using the big gear wheel or the small gear wheel?

Predicting: Which one is ‘better’ for going up-hill, a big gear wheel or a smaller one?

Analysing: The smaller wheel or lower gear is better for going up-hill, as in a car.

Interpreting: This allows more turns of the pedals to be converted to turning the axle as if in ‘smaller stages’.

#### **4. Extension Activities**

Using Lego™, Meccano™ or gear sets from a science supplier, experiment freely with gear pairs and compare them in terms of number of turns. Turn one wheel one full revolution and record how many times the other turns; try to see if a pattern emerges.

#### **5. ICT Possibilities**

Record and graph results from the experiments using a spreadsheet program.

## Appendix 10

### **Assessing development in science through the analysis of video-recorded senior-to-junior tutoring**

Sinéad O'Reilly, Thomas McCloughlin, and Helena Walker

St. Patrick's College, Drumcondra, Dublin 9

#### Background

As any parent of a four – five year old knows, children ask questions. However, teachers report a difficulty encouraging young children to ask questions (Macro and McFall (2004). Pollard (2003, p. 284) points out that the rules of communication in classrooms are significantly different from the rules of communication in other contexts. Tizard and Hughes (1984) found that very young children modify the type of questions they ask in different contexts – in response to teacher expectations; pointedly, very young children ask fewer 'curiosity'-type questions in school than at home. The teaching and learning of science depends on the natural curiosity of the child, therefore if the child's curiosity is being stifled this impacts negatively on the learning experience. Many articles on questioning provide strategies for encouraging children's questions (Macro and McFall, 2004, Rutledge, 2004, Wardle, 2004).

A workshop to outline these strategies was presented to a group of teachers to encourage children in this area with a view to analyzing questions younger children pose. The questions children ask tell us a lot about their understanding (Watts *et al.*, 2007). Analysis of these questions reveal their thought processes, worries, and what they wish to find out about.

Assessing attainment in science is notoriously problematic. Although science is a practical subject, in Ireland, the tendency has been for assessment to be typically pen-and-paper. Also, how one can be sure what one wishes to assess is actually assessed is not fully explored. Even if a child provides a correct answer in a test, how can the administrator be sure that it means that the student demonstrates a cognitive improvement in their science reasoning ability, or has memorized an answer, or answers due to linguistic proficiency? Furthermore, it is an existing question in science education that poor performance in an assessment procedure may not necessarily mean poor understanding: it may be due to a problem in the child's rote learning ability, linguistic proficiency or some other contingency.

This work hypothesizes that if the educator has some record that demonstrates a good teaching knowledge of the topic, then there must be a minimum adequate understanding of the topic to teach it. This turns about the traditional maxim: '*I teach best that which I must learn*' to become: '*I have taught that which I have learned*'. The record of the teaching in this work is a video-recording, and we are concerned with the

science learning in children ultimately.

A further aim of this work is to improve science teaching and teacher knowledge also, and to that end a video-recording of senior primary students teaching junior primary students can provide a basis for assessing the senior students ability in science, but also their teacher's ability to coach them in the first place.

Video analysis is not new in terms of classroom research (Gais, 2005, p. 119), but they were typically used solely for teacher education research and little attention was given to empirical methods (*cf.* Wild, 2003, cited in Gais, 2005, p. 119). Reusser *et al.* (1998); Stigler *et al.* (2000); Prenzel *et al.* (2001); Labudde (2002); Clausen *et al.* (2003); and Osborne (2005) all carried out research which involved video-recording lessons taking place, which demonstrates an increasing trend in the employment of this video-recording as a research tool. As part of the TIMMS programme, science lessons were video-recorded and analysed also (Roth, 2005).

Senior-to-junior tutoring (S2JT) is a Vygotskian metacognitive approach to learning science through parallel strands of determining junior primary students prior knowledge via question analysis, and development of communication skills in senior primary students.

## Methodology

Fourteen schools in south County Kerry, selected as a matter of convenience, were provided with digital video cameras and representative teachers (1 – 2) from each school were instructed on their use. Training sessions on the topics of forces, light, sound, electricity were given to the teachers and the teachers were instructed to teach these topics to their own classes. Following the training and whole class phases in 5<sup>th</sup> or 6<sup>th</sup> class, the teachers selected students from those classes who would act as tutors to junior class children in groups of 4 – 5.

The S2JT phases consisted of a structured lesson whereby one phase, 'talk-time', which takes place prior to the lesson, is video-recorded. The tutoring phase then takes place. Following this a repeat of the talk-time is video-recorded, and the two video-recorded clips compared.

Comparison of the two tutoring clips was assisted by the use of Transana v.2.1 . This is a qualitative analysis tool of video-clips developed by the University of Wisconsin, and was available, though no longer, as 'freeware'.

A coding procedure was developed for the video-analysis (Table 1.). Following advice from Peter Fensham (*pers com.*, 2004), it was decided to focus on children's questioning. In the analysis of the S2JT phases, there could potentially be a number

of types of questions, but the one that was felt most important were those posed by junior students; with a view to probing their understanding of a science topic.

Transcripts were produced for each video, and the codes inserted with time markers as keywords. 'Keyword maps' were produced for each lesson.

**Table 1.** Coding system developed for this work

Type of questions	Explanation and examples
Questions of origin	Question posed by the junior pupil to find out origin of something. Where does air come from?
Mechanistic question	Question posed by the junior pupil to find out how something happens/works. How do you get electrocuted? How does air kill fish?
Teleological question	Question posed by the junior pupil to find out purpose of something. What is x used for?
Causal question	Question posed by the junior pupil to look for a reason why something happened. Why does the bulb light up?
Procedural question	Question posed by the junior pupil to find out how something is set up. How do you attach the buzzer to the battery?
Extension questions	Question posed by the junior pupil that the draw on/relate to their environment. Is that how you switch the light on in your own house?
Investigative question type A	Question posed by the junior pupil which could be investigated in class but where the child has no conception of how this could be investigated. How far away is the moon?
Investigative question type B	Question posed by the junior pupil which leads them to suggest ways they might answer/investigate it. If you put a small hole would it still work? What happens if...

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## Appendix 11

### Sensory integration and science.

#### Improving science through the senses of movement, touch and balance

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#### Background

Sensory integration is the neurological process whereby sensory information from a variety of inputs is 'integrated' to give a coherent picture of what the world is like and allows the individual to move within and interact with the world. Maddock (1997) suggests that the medium of science is worthwhile in the education of children with special educational needs. O'Reilly (2004) and O'Reilly & McCloughlin (2005) provided the initial evidence that science education is one possible medium through which sensory integration can be achieved. It was hypothesised that sensory-based science lessons would provide enhanced sensory integration and furthermore improve the children's attainment in science in general.

#### Methodology

*A pre-experimental design* was used in a study involving primary school children (n=199, average age = 7.28 years), of which the majority (n=176) followed a programme of fifteen sensory-based lessons juxtaposed between a pre-test and post-test. The first stage of the study was the sensory screening of all children in the cohort, prior to the implementation of a program of sensory-based science lessons. The instrument used was three sections of the Short Sensory Profile (3SSP) (Dunn, 1999) notwithstanding the difficulties with the long version of the Sensory Profile experienced by O'Reilly (2004) and O'Reilly & McCloughlin (2005). The three parts were *modulation relating to body position & movement* (mr); *vestibular processing* (vp); and *touch processing* (tp). The test consisted of a 38-item norm-referenced questionnaire, which is completed by caregivers whom were given an introductory letter, permission slip and a simple set of instructions. The Sensory Profile purports to "ask questions in a way that enables persons to report on what is happening inside their child's body" (Dunn, 2001). The 3SSP was repeated on completion of the sensory science lessons. Confidence intervals were calculated by finding the product of the standard errors of measurement and the standard deviation and subtracting/adding this product to the raw score for the relevant section. These were plotted for each student using SPSS. Secondly a multiple choice age-appropriate science test was also administered to the cohort as a pre and post-test. A paired two-

tailed Student's t test (assuming unequal variances) was performed on these results using the EXCEL data analysis package (Table 1.).

## Results

Figure 1. to 3. show the plots of the raw scores with confidence intervals for pre-test (red) and post-test (green)

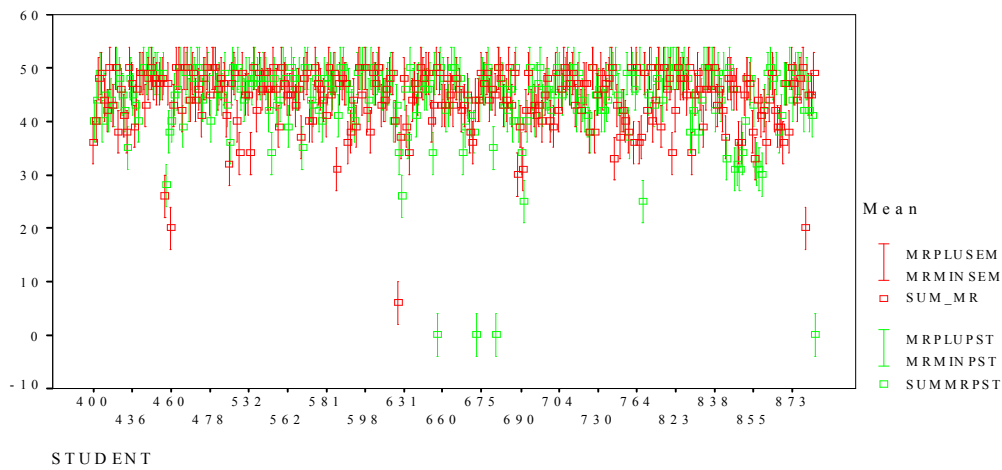


Figure 1. clustered high-low plot of scores and confidence intervals with respect to 'mr'

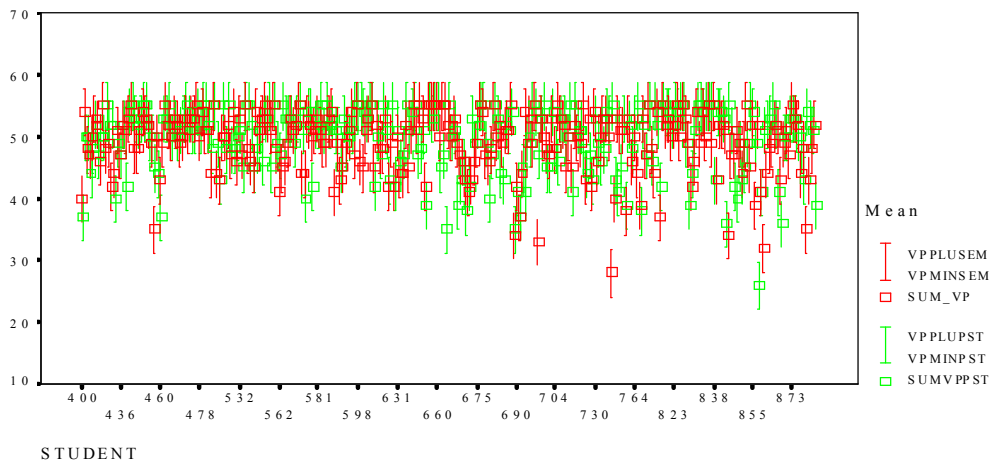


Figure 2. clustered high-low plot of scores and confidence intervals with respect to 'vp'

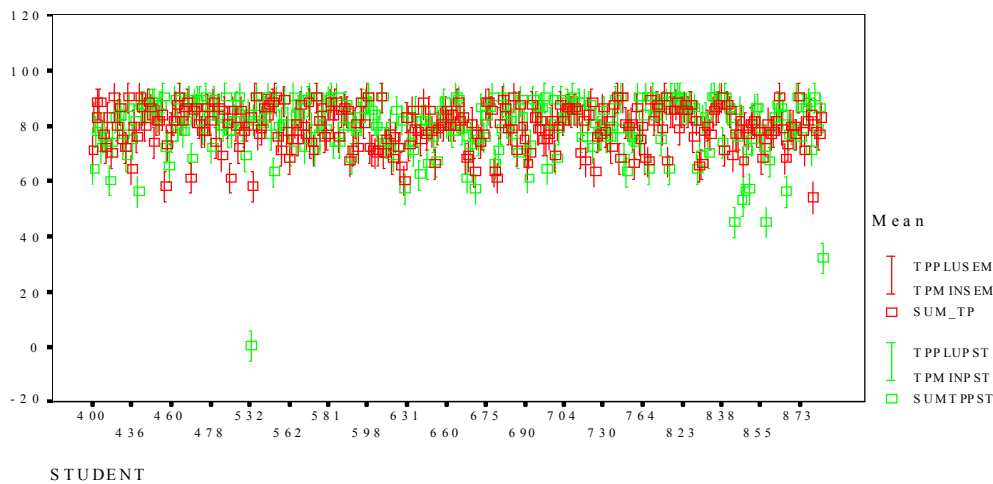


Figure 3. clustered high-low plot of scores and confidence intervals with respect to ‘tp’

Many of the students have the maximum or nearly maximum score in the pre-test so no improvement is likely. Out of the cohort, 8 students for mr (Figure 1.), 13 for vp (Figure 2.), and 15 for tp (Figure 3.) showed a significant improvement in those respective domains. A great many others showed a non-significant increase in their score, however the upper tails of the plots were very close to the maximum so that a significant improvement would not have been possible. A small number of students had scores in the lower part of the graph. These are discounted because the level of sensory processing indicated by these scores falls outside the norms for mainstream schooling. Also the disparity between pre and post administrations for these students is too extreme to be accounted for by the intervention. With respect to amelioration in science, from Table 1., it can be seen that the sensory science lessons had a significant effect on attainment in this domain.

Table 1. t-Test: two-sample assuming unequal variances

Condition	Control Group	Experimental Group
Critical t value	2.05	1.97
Calculated t value	0.03	4.80
P value	2.05	0.00

### Conclusion

The sensory profile post-test results indicate that a number of students performed at a level typical for children without difficulty in this area and thus would not show an increase in their scores. The results show increases for approximately a fifth of the students. This would indicate that sensory science lessons contributed to this improved performance. The statistical analysis (Table 1.) of the science scores showed a significant improvement had occurred as had been hypothesised. This could be due in part to heightened motivation. By adapting the existing science curriculum to allow for children’s’ desire to move and participate in activities that provide appropriate stimulation for the senses, sensory difficulties that create barriers to functional

performance can be redressed and learning enhanced.

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## Appendix 12

### Development of Science in Ten Kerry Schools and other Selected Schools

#### Financial statement

RD 02/04 Development of Science in Ten Kerry Schools & other Selected Schools		Oct-04 to Sep-05  2005	Oct-05 to Sep-06  2006	Oct-06 to Sep-07	Total to Date
<b>Income</b>					
Irish American Partnership		7,189.24	7,837.00	7,425.00	22,451.24
Dept of Education & Science		35,928.00	35,928.00		71,856.00
DES - PSWT		8,982.00	8,982.00		17,964.00
		<b>52,099.24</b>	<b>52,747.00</b>	<b>7,425.00</b>	<b>112,271.24</b> 134,762.24
<b>Expenditure</b>					
Lap Top & Travel Case		1,363.66			1,363.66
Field Expenses		14,349.72	9,878.34	6,341.28	30,569.34
Basic Science consumables		2,407.15	7,063.78	4,231.23	13,702.16
Sinead O'Reilly – Sec 193	To Sept 07	15,583.37	17,000.04	18,883.04	51,466.45
Academic Programme – Course Fees		3,103.00	1,660.00	1,768.00	6,531.00
<b>Committed Project Expenditure</b>					
Sinead O'Reilly – Sec 193	To Oct 07			1,416.67	1,416.67
Printing/Publishing/Dissemination				16,826.96	16,826.96
Programme Support Costs				10,000.00	10,000.00
Travel & Subsistence				2,850.00	2,850.00
		<b>36,806.90</b>	<b>35,602.16</b>	<b>62,317.18</b>	<b>134,726.24</b>