Language in Science Project (LiSP)

Marie Ryan & Peter E. Childs
Department of Chemical & Environmental Sciences,
University of Limerick, Ireland
Structures of Presentation

- Brief background of the research project
- Literature review
- Conclusions Phase 1
- Conclusions Phase 2
- Motivation for Phase 3
- Methodology Phase 3
- Results
- Discussion of results
- Conclusions
- Recommendations
Overall Aim of the Research

To **improve** the teaching and learning of science in the Irish **Junior Cycle** by **investigating** the role of language and **addressing** the problem of language in science education.
Personal Observations of the problem

- During 4th year Teaching Practice (2011)

Struggling Teacher

- Chemistry Teacher
- 7 out of 11 pupils were non-native English Speakers
- She couldn’t find any teaching strategies for the Irish context
- Her colleagues in the science department were also unable to assist her

Background to the Research

Formulated Initial Research Question

Due to the lack of knowledge displayed by these teachers towards the problem:

- Are Irish teachers aware of the problems caused by the role of language in teaching science?
The basis of this research is captured in Jonathan Osborne’s words:

‘Science without literacy is like a ship without a sail. So just as it is impossible to construct a house without a roof, it is impossible to build understanding of science without exploring how the multiple languages of science are used to construct meaning’ (Osborne, 2002).
Wellington and Osborne (2001) claimed that “Language is a major barrier (if not the major barrier) to most pupils in learning science” (p. 2).

Science has its own language and learning the language acts as an impediment to many pupil’s acquisition of scientific knowledge and understanding.
It has a specialised, precise and unfamiliar vocabulary.

It uses terms with different meanings in everyday settings compared to those in a scientific context.

It uses symbolic language which contributes to students' difficulties with science.

Its use of logical connectives in Mathematics can be challenging for students.

However, since SMEC, DCU, 24-25 June, 2014.
Phases of the Research

Phase 1
To identify the level of awareness of practising and student teachers of science to the problems created by the complex and multifaceted nature of the language of science in theory and practice.

Phase 2
a) To assess what facets of the language of science are posing the greatest difficulty to pupils.
b) To develop teaching and learning strategies and materials to make the teaching and learning of science at Junior Cycle level more effective.

Phase 3
a) To implement the developed teaching and learning strategies in second level schools.
b) To evaluate the effect of the developed teaching and learning strategies on the problems caused by the role of language in science teaching.

SMEC, DCU, 24-25 June, 2014
While Irish Science teachers are aware that the language of science is a barrier to pupil’s acquisition of scientific knowledge and understanding, their awareness appears to be almost limited to the technical language of science e.g. isotope.

The results of the teacher questionnaire found that 87% of teachers (75 out of 86) were aware that the vocabulary and usage of normal English in a science context was a problem for pupils, however only 11 teachers (41%) actually highlighted such words in the two extracts from a science textbook (case study n=27).

This raises concern about how aware teachers are in practice to these non-technical words or words which have a dual meaning and as such how are they dealing with these words when met in their own teaching.

67% of the teachers felt that they are not adequately equipped with teaching methodologies and strategies to deal with this problem especially considering the linguistic diversity of our classrooms.
Several obvious trends emerge. The first is that very few of the words tested turned out to be satisfactory in all formats. When one compares the results from the current study and the 1985 Cassels & Johnstone study, the results are alarming. The evident deterioration in pupils’ understanding of the given words is shocking (-38%).

Many of the words which science teachers use are not readily accessible to all their pupils.

Things are at their most dangerous stage when both a learner and teacher know a meaning of a word and each assumes that the other shares the same meaning.

\[ n=159 \text{ (Package 1)} \quad n=95 \text{ (Package 2)} \]
Summary of Results Phase 2

**Gender:** No significant difference

**Age:** General misunderstandings diminish with age, but a degree of misunderstanding is still apparent even with third-level student teachers of science and the format of the question does have an effect.

**Native or Non-native English Speaker:**

Native English speaking pupils outperformed their non-native counterparts with 69% of native pupils giving correct answers in comparison to 31% of non-native English speaking pupils. Similar to the previous factors, the format that the word was offered in effected performance. Native English speaking pupil’s outperformed non-natives based on the average of the four formats but this does not mean that native English speaking pupils did better than non-natives in all of the formats that the word was questioned in.
We cannot improve Irish second-level science education without addressing the underlying problem of language in science teaching.

The results of phase and 1 and 2 highlight the need for a programme to be devolved to help teachers tackle the problem of the role of language in science teaching and learning and increase their awareness to the problem in its entirety.

Science teachers are central agents to achieving this goal, accordingly they need to be aware of the difficulties pupils are presented with when learning science and equipped with teaching strategies and methodologies to alleviate and deal with pupils’ problems in their own teaching.
Iceberg

What we see often is only a fractional part of what it really is.
Aim of Phase 3

• To alleviate difficulties that Irish pupils have with the use of language in science education at the Junior Cycle;

• To improve pupil’s ability to understand and utilise the language used in science education at this level;

• To address the area of the lack of teaching and learning strategies to deal with the problem of language and literacy specifically in science education.
Methodology-Phase 3

The first consideration was to the level at which the project would be targeted at. It was decided to focus on the Junior Science Syllabus for a number of reasons:

- it is pupils first encounter with science in its entirety
- many pupils are turned off science by the time they reach senior cycle and do not opt to continue studying it
- pupils are faced with numerous highly complex terminologies and words with dual meaning for the first time at this level

Once the Junior Cycle was chosen, the keys aims of science education at this level were established in order to assess how best to achieve them in the context of this project.
Language in Science Project (LiSP)

Many teaching strategies and philosophies, that have been proven successes in the area of developing language and literacy and thinking skills, have been included in this programme and applied to five Junior Science topics from the current syllabus.

The steps involved in developing the programme are as follows:
Step 1: Selection of content to be covered in this intervention programme

The five topics to be included in the LiSP intervention programme are as follows:

- **Food**
- **Digestion**
- **States of Matter**
- **Classification of substances; elements, compounds and mixtures.**
- **Atomic Structure**

These *topics were chosen* for the following reasons:

- Their dense concentration of *new scientific terminologies* and use of non-technical and technical words with a *dual meaning*.
- These topics are *fundamental topics* in which pupils need to have constructed a good foundation in order to understand more advanced scientific topics at a later stage in both the junior and senior cycle.
- An analysis was carried out with the teachers participating in the project (intervention teachers or control teachers) in order to establish which topics they covered at the beginning of the school year. It was established that the five chosen topics were to be *introduced quite early* in the Junior Cycle by all teachers involved, therefore, they seemed the most logical topics to target due to the time constraints of a project of this nature.
Step 2: Development of the Intervention Package for teachers

The five topics that were included in this programme had a similar layout as follows:

- **Sample lesson plan** which included the key words and concepts of that topic
- **Introduction to the topic** and the key concepts and learning outcomes of that topic
- **Worksheets** e.g. cloze tests
- **Classroom activities**: these included games, some of which included the use of word cards. All resources for these games were provided either in the booklet on that topic or in the resource pack which accompanied that topic. Graphic organisers specific to the topic were also included in the booklet.
- **Other teaching ideas**: In this section of the booklets, teachers were provided with other teaching ideas such as the following:
  - **Prefixes and Suffixes**
  - **Use of Science news (web links to newspaper articles on the topic)**
- **Powerpoints**

  - The entire LiSP package was distributed to teachers in a **box file** with separate labelled folders for each of the **games packages** which accompanied each topic.
LiSP
Teaching and visualisation tools used in the lesson

- [http://spunout.ie/health/article/balanced-diet](http://spunout.ie/health/article/balanced-diet)
Step 3: Piloting the Intervention Programme.

- The researcher felt that it would be beneficial to pilot the intervention programme in one school in order to highlight any flaws in the programme or areas which could be improved.

- **Three** of the science teachers in this school were involved in the pilot. They were provided with training on how to best utilise the resources and teaching ideas after the Easter break of the school year 2012-2013.

- Teachers were asked to keep a portfolio of their views on using the programme i.e. the positive and negative aspects of it and the areas which they felt could be improved.

- Following the pilot of the LiSP, the researcher made the appropriate adjustments based on the feedback received from the teachers. The LiSP package was then printed on a larger scale and ready for distribution to the Intervention Schools.
Step 4: Distribution of the Intervention Package and training of teachers involved in the Intervention Programme LiSP.

- Teachers were provided with training on how to use the resources and teaching ideas at the start of the school year 2013-2014.

- 11 teachers from 7 schools were involved in the programme.
- 5 teachers from different schools acted as a control.

- The LiSP programme was implemented in schools during the school year of 2013-2014 mostly in the first term.
- The researcher remained in regular contact with the Intervention teachers throughout the teaching process, with classroom observations and discussion sessions in each school.
- At the beginning of the Intervention programme all teachers received a pre-questionnaire to establish their level of awareness to the role of language in science education. All teachers also received the extracts of text document which aimed to assess how aware teachers are in practice to the different facets of the language in science.
- At the beginning of the programme, all pupils (intervention and control) received a standard test to act as a mode of assessing the effectiveness of the intervention programme.
- The intervention pupils were then taught the five topics using the LiSP strategies and materials. At the end of each of the five topics, all pupils (intervention and control) completed an end of topic test.
• The teachers’ views were collected through a teacher portfolio, regular contact and the post-teacher questionnaire at the end of the project.

• The results of the intervention pupil group were compared with those of the control group (taught in the traditional way) in order to determine if the intervention programme had any effect on their ability to understand the concepts and main points of each of the five topics. The standard test completed by all pupils before the beginning of the programme was used to add validity to any deductions that could arise from the results of the end of chapter tests. The standard test and end of chapter tests for the intervention group and control group were identical.
Can the intervention and the control groups be compared?
In order to permit the analysis of the effectiveness of the ‘LiSP’ intervention programme it was important to determine if the intervention and control groups used in phase three of this investigation could be compared with each other. In order to determine this, cross tabulation tests between the two cohorts were carried out using SPSS 21 for Windows.

Results of significance tests should have \( p \)-values greater than 0.05 to allow for these two groups to be compared with each other.

\[
\text{n}=269 \text{ (Intervention pupils)} \quad \text{n}=144 \text{ (Control pupils)}
\]
## Intervention pupil status versus various factors

<table>
<thead>
<tr>
<th>Intervention pupil status (yes or no) versus</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>gender</td>
<td>0.055</td>
</tr>
<tr>
<td>native or non-native English speaker</td>
<td>0.162</td>
</tr>
<tr>
<td>Testing the understanding of the words in the standard test with regard to the pupil status (intervention pupil or control pupil)</td>
<td></td>
</tr>
<tr>
<td>percentage</td>
<td>0.165</td>
</tr>
<tr>
<td>excite</td>
<td>0.012</td>
</tr>
<tr>
<td>capable</td>
<td>0.789</td>
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<td>repel</td>
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<td>contrast</td>
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<td>convention</td>
<td>0.151</td>
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<tr>
<td>constituent</td>
<td>0.201</td>
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<tr>
<td>crude</td>
<td>0.042</td>
</tr>
<tr>
<td>displace</td>
<td>0.348</td>
</tr>
<tr>
<td>initial</td>
<td>0.165</td>
</tr>
<tr>
<td>probability</td>
<td>0.069</td>
</tr>
</tbody>
</table>
Results for Phase 3

• The results of the standard test highlighted that overall it is possible to compare the two cohorts of pupils; intervention and control; for phase three of this investigation as the majority of the p-values did not differ significantly. An extensive amount of data was collected and analysed in phase three of this investigation, all of which cannot be stated in this presentation. The following table highlights the results of the intervention and the control group for one of the end of chapter tests. The p-values for the two cohorts of pupils are also stated in order to highlight if there is a significant difference between the two groups.

For the purposes of reporting the results of the two groups of pupils the following colour keys will be used:

• **No Colour i.e. in black writing** = The intervention group achieved a higher percentage of correct answers than the control group. The difference between the two cohorts is not significant i.e. p-value >0.05.

• **Shaded in Khaki** = The difference between the two cohorts is significant i.e. *(p value <0.05 = significant)*

• **Red Writing** = The control group out-performed the intervention group
### End of Chapter Test on the Atomic Structure:

<table>
<thead>
<tr>
<th>Place in Test</th>
<th>Words</th>
<th>Intervention Pupil (Total = 27)</th>
<th>Control Pupil (Total = 27)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Question 1:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Space 1</td>
<td>Element</td>
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<td>23 (85%)</td>
<td>.528</td>
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<tr>
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<td>Nucleus</td>
<td>26 (96%)</td>
<td>21 (78%)</td>
<td>.100</td>
</tr>
<tr>
<td>Space 3</td>
<td>Protons</td>
<td>26 (96%)</td>
<td>21 (78%)</td>
<td>.063</td>
</tr>
<tr>
<td>Space 4</td>
<td>Nucleus</td>
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<td>18 (67%)</td>
<td>.000</td>
</tr>
<tr>
<td>Space 5</td>
<td>Electrons</td>
<td>26 (96%)</td>
<td>22 (81%)</td>
<td>.000</td>
</tr>
<tr>
<td>Space 6</td>
<td>Neutral</td>
<td>26 (96%)</td>
<td>22 (81%)</td>
<td>.228</td>
</tr>
<tr>
<td>Space 7</td>
<td>Smallest</td>
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<td>20 (74%)</td>
<td>.118</td>
</tr>
<tr>
<td>Space 8</td>
<td>4.00</td>
<td>26 (96%)</td>
<td>19 (70%)</td>
<td>.044</td>
</tr>
<tr>
<td>Space 9</td>
<td>2</td>
<td>25 (93%)</td>
<td>17 (63%)</td>
<td>.042</td>
</tr>
<tr>
<td>Space 10</td>
<td>2</td>
<td>26 (96%)</td>
<td>16 (59%)</td>
<td>.000</td>
</tr>
<tr>
<td>Space 11</td>
<td>Outside</td>
<td>25 (93%)</td>
<td>17 (63%)</td>
<td>.073</td>
</tr>
<tr>
<td>Space 12</td>
<td>Nucleus</td>
<td>26 (96%)</td>
<td>21 (78%)</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Question 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silver</td>
<td></td>
<td>26 (96%)</td>
<td>18 (67%)</td>
<td>.019</td>
</tr>
<tr>
<td><strong>Question 4:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proton</td>
<td></td>
<td>25 (93%)</td>
<td>22 (81%)</td>
<td>.145</td>
</tr>
<tr>
<td>Positive</td>
<td></td>
<td>24 (89%)</td>
<td>12 (44%)</td>
<td>.002</td>
</tr>
<tr>
<td>Neutron</td>
<td></td>
<td>25 (93%)</td>
<td>16 (59%)</td>
<td>.015</td>
</tr>
<tr>
<td>Inside</td>
<td></td>
<td>25 (93%)</td>
<td>20 (74%)</td>
<td>.169</td>
</tr>
<tr>
<td>Negative</td>
<td></td>
<td>27 (100%)</td>
<td>16 (59%)</td>
<td>.001</td>
</tr>
<tr>
<td>Outside</td>
<td></td>
<td>26 (96%)</td>
<td>15 (56%)</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Question 5:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td></td>
<td>25 (93%)</td>
<td>20 (74%)</td>
<td>.187</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>24 (89%)</td>
<td>17 (63%)</td>
<td>.017</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>25 (93%)</td>
<td>22 (81%)</td>
<td>.224</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>25 (93%)</td>
<td>12 (44%)</td>
<td>.001</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>27 (100%)</td>
<td>16 (59%)</td>
<td>.001</td>
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<tr>
<td><strong>Question 6:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Li Protons</td>
<td></td>
<td>26 (96%)</td>
<td>20 (74%)</td>
<td>.066</td>
</tr>
<tr>
<td>Li Neutrons</td>
<td></td>
<td>24 (89%)</td>
<td>16 (59%)</td>
<td>.027</td>
</tr>
</tbody>
</table>
Discussion of Results

A higher percentage of the intervention pupils opted for the correct answer to the questions in the end of chapter test in comparison to the control group pupils. It is important to state that none of the results were written in red writing as this would have signified that a higher percentage of correct answers were achieved from the control group rather than the intervention group. This alone is a very positive indicator of the effectiveness of the ‘LiSP’ intervention programme.
Discussion of Results

The positive variance between the two groups in favour of the intervention pupils indicates that participation in the ‘LiSP’ intervention programme has been successful in promoting the correct understanding and use of language in science education.

This deduction was made based on how comparable the two cohorts of pupils were when they completed the standard test and secondly, it was based on the lack of a significant difference between the intervention and control teacher pre-questionnaires prior to the commencement of the intervention programme.
Conclusions

• It was observed that pupils in the intervention group for this phase of the investigation were **stronger** than pupils in the experimental group, based on the results of the end of chapter tests and the standard test.

• Participation in the ‘LiSP’ intervention programme was shown to have a **positive effect in promoting pupils’ correct understanding and use of language in science education.**

• According to observations and the responses to the teacher interviews/portfolio, the pupils who participated in the programme **enjoyed** the groupwork and competitive elements of the package the most. **Pupil participation level in class increased** as a result of using the intervention programme package and teaching ideas.

• **The teachers** who participated in the intervention programme were **very positive about it** and felt that it was **very appropriate for Junior Cycle pupils.**

• The teachers who participated in the intervention programme stated that they will **use the intervention programme package again** and will incorporate the teaching ideas and materials into the teaching of other chapters.
Recommendations arising from this study

• **All pupils in Irish Second-level schools should to be assessed** in terms on their ability to understand and utilise the language in science education and manipulate words to suit the context that they are used in. This would increase teacher awareness to the level that each pupil is at in a class and allow them to teach the entire class more effectively and target problem areas.

• The ‘LiSP’ intervention programme materials that have been developed for this project need to be **edited and altered** according the recommendations made by the participating teachers and made available for teachers to use e.g. colour code questions and answers.

• A similar approach to the one taken in the ‘LiSP’ intervention programme should be taken to the **other chapters on the Junior Certificate Science syllabus**. Teachers need to be made aware of the project and the advice and resources that it offers.

• A set number of **command words** should be assigned to state and in-class examinations. The repeated use and exposure of this set of command words will make pupils confident in their understanding of use of these words. This will help minimise the confusion that many pupils have with what the **wording of exam questions** and what they are being asked to do rather than the **science content itself**.
Recommendations arising from this study

• Current practicing teachers need to be exposed to the problem of the language of science in its entirely i.e. all the different facets to the problem, in order to increase their level of awareness to the problem and initiate a change in their practice.

• Student teachers need to be exposed to the different aspects of the problem during the course of their teacher education. Their level of awareness to the problem and their exposure to the resources and teaching strategies that help alleviate the problem need to be increased. Student teachers need to start their teaching career with confidence that they are equipped to deal with the language barrier that many pupils are presented with.
Thank you for your attention
References:


Appendix
The inspiration for the content of the ‘LiSP’ intervention programme came from a number of different sources as outlined in the diagram below:
It must be noted that not all of the 269 pupils from the intervention schools were taught using the intervention programme. 3 of the 7 intervention schools had both intervention and control pupils which allowed for triangulation of the results.
## Control Programme Schools

<table>
<thead>
<tr>
<th>School Type</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
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<tr>
<td>DEIS School</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>(High proportion of non-nationals)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Limerick urban</td>
<td>Limerick rural</td>
<td>County Cork rural</td>
<td>County Kerry rural</td>
<td>County Tipperary rural</td>
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<tr>
<td>Gender</td>
<td>All girls</td>
<td>Mixed</td>
<td>All boys</td>
<td>Mixed</td>
<td>Mixed</td>
</tr>
<tr>
<td>No. of students involved</td>
<td>32</td>
<td>28</td>
<td>27</td>
<td>31</td>
<td>26</td>
</tr>
<tr>
<td>Total Control student Cohort</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>144</td>
</tr>
</tbody>
</table>

**Table 1.2: Summary of the Control Schools that participated in phase three of this investigation.**
## Intervention Pupil versus various factors:

<table>
<thead>
<tr>
<th>Intervention pupil status (yes or no) versus ...</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>gender</td>
<td>0.055</td>
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<td>initial</td>
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<tr>
<td>baby</td>
<td>0.450</td>
</tr>
<tr>
<td>lead</td>
<td>0.139</td>
</tr>
<tr>
<td>feather</td>
<td>0.801</td>
</tr>
</tbody>
</table>
2. Proficiency in Language Use

• English language proficiency underpins the use of language in science education but science has its own problems.

• In order for a pupil to effectively negotiate the language used in science education, they must first have reached an acceptable level of English language proficiency.
Non-native English speakers with a low proficiency level in English have relatively disadvantaged educational outcomes in comparison to pupils who are competent in the English language.
The Irish Context

This is very pertinent to Ireland’s school population which is becoming increasingly more culturally and linguistically diverse (Lee, 2000; NCCA, 2006), a trend which continues to persist according to a survey conducted by Irish Times (30 March 2012, p. 62).

In 2009 it was estimated that about 10% of students in primary schools and 8% of students in post-primary schools have nationalities other than Irish (OECD, 2009). According to the Dail Eireann Debate series in July, 2012, 12% of pupils in post-primary education have nationalities other than Irish (Dáil Éireann, 2012).

As stated by the ESRI’s report, “Adapting to Diversity: Irish Schools and Newcomer Pupils” (Smyth et al., 2009), over 75% of newcomers at primary level and approximately 70% of newcomers at post-primary level are non-English speaking pupils.

NCCA- National Council for Curriculum and Assessment
OECD- Organisation for Economic Co-operation and Development
ESRI- The Economic and Social Research Institute
Ireland has the most evenly distributed spread of migrant students across schools within the country of any of the participating OECD countries (approximately 90% of post-primary schools in Ireland record migrant students) (OECD, 2009).

However, the multi-faceted nature of the language of science is also a problem for native English speakers as well as non-native English speakers, although it is intensified for the latter group (Childs and O’Farrell, 2003) and is enhanced in mixed-ability teaching.
Summary of Result of Phase 2 and 3

• Results from phase one of this investigation showed that teachers have a level of awareness to the problems caused by the use of language in science education, however, this awareness appears to be almost limited to the technical language of science e.g. isotope. This phase also highlighted that teachers would like to get more support on how to deal with the problems presented by the language of science especially in the form of teaching and learning resources and materials.

• Results from phase two of this project showed that the majority of the pupils involved in this study did not have a comprehensive understanding of the words tested regardless of the context or the format the word was presented in. An evident deterioration in pupils understanding of the given words in comparison to the Cassel and Johnstone study conducted in 1985 was noted. Another important outcome of this phase was that many of the words which teachers of science use at all levels (second and third-level) are not readily accessible to all their pupils.

• Results from phase two indicate that Junior Certificate science pupils possess difficulty in understanding or comprehending scientific concepts which underpin Science due to the language that is used in the classroom and in textbooks.
Influence of Phase 1 Results on Phase 2

Phase one highlighted that teachers:
1. are aware in theory of the problems posed by the role of language
2. this awareness was predominantly based on their recognition of the complex and technical language of science and not necessarily the everyday words with dual meanings for example

Phase two therefore set out to do three things:
• determine the particular areas of need of pupils through the pen and paper test instrument (diagnostic test);
• establish if there is any notable difference in the results with regard to gender, class year and whether the pupil is a native or non-native English speaker;
• highlight to teachers that non-technical words can also be problematic in the science classroom and must not be overlooked especially dual-meaning words.
In the periodic table, elements are arranged in order of increasing atomic number. All atoms of the same element have the same number of protons. However, some atoms of the same element have different mass numbers and, as a result, have different numbers of neutrons. These are known as isotopes.

A popular pair of isotopes are carbon-12 and carbon-13 which are used in carbon dating. Both of these atoms have an atomic number of 6 which means that they are both carbon. However, they have different mass numbers and, as a result, different numbers of neutrons in their nucleus.
### In Ireland

<table>
<thead>
<tr>
<th>Secondary Schools</th>
<th>Vocational Schools</th>
<th>Community and Comprehensive Schools</th>
<th>Total</th>
<th>DEIS*</th>
</tr>
</thead>
<tbody>
<tr>
<td>403</td>
<td>247</td>
<td>91</td>
<td>742</td>
<td>202</td>
</tr>
<tr>
<td>54%</td>
<td>33%</td>
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<td>100%</td>
<td>27%</td>
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</tbody>
</table>

*Table 1: Breakdown of Post-primary Schools in Ireland according to School type*

### In Munster

<table>
<thead>
<tr>
<th>Secondary Schools</th>
<th>Vocational Schools</th>
<th>Community and Comprehensive Schools</th>
<th>Total</th>
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<tr>
<td>122</td>
<td>70</td>
<td>24</td>
<td>212</td>
<td>47</td>
</tr>
<tr>
<td>57%</td>
<td>33%</td>
<td>11%</td>
<td>100% in Munster, 29% of total schools in Ireland</td>
<td>22%</td>
</tr>
</tbody>
</table>

*Table 2: Breakdown of Post-primary Schools in Munster according to School type*
The 212 schools, excluding the four schools used in the pilot study, were then divided into strata according to school type and each were assigned a number which was recorded. The appropriate number of schools were then randomly selected using the online research tool of Research Randomizer accessed via [http://www.randomizer.org](http://www.randomizer.org).
212 schools in total, **100 schools** were targeted

- 57 schools will be Secondary
- 33 will be Vocational and
- 11 will be Community and Comprehensive

**Secondary Schools**

**Set #1:**

3, 4, 5, 6, 8, 9, 10, 11, 13, 14, 16, 18, 19, 22, 25, 26, 28, 31, 35, 36, 38, 41, 42, 46, 48, 49, 51, 52, 53, 54, 58, 60, 62, 66, 68, 70, 74, 76, 77, 79, 82, 84, 88, 91, 94, 96, 97, 102, 105, 106, 111, 113, 114, 117, 118, 121, 122

- Numbers randomly selected by research randomizer
- [http://www.randomizer.org/form.htm](http://www.randomizer.org/form.htm)
“HAVE YOU NOTICED IT, TOO?”
• "Elephant in the room" is an English metaphorical idiom for an obvious truth that is being ignored or goes unaddressed. The idiomatic expression also applies to an obvious problem or risk no one wants to discuss (Cambridge University Press, 2009).

• It is based on the idea that an elephant in a room would be impossible to overlook; thus, people in the room who pretend the elephant is not there have chosen to avoid dealing with the looming big issue.
The Montillation of Traxoline

It is very important that you learn about traxoline. Traxoline is a new form of zionter. It is montilled in Ceristanna. The Ceristannians gristerlate large amounts of fevon and then brchter it to quasel traxoline. Traxoline may well be one of our most lukized snezlaus in the future because of our zionter lescelidge.

• Directions: Answer the following questions in complete sentences. Be sure to use your best handwriting.

• 1. What is traxoline?
• 2. Where is traxoline montilled?
• 3. How is traxoline quaselled?
• 4. Why is it important to know about traxoline?
It must show low mammalian toxicity and phytotoxicity.

(Kirkman 1966: 152)

• Most readers will be exasperated at such a statement, which will only be understood by the specialist concerned at first reading.

• But what the writer means is not more than “It must be harmless to animals and plants”.

• The second version, accordingly, is much more communicative because it is shorter and uses more familiar words; most readers will find it easier to digest than the stiffer, more scientific version.
<table>
<thead>
<tr>
<th>Level</th>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Second Level</strong></td>
<td>356,107</td>
</tr>
<tr>
<td>Secondary</td>
<td>186,622</td>
</tr>
<tr>
<td>Vocational</td>
<td>114,761</td>
</tr>
<tr>
<td>Community and Comprehensive</td>
<td>54,724</td>
</tr>
<tr>
<td><strong>8% Non-native students</strong></td>
<td>28,489</td>
</tr>
</tbody>
</table>
For many of these students, their exposure to English is limited to their school environment, which in the majority of cases is not sufficient for them to gain an acceptable command of the English language. This is a particular problem in Science as unless one masters the language one cannot understand the science.

Lemke (1997) reported that English as a second language (ESL) learners have to immerse themselves simultaneously in two social practices when learning science: one which has to do with learning a new language (i.e. English) and the other which has to do with learning science (i.e. language of science).
According to Borg and Gall (1983, p.241), the first stage in sampling is to define the target audience.

- **practising Irish science teachers**

However, “the cost of sampling an entire population to answer a specific question is usually prohibitive in terms of time, money and resources” (Lunsford & Lunsford, 1995). Therefore, it was essential to select a subset of subjects which are **representative** of the target population (Lunsford & Lunsford, 1995).
### In Ireland

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*Table 2: Breakdown of Post-primary Schools in Munster according to School type*

DEIS: Delivering Equality of Opportunity in Schools
### Systematic stratified sampling approach

<table>
<thead>
<tr>
<th>School Type</th>
<th>No. of Schools who received the questionnaires (n=100)</th>
<th>No. of Schools who returned questionnaires (n=29)</th>
<th>% of Schools who returned questionnaires</th>
<th>% of school type in study (ideal)</th>
<th>% of school type in study (actual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary School</td>
<td>57</td>
<td>16</td>
<td>28%</td>
<td>57%</td>
<td>55%</td>
</tr>
<tr>
<td>Vocational School</td>
<td>33</td>
<td>9</td>
<td>27%</td>
<td>33%</td>
<td>31%</td>
</tr>
<tr>
<td>Community and Comprehensive School</td>
<td>11</td>
<td>4</td>
<td>36.4%</td>
<td>11%</td>
<td>14%</td>
</tr>
</tbody>
</table>

The 212 schools, excluding the four schools used in the pilot study, were then divided into strata according to school type and each were assigned a number which was recorded. The appropriate number of schools were then randomly selected using the online research tool of Research Randomizer accessed via [http://www.randomizer.org](http://www.randomizer.org).
Types of Secondary Schools

The main difference between them lies in how they are managed, who owns them and how they are funded.

- **Secondary Schools**
  - 55% of students attend these schools
  - Generally denominational
  - Traditionally very academically oriented.

- **Vocational Schools**
  - Non-denominational
  - Managed by VEC’S
  - Mainly dedicated toward the development of manual skills and the preparation of young people for trades.

- **Community/Comprehensive Schools**
  - Denominational
  - Managed by the Board of management representative of local interest.
  - Combination of both academic and vocational subjects in a wide curriculum.
212 schools in total, **100 schools** were targeted

- 57 schools will be Secondary
- 33 will be Vocational and
- 11 will be Community and Comprehensive

**Secondary Schools**

**Set #1:**
3, 4, 5, 6, 8, 9, 10, 11, 13, 14, 16, 18, 19, 22, 25, 26, 28, 31, 35, 36, 38, 41, 42, 46, 48, 49, 51, 52, 53, 54, 58, 60, 62, 66, 68, 70, 74, 76, 77, 79, 82, 84, 88, 91, 94, 96, 97, 102, 105, 106, 111, 113, 114, 117, 118, 121, 122

- Numbers randomly selected by research randomizer
- [http://www.randomizer.org/form.htm](http://www.randomizer.org/form.htm)
The language used in written materials including exam papers is often too complicated for pupils to understand – 57 (66%) ‘Agreed’.

Pupils for whom English is not their first language and also pupils with a low literacy level are presented with a dual barrier with regard understanding science- 73 (85%) of teachers ‘agreed’.

I am more cognisant of the problems posed by the language of science to these cohorts of pupils- 57 (66%) of teachers also ‘agreed’. However, they are aware that it is a whole school problem.
Where do you feel that the problem posed by the language of science lies?

- Technical language of science: 13%
- The vocabulary and usage of normal English in a science context: 23%
- Both 1 and 2: 64%

n=86
Obstacles to pupils learning Science

<table>
<thead>
<tr>
<th>Obstacle</th>
<th>Percentage of teachers %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Misconceptions</td>
<td>8</td>
</tr>
<tr>
<td>Preconceptions</td>
<td>9</td>
</tr>
<tr>
<td>Level of cognitive development</td>
<td>27</td>
</tr>
<tr>
<td>Lack of relevance to everyday life</td>
<td>31</td>
</tr>
<tr>
<td>Level of motivation and interest</td>
<td>20</td>
</tr>
<tr>
<td>Language of Science</td>
<td>23</td>
</tr>
<tr>
<td>Mathematical Aspects</td>
<td>14</td>
</tr>
<tr>
<td>Lack of Contextualisation</td>
<td>12</td>
</tr>
<tr>
<td>Teaching strategies employed</td>
<td>5</td>
</tr>
</tbody>
</table>

n=86

SMEC, DCU, 24-25 June, 2014
Was the use of language in science ever highlighted as a problem to you during the course of your teacher education?

- No: 56%
- Yes: 34%
- Unsure: 10%

n=86

SMEC, DCU, 24-25 June, 2014
Cognitive Ability of the learner.

The adolescent can reason abstractly and think in hypothetical terms.

**Formal operational (12 years–adult)**
The child can think logically about concrete objects and can thus add and subtract. The child also understands conservation.

**Concrete operational (7–12 years)**
The child uses symbols (words and images) to represent objects but does not reason logically. The child also has the ability to pretend. During this stage, the child is egocentric.

**Preoperational (2–6 years)**
The infant explores the world through direct sensory and motor contact. Object permanence and separation anxiety develop during this stage.

**Sensorimotor (0–2 years)**

Piaget (1964)
Formal Operational Level

**U.K.**

Percentage operating at the formal stage has decreased from 1976 – 2003.

- 30% of learners at age 16 are at the early formal stage (2003).
- 10% of learners at age 16 are at the late formal stage (2003).

(Shayer et al. 2007)

**Ireland**

Percentage operating at the formal stage:

- <10% of pupils at Junior Cycle in second level.
- < 20% of pupils at Senior Cycle in second level.
- < 40% of students at third level.

(Childs and Sheehan 2010)
**Phase 1**

To identify the level of awareness of practising and student teachers of science to the problems created by the complex and multifaceted nature of the language of science.

- **ACTION:**
  - Exploration of the attitudes and views of both practising and student science teachers towards the role of language in science education.

- **METHOD:**
  - Questionnaires - to practising (n=86) and student science teachers (3rd and 4th year in U.L) (n=)
**Phase 1**

To identify the level of awareness of practising and student teachers of science to the problems created by the complex and multifaceted nature of the language of science.

**ACTION:**
Exploration of the attitudes and views of both practising and student science teachers towards the role of language in science education.

**METHOD:**
Questionnaires to practising (n=86) and student science teachers (3rd and 4th year in U.L) (n=)
Phase 2

a) To assess what facets of scientific language are posing the greatest difficulty to pupils

b) To develop teaching and learning strategies and materials to make the teaching and learning of science at Junior Cycle level more effective and to reduce the rate of attrition from the scientific field at this level.

• a) ACTION:
  • Both Junior Cycle science pupils and third level science education students will be examined in order to establish what aspects of the language utilised in science education are posing the greatest difficulty to them.

  • METHOD:
  • Diagnostic test and focus groups - pupils and students.

  • b) ACTION:
  • Science teachers’ opinions on what area of Junior Certificate science syllabus (Biology, Chemistry or Physics) is causing the greatest difficulty will be established.

  • METHOD:
  • Survey/ interview - Junior Cycle science teachers

• ACTION:
  • Teaching and learning strategies will be developed based on the findings of the diagnostic test and teacher survey on the area of science which is posing the most difficulty.
**Phase 3**

*a) To implement the developed teaching and learning strategies in second level schools*

*b) To evaluate the effect of the developed teaching and learning strategies on the problems caused by the language of science*

---

**a) ACTION:**
- Teachers who are willing to participate in the programmes will be identified. Control teachers will also be identified. Teachers will be trained on how to effectively utilise the strategies and methodologies.

**METHOD:**
- Consent forms will be sent to schools, In-service day

**b) ACTION:**
- Both participating pupils and control pupils will be assessed for significant differences in the results of various examinations. Teachers’ views and opinions on the strategies will be established.

**METHOD:**
- Pre and post interview with teachers, observations of classroom practices, post-diagnostic test to pupils
Experimental Design:
Two packages were prepared each containing five words in common and forty-five different words in four formats.

The following are the five words which were common to both package A and package B.

- Percentage
- Excite
- Repel
- Average
- Characteristics

These 5 words were presented in the same format in order to verify that the sample cohorts were randomly selected.
The Four Formats:

• One word synonym without context
• Used in an everyday setting
• Used in science context
• Used in a sentence in a non-science context
By tabulating the experimental results for each acid, the pupil was able to **contrast** them. This means the pupil was able to

- point out differences.
- point out similarities.
- indicate trends.
- identify them.

**Which sentence uses the word constituent correctly?**

- The pupil was constituent about the exam results.
- By repeating the experiment, constituent results were obtained.
- The constituent of the club said you had to be 16 years old to join.
- Waste paper is a constituent of household rubbish.
‘Diagnose’ can mean
• know.
• infer.
• cut across.
• go round.

The joiner is a capable workman. This means he
• never leaves a mess.
• works very hard.
• can do his job.
• always takes his time.