



## What Makes a Successful Chemistry School?

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### Abstract

In Ireland senior cycle (Leaving Certificate, LC) Biology is almost four times as popular as Chemistry and Physics. Around 15% of the senior cycle cohort study LC Chemistry each year, but the take-up of Chemistry varies widely from one school to another. All students study the same science course in the junior cycle and so nominally have a common background entering the senior cycle. We were interested to investigate why some schools are more successful than others in attracting students to study Chemistry. By identifying contributing factors in successful schools then this might allow us to transfer them to less successful schools. This paper reports two studies, done as final year research projects by science education students. One was done in 2009 (LW) and the other in 2014 (MMcC), to answer this question: 'What makes a successful Chemistry school?' Schools where the take-up of Chemistry was significantly above the national average were identified. We termed these schools 'successful'. In 2009 we sent questionnaires to 35 successful schools in the whole country, and received 12 replies. In 2014 we identified 15 pairs of similar schools in one province of the country: one with above average enrolment for LC Chemistry and the other below average, keeping other factors the same. Questionnaires were sent to all the 15 pairs, 30 schools in total, to identify factors common to successful schools and not found in less successful schools. Results from 8 complete pairs (16 schools, 53%) were returned and analysed.

From the 2014 results we could identify common factors in the successful schools, similar to but more extensive than from the 2009 study. The data enabled us to produce a profile of a successful Irish second-level school in relation to Chemistry enrolment. These factors influence the view students have of science and particularly whether they want to study the physical sciences in the senior cycle.

This study gives ideas for helping schools increase their take-up of Chemistry. Irish schools offer the same curriculum but can vary widely in size, type, style, location, resources and intake, thus the actual educational experience received by students can thus vary widely.

**Keywords:** *Chemistry education; secondary education; chemistry take-up;*

### 1. Introduction

In Ireland senior cycle Biology is almost four times as popular as Chemistry and Physics. Around 15% of the senior cycle cohort study Chemistry each year, but the take-up of Chemistry varies widely from one school to another. All students study the same science course in the junior cycle and so nominally have a common background when they enter senior cycle, although science is not compulsory in the second level curriculum. The major imbalance in Ireland between Biology and the Physical Sciences has been a concern for many years and in 2000 resulted in a government Task Force on the Physical Sciences being set up to investigate the problem and make recommendations [1]. We were interested to investigate why some schools are more successful than others in attracting students to study Chemistry. By identifying contributing factors in successful schools this might allow us to transfer them to less successful schools. Some schools offer the Transition Year Option (TYO), an optional year between the junior and senior cycles, where schools are free to be more innovative as they are not bound by a prescribed curriculum.

### 2. Literature survey

Very little work has been done on why some schools are more successful than others in particular sciences, although there has been work on subject choice in Ireland [2]. The main findings of this study were that schools that encourage take-up of senior cycle science:

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- Have compulsory Junior Certificate Science [2] (p.28,118)
- Have a flexible approach to subject choice (allow students to choose later) [2] (p:105)
- Emphasise practical work and experimentation [2] (p:236)
- Have teachers that take an active role in their own professional development: through participation in activities run by the Irish Science Teachers Association (ISTA) [2] (p:237)

A similar study in the UK [3] [4] identified the following factors that promote the take-up of post-16 science:

- Curriculum continuity and planning to ensure that pupils make progress in their learning each year;
- Lively, experiential, colourful teaching of science in Key Stage 3 and (less so) in Key Stage 4;
- Teaching that challenges, asks questions, is relevant, meaningful and purposeful;
- A curriculum enriched by visits, visitors and projects that bring the world of science into the classroom; and
- Good resourcing, effectively used and targeted at identified priorities.

Our particular interest was in the uptake of chemistry in the senior cycle and led to the following research questions:

RQ1. Why are some Irish schools more successful than others in encouraging students to take up Chemistry?

RQ2. Does chemistry take-up depend on school type (mixed or single sex), location (urban or rural) or size?

RQ3. Is it possible to identify a profile of a successful school?

Answers to these questions would be helpful in trying to increase enrolment in senior chemistry courses and might also have relevance to other countries.

### **3. Research design**

Two studies were done to try and investigate the problem of low Chemistry take-up and answer our research questions. In each study the school enrolment figures for LC Chemistry, relative to the school's LC cohort, were used to identify successful schools i.e. schools which attracted much more than the average enrolment. Both studies were done by pre-service science teachers (PSSTs) for their final year projects (FRP), as part of their degree. Both students (LW and MMcC) were studying Physical Education and Chemistry. Schools are not all the same and differ in school type, gender (mixed or single-sex), size and location (rural versus urban),

#### **3.1 Study 1**

In this study (LW) identified 35 schools in Ireland (11 fee-paying, 24 state funded) which enrolled over 30% in LC chemistry, twice the national average (14%, 2009), although not every school offers Chemistry (536 out of 704 schools). The chemistry teacher in these schools was sent a questionnaire to identify what factors were present in the schools, having first validated and revised the questionnaire in a pilot study. 12 replies (34%) were received and analysed to identify common factors.



### 3.2 Study 2

Table 1. Characteristics of schools who responded in study 2

Code	Type	Location	Size of LC cohort	% chemistry
A1	Mixed	City	83	22
A2	Mixed	City	92	14
B1	Mixed	Country	40	26
B2	Mixed	Country	45	13
C1	Mixed	City	190	27
C2	Mixed	City	230	15
D1	Mixed	City	95	34
D2	Mixed	City	120	14
M1	Male only	City	96	32
M2	Male only	City	120	15
N1	Male only	Country	39	13
N2	Male only	Country	50	30
I1	Female only	City	78	28
I2	Female only	City	73	15
J1	Female only	Country	65	9
J2	Female only	Country	60	33

This study (MMcC) was done 5 years later (2014) and focused only on schools in Munster, one province of Ireland, which contains a sizeable number of schools (over 200), which are representative of the variety of schools in the whole country. From the enrolment figures relative to the LC cohort, matched pairs of schools were identified: they were classed as successful (above average) or unsuccessful (below average) and matched for school type, gender and location. Fee-paying and 'grinds' (which coach for the state examinations) schools were not included, as not being representative of the Irish school population. 15 matched pairs of schools were identified and the Chemistry teachers were sent a questionnaire based on that used in the first study. 8 complete pairs were returned (16 schools, 53%) and analysed to look for differences in the factors between successful and unsuccessful schools. (See Table 1)

Some limitations of the two studies:

- Both studies had a small sample based on actual returns.
- The results were obtained only by means of a written questionnaire, which can produce bias or incorrect answers.
- The choice of criteria for successful or unsuccessful schools was arbitrary.
- Only the teachers were surveyed and not their students.

Ethical approval was obtained for the study. Each school was given a code and no individual schools or teachers were identified in the results.

## 4. Results

### 4.1 Study 1

Study 1 was more limited in scope and only successful schools were targeted. The following were found to be common characteristics of the successful schools:

- Compulsory junior cycle Science.
- A flexible timetabling system at senior cycle to facilitate wide subject choice.
- An emphasis on practical work.
- Outside resources used in teaching
- At least one qualified Chemistry teacher taking junior cycle Science classes
- Three year allocation of Science teachers in junior cycle
- A tradition of Science in their school.



- Good facilities/resources
- Existence of Transition Year
- Availability of Laboratory Technicians
- Involvement in external Science events such as BT Young Scientist and Science week
- Teachers who are actively involved in their professional development through attendance at in-service and active membership of ISTA.

#### 4.2 Study 2

For each of the questions, the number of successful and unsuccessful schools which gave positive answers were identified (see Table 2 for an example). This enabled us to see which factors were present in each type of school. An example of this is shown below:

Table 2. Is a science culture important in the school? (Bold = successful schools)

Is important	Not important
<b>A1</b>	B2
A2	M1
<b>B1</b>	J1
<b>M2</b>	D2
I1	C2
<b>N2</b>	I2
<b>J2</b>	N1
<b>D1</b>	
<b>C1</b>	

For all factors, it was found that they were more represented in the successful than in the successful schools. For example when the question was: 'Is a science culture present in the school', Table 2 shows the responses (successful school codes in bold.) All successful schools consider a science culture important and only one of the unsuccessful schools.

Table 3 below shows a summary of all the factors. The differences were independent of the various school factors ( RQ2). There is clearly a different profile for those schools were are successful in encouraging students to take senior cycle Chemistry and schools which are unsuccessful. (RQ1) These data allow us to draw up a profile of a successful Chemistry school (RQ3).

Table 3. Summary of factors influencing take-up of Chemistry

Factor	No of successful schools where present (N=8)	No of less successful schools where factor present (N = 8)
Head of science	6	0
Science budget	6	0
3 laboratories	7	3
Use of outside resources	8	5
Science culture important	8	1
Timetabling Junior science (2 single, 1 double)	7	4
Non-mandatory experiments	6	1
TY compulsory	7	2
Science tradition in school	8	3
Science promotion	8	4
External competitions	8	3
JC science teachers qualified in chemistry	27	16

#### 5. Discussion & conclusion

If subject choice only depended on the presence of a charismatic teacher in a school then it would be difficult to replicate. However, if the factors which promote the take-up of science, in our case





Chemistry, are institutional or procedural, then these could be replicated in other schools. It would appear from our findings in Irish schools that most of the factors could be implemented in all schools, given the will and commitment of the management and science teachers. The two sets of results are in substantial agreement and allow us to draw up a profile of a school which is successful in encouraging students to take-up LC Chemistry.

A profile of a successful chemistry school:

- Compulsory junior cycle Science.
- Emphasis on practical work in junior cycle (JC) and senior cycle (LC) science – beyond the mandatory requirements.
- Use of outside resources in teaching.
- Many junior cycle science teachers qualified to teach Chemistry.
- A pro-science tradition in the school supported by the management.
- Good facilities and resources – especially laboratories.
- Compulsory Transition Year including science modules.
- Involvement in external science events e.g. science fairs.
- Teachers involved in CPD courses.
- Science promotion activities in the school.
- Proper timetabling of junior cycle science to allow for adequate laboratory usage.
- Head of Science/science coordinator.

Most of these factors are not specific to Ireland and are what one would expect for a school and science teachers who are trying to teach science in the best possible way. Similar factors should also apply to the promotion of senior cycle Physics. A deliberate school policy to promote senior cycle science and provide adequate resources and encourage teacher CPD, should work to improve the take-up of senior cycle sciences, particularly Chemistry and Physics.

These were preliminary studies and raise a number of questions and an agenda for future work:

- Will a larger sample replicate these findings?
- Which are the most important factors of the ones identified?
- Is it possible to increase Chemistry (or Physics) take-up by implementing some or all of the factors in schools where they are not present?
- Will a survey of junior cycle students identify the same or other factors encouraging them to take senior cycle science?

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### **References**

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