



## SPECIAL ISTA ANNUAL CONFERENCE

FROM JC SCIENCE TO LC SCIENCES:  
ISSUES AND CHALLENGES.

- 7<sup>TH</sup> / 8<sup>TH</sup> FEBRUARY 2020 - EXPLORIUM DUBLIN -  
*See News Section inside*

Volume 55  
Number 1  
November 2019

Teachers' views on possible LC science specifications.

**AERPRIZE** Biennial Competition details.

The GLOBE (Ireland) Programme.

Myths, Mistakes & Misconceptions about Respiration.

Pioneer of Science Education - William Heller.



## **SCHOOL LABORATORY SUPPLIES & LABORATORY WASTE MANAGEMENT**



**CHEMICALS**

**CONSUMABLES**

**EQUIPMENT**

**LABORATORY WASTE  
MANAGEMENT**

Ocon is an Irish owned company in the Laboratory supply industry for over 30 years. We offer a full range of Laboratory supply including a waste management service nationwide.

 **021 4318555**

education@oconchemicals.com  
[www.oconchemicals.com](http://www.oconchemicals.com)

# In this issue of SCIENCE

<b>President's Reflection</b> .....	Gerald Fleming.....	3
<b>Chairman's Report</b> .....	A Ó Súilleabháin.....	5
<b>News &amp; Views</b> .....	Mary Mullaghy.....	8
ISTA President Receives Highest Honour.....		8
Dave Fahy RIP:.....		8
ISTA Annual Conference 2020.....		8
Senior Science Quizzes.....		8
Chemistry in Action.....		8
Science & Technology in Action.....		8
ICASE – World Science & Technology Education Conference.....		8
The Great Irish Science Book.....		9
Women in their Element.....		9
<b>Transit of Mercury 2019</b> .....	Seosamh Ó Braonáin.....	9
<b>AerPrize Competition 2020</b> .....	Info & Entry Details.....	10
<b>Moving from JC Science to the LC Sciences</b> .....	Dr Declan Kennedy.....	12
<b>Astrophotography in the classroom</b> .....	Dr. Richard Moynihan.....	18
<b>GLOBE (Ireland) Understanding of the real-life implications of science</b> .....		20
<b>SciFest: Take STEM from the classroom to the world stage</b> .....	Hugo Rowsome.....	22
<b>What happened to the Physics &amp; Chemistry course?</b> .....	Dr. Peter E. Childs.....	25
<b>STEMreach Problem Solving &amp; Puzzle Fair</b> .....	Dr Cordula Weiss.....	26
<b>Implementing 'Blended Learning' into Modern Day Science Teaching</b> .....	Ryan Gallagher.....	28
<b>Get Your Writing Right!</b> .....	Randal Henly.....	31
<b>Sea of Desolation</b> .....	Paul Holland.....	32
<b>McCulloch's Musings</b> .....	Ian McCulloch.....	34
<b>Myths, Mistakes &amp; Misconceptions about Respiration</b> .....	Declan Cathcart.....	36
<b>A Day on The Bog</b> .....	Nuala Madigan.....	41
<b>Pioneers of Science Education #8: William Mayhowe Heller</b> .....	Dr. Peter E. Childs.....	42
<b>Crossword</b> .....	Randal Henly.....	50



**W**elcome to the first ISTA journal for the 2019/20 school year. This is a bumper issue

with great articles, too many to mention them all here. I would however like to bring your attention Dr Declan Kennedy's article discussing the imminent release of the new Leaving Certificate science syllabi. In his article Declan reviews the response of ISTA members, to the prospect of the same format used for the Junior Certificate being used for the new Leaving Certificate science syllabi. The responses were so unanimously opposed to such a scenario that we have decided that a special and earlier ISTA AGM will be held in February (more details in News Section). This will give all of us a chance to take part in

**C**over photo: Puffin on the Saltee Islands off Co. Wexford. Your students can also learn to fly like a puffin if they enter the AerPrize competition - see details inside.

reviewing what makes a good syllabus and make it clear to the NCCA that we do not want a repeat of the fiasco that is the Junior Certificate science syllabus.

This year's rather belated Junior Certificate results came as quite a shock to most science teachers with only 2% of their students nationwide achieving a distinction in this the first running of the new exam. It would seem from the reports of correctors that this was the level that the SEC felt appropriate for the cohort of students taking science. If this is the case, for a common level paper, at Junior Certificate level then we can expect that the success rate in any forthcoming paper for the updated Leaving Certificate science course will be no better. Many of you have expressed your concerns that students will be put off taking Leaving Certificate science subjects as they will perceive them as being too difficult and offering them little chance of achieving

the high grades and the associated points they are looking for. So if any of this concerns you do make sure to read Declan's article and sign up for our special symposium in February.

I must also draw your attention to the second running of the AerPrize ([www.aerprize.com](http://www.aerprize.com)) competition, aimed at

Continued on page 50.



## Write for 'SCIENCE'

Contributions of features, news items and photographs for SCIENCE are always welcome and should be sent to the Editor at [snjnfogarty@gmail.com](mailto:snjnfogarty@gmail.com).

Contributors' guidelines can be downloaded from the ISTA website, [www.ista.ie](http://www.ista.ie).

To join ISTA and receive three issues of SCIENCE delivered to you each year, please also go to our website.

SCIENCE is the journal of the Irish Science Teachers Association (ISTA). The ISTA promotes the interests of Irish Science Teachers.

SCIENCE is published three times a year. The material published in SCIENCE by the voluntary editorial team and contributors must not be taken as official ISTA policy unless specifically stated.

### ISTA Council Executive

**Association President**

Gerald Fleming

**Chairperson**

Aodhagán Ó Súilleabháin.

[aosuilleabhain@heywood.ie](mailto:aosuilleabhain@heywood.ie)

**Vice-chairperson**

Seán Finn.

[s.finn@ucc.ie](mailto:s.finn@ucc.ie)

**Honorary Secretary**

Dr. Maria Sheehan.

[mariasheehan400@gmail.com](mailto:mariasheehan400@gmail.com)

**Past-chairperson**

Seán Fogarty.

[snjnfogarty@gmail.com](mailto:snjnfogarty@gmail.com)

**Treasurer**

Brian Clarke.

[bclarke@cik.ie](mailto:bclarke@cik.ie)

**Assistant Treasurer**

Dr. Brian Smyth

[bds53@eircom.net](mailto:bds53@eircom.net)

**Membership Secretary**

Dr. Declan Kennedy.

[d.kennedy@ucc.ie](mailto:d.kennedy@ucc.ie)

**Website Administrator**

Mary Mullaghy.

[mmullaghy@gmail.com](mailto:mmullaghy@gmail.com)

**Editor of SCIENCE**

Sean Fogarty.

[snjnfogarty@gmail.com](mailto:snjnfogarty@gmail.com)

### ISTA Branch Representatives

**CORK.**

Ryan Gallagher.

[ryangallagher2010@hotmail.com](mailto:ryangallagher2010@hotmail.com)

James Holden.

[jimmyholden2gmail.com](mailto:jimmyholden2gmail.com)

**DONEGAL.** Christopher Hegarty.

[christopherhgart@donegaletb.ie](mailto:christopherhgart@donegaletb.ie)

**DUBLIN.**

Humphery Jones.

[humphery.jones@gmail.com](mailto:humphery.jones@gmail.com)

Sean Kelleher.

[kellehersean@yahoo.ie](mailto:kellehersean@yahoo.ie)

Mary Sheridan.

[mary.j.sheridan@gmail.com](mailto:mary.j.sheridan@gmail.com)

**GALWAY.** James Stephens.

[jamesstephens24@gmail.com](mailto:jamesstephens24@gmail.com)

**KERRY.**

**KILDARE.** Dorothy Fox.

[dorothyfox@wicklowvec.ie](mailto:dorothyfox@wicklowvec.ie)

**KILKENNY/CARLOW.** Rachel Hott

[rachel.balance@gmail.com](mailto:rachel.balance@gmail.com)

**LIMERICK/CLARE.** Maria Sheehan.

[mariasheehan400@gmail.com](mailto:mariasheehan400@gmail.com)

**NORTH MIDLANDS.** Irene O'Sullivan

[osullivan.irene@gmail.com](mailto:osullivan.irene@gmail.com)

**SLIGO.** Caroline Hooper.

[Hopper.caroline78@gmail.com](mailto:Hopper.caroline78@gmail.com)

**TIPPERARY.** Paddy Daly.

[patrickdaly1943@gmail.com](mailto:patrickdaly1943@gmail.com)

**WATERFORD.** Mary McDonagh.

[mmcdonagh@delasallewaterford.ie](mailto:mmcdonagh@delasallewaterford.ie)

**WEXFORD.** Sean Fogarty.

[snjnfogarty@eircom.net](mailto:snjnfogarty@eircom.net)

### Editorial Team

**Editor**

Sean Fogarty.

[snjnfogarty@gmail.com](mailto:snjnfogarty@gmail.com)

**Assistant Editor for Biology**

Siobhán Sweeney.

[siobhanscottsweeney@gmail.com](mailto:siobhanscottsweeney@gmail.com)

**Assistant Editor for Chemistry**

Mary Mullaghy.

[mmullaghy@gmail.com](mailto:mmullaghy@gmail.com)

**Assistant Editors for Physics**

Richard Fox.

[richardtw.fox@gmail.com](mailto:richardtw.fox@gmail.com)

Seosamh Ó Braonáin.

[obraonainseosamh@gmail.com](mailto:obraonainseosamh@gmail.com)

**Assistant Editor for Primary Science**

Dr. Maeve Liston.

[maeve.liston@mic.ul.ie](mailto:maeve.liston@mic.ul.ie)

**Advertising Sales Director**

Aodhagán Ó Súilleabháin.

[aosuilleabhain@heywood.ie](mailto:aosuilleabhain@heywood.ie)

# MORE POSSIBILITIES WITH VERNIER



**Vernier**  
SOFTWARE & TECHNOLOGY



[WWW.VERNIER.COM](http://WWW.VERNIER.COM)  
CALL 043 334 1989



# President's Reflection

Gerald Fleming



The Nobel Prizes in some of the scientific disciplines were announced recently, and it is interesting to reflect on the topics that were the subject of the prize-winner's work. The prizes in chemistry, shared between three researchers, were for work in developing lithium-ion battery technology. The development of these devices has greatly increased the "energy density" of rechargeable batteries and enabled smaller viable battery packs to be developed for mobile phones, laptops and the like. More recently it is the same battery technology that provides the power to electric cars. Given that we will probably all be moving over to electric cars in the next decade or so the timeliness of this breakthrough in electro-chemistry is striking.

Of course, as is usual, the Nobel Prize is awarded for work carried out some time ago – in this case during the 1970s and 1980s. Still, it is impressive to realise how quickly the technology made it from the research laboratory into enabling smartphones and other "essential" tools to modern-day living, and to realise that without this work we might still be carrying around mobile phones that were the size of a small brick, and suffering a lot more "charging anxiety". There is still a bit of work to do before the batteries that power electric cars can deliver the range of a tank of petrol or diesel, but every year seems to bring improvement and no doubt the solution will be found.

It is a quirk of the lithium-ion battery that, under certain conditions, such as excess applied pressure, they can spontaneously combust. Thus the extra lecture we now routinely receive during the pre-flight safety demonstrations on-board aircraft, about calling your friendly steward or stewardess if your mobile phone happens to fall into your seat. Adjusting the seat while the phone is trapped may inadvertently provide that applied pressure, and one place you don't need even a small fire is on a Boeing or Airbus!

In contrast, the Nobel Prize for Physics was shared between two research efforts in the related fields of astronomy and cosmology. The stars have fascinated mankind throughout our existence, and the most ancient cultures made records of what they saw in the night skies, marvelling at the rich textures of starlight now invisible to most of us in the western world, living as we do in a light-polluted environment where true darkness has become almost unknown.

So it is interesting that the stars are still a subject of fascination and study, and all the more astonishing when we read that the 2019 Nobel Prize for physics was given for work that "contributed to answering fundamental questions about our existence" no less! As someone who was a physicist before specialising as a meteorologist, I am fascinated by how physics looks at the very largest things we know about - stars and galaxies – and the very smallest – sub-atomic particles such as quarks, mesons, muons, bosons, neutrinos – and in each case derives very profound and



fundamental insights into who and what we are, and where we came from.

I am reminded that the work of physics derives from what used to be called "natural philosophy" and that, for all the technological development spawned by physics discoveries down through the ages, the essential philosophical imperative that drives physics remains as strong as ever. As humans the impetus to understand and make sense of the world around us remains an essential challenge; that which differentiates us from the animals and is in many ways the essence of our "humanity".

All of which emphasises the need for "basic" scientific research; research that is not directed at improving some technological process, or focused on processes and developments that can be patented and monetised (although there should be a place for all of these too). Basic research, aimed at broadening and deepening our knowledge and understanding of ourselves and all that is around us, is an obligation placed upon us by our role as representing the highest point (thus far) in the evolutionary process.

Of course there are many who would challenge the notion of humans as the highest point of the evolutionary process, and there is a wealth of evidence to support that view. Among that evidence might be that we have known about climate change and its attendant risks to our existence for many decades now, but we have still to put a meaningful dent in the ever-increasing rise of carbon dioxide emissions to the atmosphere. During the upcoming Science Week in early November, I will be presenting a documentary on RTÉ One television, along with environmental scientist Dr Cara Augustenborg, during which we will look at the challenges of Climate Change in the Irish context.

I got to interview some very fascinating people during the making of the documentary, and while none of them underestimated the scale of the challenge nonetheless there was an overall positive sense that we can get on top of this problem and devise carbon-neutral lifestyles that will not entail tremendous sacrifices at the personal or community level. Of course our temperate climate and ocean-side location will shield us from the worst of the physical manifestations of climate change, but other parts of the world – and of Europe – will be much more seriously affected and may become virtually uninhabitable. Dealing with the social and political fallout from all of that may prove a challenge of a different order.

During the making of the documentary I got to visit Greenland and to walk on to the edge of the icecap there. Once you adjust to the noise of the wind that howls down from the centre of Greenland, where the icecap reaches to an altitude of about 4,000 m, the prevailing sound is the constant drip-drip-drip as the edge of the icecap slowly melts and retreats. This is the audio track of climate change; slow, steady and seemingly inevitable.



A DIVISION OF  
SCIENTIFIC & CHEMICAL SUPPLIES



Supporting science teachers to  
inspire tomorrow's scientists today  
with innovative, curriculum-relevant  
equipment and resources  
for the classroom



▶ Over 60 year's  
experience serving  
Primary, Secondary,  
FE & HE customers



▶ Large  
inventory



▶ Branches in  
the UK and  
Ireland



▶ Curriculum  
focused



▶ Dedicated  
regional territory  
managers

Discover more at

[www.shawscientific.com](http://www.shawscientific.com)

View/download our current science catalogue.  
Scan with a QR reader  
(available free from your app store)



@ScichemEdu ScichemScience



Physics



General  
Labware



Biology



Chemicals



Chemistry



Early Learning  
& Primary



Data Logging

Terms and conditions: Cannot be used in conjunction with any other offer or discount. Discount is valid for education customers in the Republic of Ireland only. ISTA15 discount code expires on **31st May 2019 at 11:59pm**. The discount will be applied to the goods total only and excludes Carriage and VAT. Discount valid on catalogue lines only and excludes Data logging and chemical product lines. You must enter or quote code **ISTA15** to redeem your discount.

**Shaw Scientific**  
Unit 14-15,  
Barrycourt Business Park  
Carrigtwohill, Co Cork

**021 488 2388**  
 **cork@scichem.com**



**besa**   
BRITISH EDUCATIONAL  
SUPPLIERS ASSOCIATION

# Chairman's Report

Aodhagán Ó Súilleabháin



I hope that all readers of SCIENCE have enjoyed settling into the new academic year with its many challenges and are feeling energised after a much needed mid-term break. Many thanks to Mr Sean Fogarty, our editor, on behalf of all ISTA members throughout the country, for his patience and energy in putting this issue of SCIENCE together with such a wonderful result. Thank you also to all the contributors and advertisers.

## Senior Cycle Review

### National Consultation forum

I was delighted to be in a position to attend the 'Senior Cycle Review: National Consultation forum' in Croke Park on Wednesday, 16<sup>th</sup> October. After an introduction by the NCCA chairperson, Ms Mary O'Sullivan, Ms Beatriz Pont, Senior Education Policy Analyst (OECD) presented the preliminary findings of the OECD assessment. Findings indicate that the Irish Leaving Certificate holds high levels of trust by the public, is deeply rooted in national culture and that the Leaving Certificate assessment and points system, "*gatekeeper to Higher Education*," results in highly motivated students with above average anxiety levels. The introduction of the Junior Cycle came to my mind at this point. The confusion that resulted at Junior Cycle level from the introduction of new specifications, while most teachers were unable to engage with CPD due to industrial action, simply cannot be allowed to happen at Senior Cycle level. We will see unprecedented levels of stress among our students. Notably, the report also found an above average index of teacher support in Science lessons. Ms Evelyn O'Connor of the NCCA then outlined what was emerging from the NCCA review to date and outlined the guiding principles for an evolving Senior Cycle. A report of this review will be issued in due course.

Ms Deirdre MacDonald, President of the ASTI and Mr John MacGabhann, General Secretary of the TUI gave their perspectives. Ms MacDonald emphasised that our current external assessment systems are highly regarded internationally and that the teacher/student relationship is essential and must not be interfered with. She claimed that everything that matters does not need to be timetabled explaining that much current extracurricular school activity developed life skills. She also emphasised that we need to thoroughly examine Junior Cycle and its outcomes before moving on to the Senior Cycle, stating, "*We cannot build on wet cement*". Mr MacGabhann emphasised that teachers "*will not fall victim to workload*" however virtuous the purpose may be. He stressed the importance of retaining the 6 - 7 subjects of the Leaving Certificate, discouraging excessive specialisation at this point. He called for curriculum developers to "*not be lured into fads and fashion*", encouraging a focus on durability and validity instead. He

also reiterated "*Mr Google has his place, but it cannot become the touchstone for everything*". He concluded with the assertion that the points race has to figure strongly in curriculum reform.

At this point, the Minister for Education and Skills Mr Joe McHugh, TD, arrived and addressed the assembly. He spoke eloquently to reassure us that he was conscious of the current flux and pace of change happening in second level and spoke of "*ensuring we take the time to get this right*". He encouraged the continuation of consultation mechanisms saying "*If we are going to get it right we need to hear everybody's voice*". He acknowledged teachers as equal arbitrators in going about change and stressed teachers' ability to be pragmatic. He highlighted the need to move toward pathways instead of endgames and acknowledged the need to ensure we equip schools with guidance councillors. He stressed the importance of apprenticeships and the need to prepare young people for life, progression and the development of resilience and responsibility. He acknowledged that the current Leaving Certificate system provides a lot of this, requiring time management, prioritisation etc. He appreciated the extensive comments from teachers and parents on the pressure Leaving Certificate students are under during the three weeks of the State Examinations and emphasised the current opportunity to address this. He concluded his address with an Irish phrase 'Rotha Mór an tSaoil', using it to emphasise the need to ask ourselves what we can take from the past to build for the future.

The remaining events comprised of the presentation of three table discussion questions that were opened for stakeholders to discuss in groups and submit their comments. Each discussion was preceded with a thoughtful overview of feedback to date by Ms Louise O'Reilly (NCCA) with perspectives presented by other invited speakers. Of particular note was the suggestion by Mr Tim Desmond, Head of Examination and Assessment Division, SEC, that pressure surrounding the Leaving Certificate examinations, with the "*relentless pursuit of CAO points*", could be reduced by having more general entry courses into Third Level Institutions. This received a spontaneous round of applause. The discussion questions put to all present were:

- How can we develop and diversify pathways and curriculum programmes?
- How can we broaden assessment and reporting to support successful transitions beyond school?
- What are the implications of senior cycle change for professional learning and for teachers and school

leaders?

Overall the day was a productive opportunity for those attending to be informed of the findings of the review of Senior Cycle to date, to reflect on these findings and to have some input on the key questions outlined above. I came away with the feeling that those involved in curriculum reform are very much open to ideas and that the development of solutions to some of these issues will not be straightforward. I would encourage teachers to engage in such events if the opportunities present themselves in the future.

### Senior Science Specifications

I would like to thank our subject convenors, Mr Sean Finn (Physics), Ms Lisa Darley (Chemistry) and Ms Margaret Hourigan (Biology), for their work so far on the Senior Science development groups, the first meeting of which took place on September 13<sup>th</sup> in Athlone. The curriculum specification for each subject is due to be published in September 2020 and is scheduled to be introduced to classrooms in September 2021. Well done to all science teachers who attended the Focus Group sessions on the Senior Science Specification development or completed the online questionnaire. It is vital that each teacher considers the issues involved and communicates their views. Ms Beatriz Pont (OECD) asked of curriculum development at the Senior Cycle Review in Croke Park "Does it have vision, theory of change? Does it have inclusive stakeholder engagement?" Many science teachers are extremely busy at this time of year, working far beyond the allocated teaching hours on sporting events, CBA planning, CPD, Open Nights and other events that need attention and careful planning. Many teachers I engage with do not regularly look up the NCCA website. It is clear that many teachers were unaware of the mechanisms of consultation available and of the deadlines for these mechanisms. The NCCA could do more to ensure that teachers are aware of these consultation devices and deadlines e.g. posters placed in every staffroom in the country. As Ms Pont said, "*If stakeholders are not included then it will not be implemented in the classroom*".

In the ISTA report '*Listening to the Voice of Science teachers*' a staggering 85% of science teachers responded that they would be either dissatisfied with (33%) or found unacceptable (52%) the application of the Junior Science specification template to the specifications of the Leaving Certificate sciences. This style of template has already been applied to the Leaving Certificate Agricultural Science specification. I certainly hope the Senior Science development groups can produce a satisfactory specification that will not raise the stress levels of both teachers and students, with such high consequences resulting from the Leaving Certificate assessment. This will undoubtedly happen if there is no clarity with regard to the depth of treatment of learning outcomes, a recurring issue in the feedback the ISTA received in its report '*Listening to the Voice of Science Teachers*'.

The ISTA will have raised these issues directly with the NCCA by the time this issue is published. A delegation from the ISTA is meeting with the NCCA very shortly to present a report on the 'Draft background paper and brief for the development of Leaving Certificate physics, chemistry and biology (September 2019)' on behalf of the ISTA.

### NCCA feedback on the early enactment of the Junior Cycle Science, Business Studies and English Specifications

Teachers are now being asked by the NCCA to provide feedback on the early enactment of the Junior Cycle Science, Business and English Specifications. Three consultation events have been organised. A maximum of 20 teachers per subject, per event, is permitted to register. The venues and dates for these events are as follows:

- Cork (Clayton Hotel, Lapps Quay, Cork City): 12<sup>th</sup> November
- Galway (Galmont Hotel, Lough Atalia Road, Galway): 18<sup>th</sup> November
- Dublin (Hilton Hotel, Kilmainham): 5<sup>th</sup> December

Registration for these events can be done through the NCCA website under Junior Cycle. Written submissions can also be made on a downloadable template found on the website and e-mailed to [consultations@ncca.ie](mailto:consultations@ncca.ie) by Wednesday 11<sup>th</sup> December 2019.

### Youth Assembly on Climate Change

It is with great enthusiasm I await the debate on Climate Change proposals by our newly formed national Youth Assembly on Climate. I applaud all those who applied for this wonderful opportunity for their enthusiasm, in what turned out to be an intensive application process, and wish all 157 who were selected as delegates on the Youth Assembly a productive and enjoyable day on Friday November 15<sup>th</sup>. On this date, they will take their seats in the Dáil Éireann Chamber to discuss what Ireland needs to do to take action on climate and environmental issues. The event will be broadcast on RTE News Now and Oireachtas TV, providing an excellent opportunity for teachers to tune in with their classes to witness the debate and provide material for further climate change discussion with their students.

### Amgen Biotech Experience

I had the pleasure of attending the Amgen Biotech Experience workshop recently in preparation for the delivery of biotechnology classes in my school. The Amgen Biotech Experience (ABE), previously endorsed by the ISTA, is an innovative science education program that empowers teachers to bring biotechnology to their laboratories. The workshop itself was well structured, professionally delivered and thoroughly enjoyable. Once I had been trained in its use ample equipment was made available to me for use in my laboratory. My heartfelt congratulations and thanks to Ms Barbara Hughes (Project coordinator), Ms Ann-Marie Barry (Technical Attendant) and Ms Fiona Wat-

ters (Public Engagement and Module Development Coordinator). Thank you also to Ms Elaine Quinn (ABE Ireland Site Director).

### ISTA AGM in the Explorium

The ISTA is very excited to hold our annual conference on the weekend of the 8<sup>th</sup> of February in the Explorium in Dublin. I had the pleasure of Mr Mark Langtry's company as I viewed the wonders of the Explorium for the first time during the summer and I must say I was very impressed with the exhibits and the activities available. As the Explorium website says *"feed your curiosity with more than 300 eye-popping interactive science and STEM experiences!"* Combined with the usual events organised for the ISTA AGM it is already shaping up for a fantastic weekend. I hope to see you there.

### JCT Science Symposium

The JCT Science team held their inaugural symposium in Cork Institute of Technology on Saturday the 14<sup>th</sup> September. A thoughtful group exercise on communication was followed by a number of presentations and workshops on a variety of topics. These included a presentation on student activities in Cork Educate together secondary school regarding climate change and a report of the activities of teachers from Temple Carraig school, Greystones and Templeogue College, Dublin who collaborated on Junior

Science planning. Congratulations to all involved.

### Young Scientist 2020

I would like to congratulate all students who qualified for this year's BT Young Scientist and Technology Exhibition and the teachers who worked with them to achieve this goal. As you all know the exhibition is a wonderful event, providing a wealth of life experiences for participants. The ISTA has a stand at the competition and we are looking for volunteers among ISTA members to take an hour at the stand to engage with the public. An e-mail will be sent to all members soon asking for volunteers to select an hour during the exhibition to attend the stand. Your support would be greatly appreciated!

### Senior Science Quiz 2019

Best of luck to all students participating in the finals of the ISTA Senior Science Quiz to be held at the Trinity Biomedical Sciences Institute, Trinity College, Dublin on Saturday 23<sup>rd</sup> November. Regional finals of the quiz were held at fourteen venues around the country during Science Week. Thanks to Ms Mary Mullaghy for all the hard work she puts in every year in preparation for this event.

That is all from me for now. I wish you the best with your teaching over the coming weeks and I hope you come out the other side of this term achieving all you set out to do!



INSTITUTE OF TECHNOLOGY  
**TRALEE**  
INSTITIUID TEICNEOLAÍOCHTA TRA LI

# CONSIDERING A CAREER IN SCIENCE?

TAKE A CLOSER LOOK AT IT TRALEE

#### ENQUIRIES TO:

School of STEM Office:  
Ms. Claire Horan  
Email: [claire.horan@staff.ittralee.ie](mailto:claire.horan@staff.ittralee.ie)  
Tel: 066 7145612



#### VETERINARY BIOSCIENCE

- » TL758 BSc in Animal Bioscience
- » TL858 BSc (Hons) in Veterinary Bioscience

#### CAREERS IN

- » Veterinary Diagnostics
- » Animal Health
- » Veterinary Practice Management
- » PG Research
- » Progress to PG Veterinary Medicine



#### WILDLIFE BIOLOGY

- » TL651 Higher Certificate in Science in Biological and Environmental Studies
- » TL851 BSc (Hons) in Wildlife Biology

#### CAREERS IN

- » Ecology & Conservation
- » Wildlife Tourism
- » Wildlife Education
- » Consultancy
- » PG Research



#### PHARMACEUTICAL SCIENCE

- » TL755 BSc in Pharmaceutical Science
- » TL855 BSc (Hons) in Pharmaceutical Science

#### CAREERS IN

- » Pharmaceuticals
- » Biopharmaceutics
- » Cell Culture
- » Laboratory Science
- » Quality Assurance
- » PG Research



#### AGRICULTURAL SCIENCE

- » TL748 BSc in Agricultural Science
- » TL848 BSc (Hons) in Agricultural Science

#### CAREERS IN

- » Agricultural Advisory Services
- » Agriculture Management
- » Agriculture Consultancy
- » PG Research



#### PHARMACY TECHNICIAN

- » TL652 Higher Certificate in Science (Pharmacy Technician) (2 years)

#### CAREERS IN

- » Community Pharmacy
- » Hospital Pharmacy

# News & Views

Mary Mullaghy



## ISTA PRESIDENT RECEIVES EUROPEAN METEOROLOGICAL SOCIETIES HIGHEST HONOUR

In September the President of ISTA, Mr Gerald Fleming, was presented with the EMS Silver Medal at the 2019 Annual Meeting of the European Meteorological Society which took place in Lyngby, Denmark. The Silver Medal is the highest award conferred by the EMS and is awarded



annually; among the previous winners is Prof Peter Lynch of UCD.

The citation for the 2019 award read: *'This award recognises his outstanding contribution to the communication of meteorological information through enhancing the public understanding of meteorological services and issues, and strengthening and fostering expertise in broadcast meteorology.'*

At the meeting Gerald Fleming gave the Silver Medal Lecture, titled:

*From Cardboard Charts to Climate Change – Four Decades of Challenges in Communicating Weather Information.*

The laudation was given by Ms Haleh Kootval, consulting specialist in meteorology and service delivery at the World Bank and former Chief of the Public Weather Services (PWS) Programme of the World Meteorological Organisation.



## DAVE FAHY RIP:



Dave, originally from Galway, was an engineer and business professional who worked on science-related events in Ireland. These included the EuroScience

Open Forum (ESOF)/City of Science in 2012, Festival of Curiosity, Sci:Com and Schrödinger at 75. "Dave had a marvellous, wry sense of humour, he knew how to handle the bureaucracy and politics of organising events and his people skills meant he could smooth things over. He didn't sweat the small stuff" said Prof Luke O'Neill who worked with him on several events. "I will miss him as a dear friend and adviser". When I approached him as ISTA chairperson/representative he provided free tickets for both ESOF and Schrödinger 75 which were raffled and distributed to ISTA members. We have all lost a great friend.

## ISTA ANNUAL CONFERENCE 2020



The ISTA Annual Conference 2020 will take place in the Explorium, on Saturday 8th February 2020. The conference will open on Friday 7th February in the Conference Hotel with a keynote speaker - details to be confirmed. The change

from the previously advertised data is due to all the flux in the Science Education landscape and the Sustainability of Science Education in Ireland. The theme this year is From Junior Cycle Science to Leaving Certificate biology, chemistry and physics: Issues and Challenges. All conference participants will also have the unique opportunity of trying out some of the activities in the Explorium - a great place for school tours of all ages. Conference Hotel: Clayton Hotel, Leopardstown, Dublin. Registration and more details will be online via a conference website later: [www.istaconference.com](http://www.istaconference.com) As it is earlier this year all branches must have their annual general meetings in advance as per the Association's Constitution.

## SENIOR SCIENCE QUIZZES



The Regional Finals of the annual ISTA Senior Science Quizzes took place in 14 venues nationwide at 7 pm on Thursday 14<sup>th</sup> November. The National Final, sponsored by BioPharmaChemical Ireland, will take place in TBSI in Trinity College on

Saturday 23<sup>rd</sup> November. We are delighted to have Mark Langtry as guest quizmaster in the Final.

## CHEMISTRY IN ACTION



The latest issue of Chemistry in Action! #114 is now out. It is also on the Chemistry in Action! website [www.cheminaction.com](http://www.cheminaction.com) together with the most recent back issues.

## SCIENCE & TECHNOLOGY IN ACTION



The 15<sup>th</sup> edition of Science & Technology in Action should be in all schools in November. Be in with a chance to win a €100 One4All voucher by taking their short teacher survey.

<https://www.surveymonkey.com/r/M39RX6C>

## ICASE – WORLD SCIENCE & TECHNOLOGY EDUCATION CONFERENCE

The 6<sup>th</sup> World Conference on Science and Technology

which is organised by ICASE (International Council of Associations for Science Education) is scheduled for Suan Nong Nooch Garden Pattaya-Thailand from 2<sup>nd</sup> - 6<sup>th</sup> December 2019. The theme of the conference is The Future of Science and Technology Education. Established in 1973, the objectives of ICASE are to extend and enhance the work of its member organizations; provide and support activities and opportunities to enhance formal and non-formal science and technology education worldwide; establish and maintain an international communication network; and encourage and support the establishment and development of professional science and technology organisations, especially where none currently exists in a country.

## THE GREAT IRISH SCIENCE BOOK



Professor Luke O'Neill has launched a new science book. The Great Irish Science Book looks at science through a child's eye. Travel through the

galaxies and stars, down to our very own planet Earth and across its fabulous features, into our wonderful bodies and all their cells, and on down to the very elements and atoms that make up all things, learning how it works along the way. The book is illustrated by Linda Fährlin and published by Gill Books, should inspire young minds as to how Ireland and its scientists have made huge contributions to science, as well as sparking their curiosity via a few experiments that will help them think like scientists.

Professor O'Neill said: "It's been such a thrill writing *The Great Irish Science Book* and Linda Fährlin did such a fantastic job with the illustrations. We hope the book will encourage the next generation of scientists to join us on our great scientific adventure".

## WOMEN IN THEIR ELEMENT



This book offers an original viewpoint on the history of the Periodic Table: a collective volume with short illustrated papers on women and their contribution to the building and the understanding of the Periodic Table and of the elements themselves. Stories of female

input, the editors believe, will contribute to the understanding of the nature of science, of collaboration as opposed to the traditional depiction of the lone genius. While the discovery of elements will be a natural part of this collective work, the editors aim to go beyond discovery histories. Stories of women contributors to the chemistry of the elements will also include understanding the concept of an element, identifying properties, developing analytical methods, mapping the radioactive series, finding applications of elements, and the participation of women as audiences when new elements were presented at lectures. As for the selection of women, the chapters include pre-periodic table contributions as well as recent discoveries, unknown stories as well as more famous ones. The main emphasis will be on work conducted in the late 19th century and early 20th century.

# Sky & Space - Transit of Mercury 2019

Seosamh Ó Braonáin



**Monday 11<sup>th</sup> of November 12.30 to 16.30** (beginning of Science Week!)



**S**unspot on the left edge,  
Mercury bottom centre.

### What is it:

Mercury comes directly in between us and the Sun, a rare event, the next one is in 2032.

### What can we see:

A small black dot will move across the Sun: **DO NOT LOOK AT THIS** ⚠

### How can we SAFELY observe:

Use the projection method with a telescope preferably at least  $\times 50$  magnification (Mercury is small).

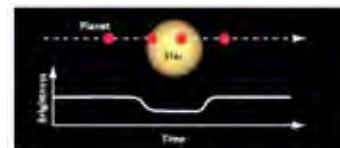


### To observe online:

check on <https://slooh.com> and NASA tv at <https://www.nasa.gov/multimedia/nasatv/#public> they are likely to broadcast live.

### Why is it important?

1. This is how planets orbiting around other stars have been discovered in recent years
2. See Junior Cycle Science exam 2019 q 10
3. The Nobel Physics Prize was awarded this year to two scientists who discovered the first exoplanet in 1995
4. The telescope used by the National Schools Observatory as described by Richie Moynihan in this issue has also discovered many exoplanets using this transit method.



### BONUS:

On 11<sup>th</sup> November and onwards, Venus is visible low in the south-west just after sunset.

For more up to date information: follow me on twitter @BraonainO

### References:

timeanddate.com, earthsky.org, examinations.ie, <https://www.rte.ie/news/world/2019/1008/1081891-nobel-prize-winner/>



**I**n a small telescope, Venus can be seen to be about 90% full phase at the moment, its phase will gradually change to a crescent by summer 2020

# AerPrize Competition 2020



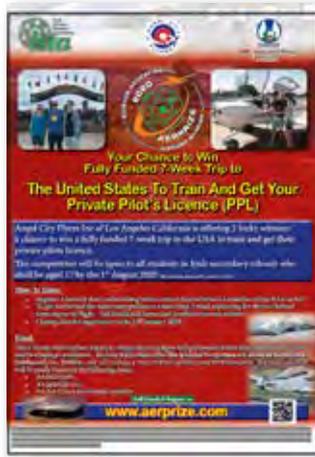
At our AGM earlier this year we confirmed the 2019-2020 round of the biannual AerPrize competition. The ISTA is once again delighted to be involved in running this competition, the aim of which is to promote STEM subjects in Irish schools. As in the 2017-2018 competition the amazing prize is a fully funded 7-week trip to the United States for two lucky second level students to train and get their Private Pilot's Licence (PPL). The competition is sponsored by Mr. Seosamh Somers and his company Angel City Flyers Inc of Los Angeles California. Angel City Flyers is a flight training and aircraft services organisation. They are seeking to encourage and promote STEM education and want to do so by showcasing the practical application of



will then go on to a second round. All members of these teams will have an equal chance to win the top prize of flight training in California.

The second round will take place at the headquarters of the Irish Air Corps, Baldonnel Aerodrome. The airbase, dating back to 1917 was the one from which the first successful east-west Atlantic crossing as well as the first Aer Lingus flight took place in 1936. It was also the destination at which Douglas Corrigan landed on his famous 'wrong way' flight across the Atlantic in 1938.

The winning teams from the first round will get to experience what life is like on a working airbase and to see many historic items in the bases extensive



science in aviation, their chosen business. With his Irish roots, Seosamh chose Ireland and requested the ISTA to assist in his project. We were delighted to be involved.

The competition was first run in the 2017- 2018 school year and the two winners went on to get their PPL in California. This time the competition will again be open to all students in Irish secondary schools who shall be 17 by the 1<sup>st</sup> August 2020 (the minimum age to qualify as a pilot

A poster is included in this issue of Science which we ask you to display in your school and bring it to the attention of 5<sup>th</sup> and 6<sup>th</sup> year students.

in the US). The students must have a contact teacher who is a member of the ISTA or IoP. The competition will again be in two parts. The initial round of the competition will be a team effort. Teams of up to four students must prepare a short (max. 5 min) video presentation on some aspect of flight training. The teams that produce the best videos

#### HOW YOUR STUDENTS CAN ENTER

- Register a team (4 max) online (they will need to give the name of a contact teacher who is a member of the ISTA or IoP).
- To get to the final the team must produce a video (max 5 min) explaining the physics behind some aspect of flight – full details and terms and conditions are on website.
- **Closing date for registration is Friday 10<sup>th</sup> January 2020.**



Aerprize 2018 winners Conor and Carmel during training in California.



Seosamh Somers addresses finalists at the 2018 AerPrize finals held at the Alantic Flight Training Academy's facilities in Cork

museum . A final selection process will take place at this stage to choose the two winning students as well as two backup students who would be available to take the place of the winners if for some reason they were unable to travel or avail of the prize. This is a fantastic chance for any student with an interest in technology or aviation or who is thinking of a career in aviation. The US PPL can easily be converted to the European version and can be extended to a commercial pilot's licence. The total value of this prize for the winners is in the order of €35,000. A poster is included in this issue of Science which we ask you to display in your school and to bring it to the attention of 5<sup>th</sup> and 6<sup>th</sup> year students. The formal commencement of the competition will coincide with Science Week when teams can register online for the competition at the competition website [www.aerprize.com](http://www.aerprize.com). Make sure to alert your students to this wonderful opportunity

*I am the product of an Irish secondary education. I know if I had had the chance to get such a prize, the opportunity would have turbocharged my efforts in science and maths. After I received an excellent education in Ireland and then further education in the EU, I chose to make my living in the USA. Aerprize is partly a way of paying something back for my great learning experience.*

*Seosamh Sommers*

FULL DETAILS AT  
[www.aerprize.com](http://www.aerprize.com)



Finalists in the 2018 AerPrize competition after receiving their AerPrize Certificates at the Alantic Flight Training Academy in Cork

# Moving from Junior Cycle Science to the Leaving Certificate Sciences:

## Should the same template of specification (syllabus) design be used?

Dr Declan Kennedy, Department of Education, UCC



In this article Declan Kennedy summarises some of the key points that arose from teachers' views on the application of the Junior Cycle template of specification design to the proposed new Leaving Certificate biology, chemistry and physics specifications. Declan is the author of several papers on Learning Outcomes in peer-reviewed journals. He is also the author of the book "Writing and Using Learning Outcomes : A Practical Guide" which, to date, has been translated into 14 languages.

### Introduction

Since the introduction of the Junior Cycle science curriculum in September 2016, various discussions have been held at ISTA Council meetings about teachers' experiences of implementing this curriculum in the classroom. Arising out of these discussions, the ISTA issued a questionnaire to science teachers throughout the Republic of Ireland during the period February - March 2019. The purpose of the questionnaire was to enable science teachers to give feedback on their experience of teaching the Junior Cycle science specification (syllabus). In this article the terms syllabus and specification are used interchangeably. A detailed discussion on the precise meaning of these two terms is provided in a separate article (Kennedy 2018)

The responses from science teachers in the light of their experience of teaching the new Junior Cycle science curriculum are presented in the report *Listening to the Voice of Science Teachers* (ISTA 2019). A total of 762 teachers responded to the questionnaire. The full questionnaire is reproduced in Appendix 1 of the above report. This article concentrates on the responses to one question (question 16) of the questionnaire, below:

16. Based on your experience of working with the new template of specification at junior science level, please indicate how you would feel if the specifications at Leaving Certificate sciences would be presented using the same template.

Very satisfied     Satisfied     Dissatisfied     Unacceptable

Please explain.

The responses from teachers are summarised in Figure 1.

The fact that 85% of teachers described their level of satisfaction as either "unacceptable" or "dissatisfied" is a very strong indicator that teachers in the classroom have found serious problems with the template of the Junior Cycle science specification. Teachers were also asked to explain the reasons why they chose a particular option.

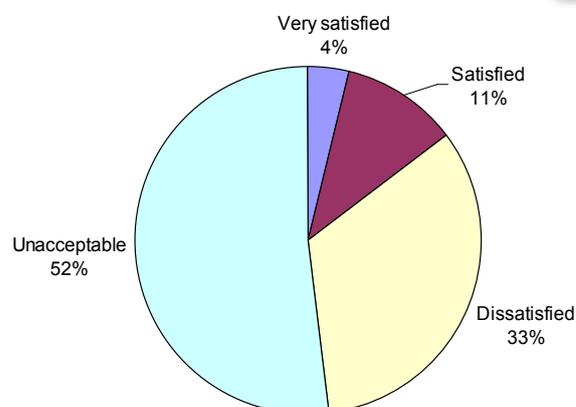


Figure 1 The level of satisfaction indicated by teachers if the same template used in the Junior Cycle science specifications were to be used for the new Leaving Certificate biology, chemistry and physics specifications.

### What concerns were raised by teachers about the template used to design the Junior Cycle science specification?

As it is difficult to capture all the key points in this short article, teachers are encouraged to read pages 79 – 95 of the full ISTA report (ISTA 2019) to get a good overview of the responses of teachers.

Many teachers commented on the **vagueness of the learning outcomes** and the need for **depth of treatment** to be supplied.

*The learning outcomes do not give enough information about depth of treatment and are open to interpretation by teachers and the State Examinations Commission.*

*The vagueness of the Junior Cycle needs to be clarified first. Teachers are still getting to grips with the new course. Leaving Certificate reforms while necessary should not be rushed in until a full assessment of the success of Junior Cycle has been carried out.*

*The new JC specification is not a specification as it is not specific at all. I have worked in the UK and have seen what a specification should look like. This vague use of a list of learning outcomes only resulted in every school wasting many hours with pointless paperwork such as the unpacking fiasco.*

*Too much work trying to "unpack the learning outcomes". Just spell it out clearly and let us get on with teaching.*

*I actually would consider leaving teaching. Totally unacceptable for students to be sitting a common exam without a detailed syllabus so that every student in the country has the exact same opportunity. It should not be up to teachers*

to decide *WHAT* to teach, it is up to teachers to decide *HOW* best to teach it.

Current JC specifications give no detail or guidelines on the depth of treatment required. The specifications are anything but specific.

What exactly is wrong with actually indicating the depth of treatment needed for each topic? The current JC specifications basically mean that different teachers can teach different topics to totally different levels with totally different time allocations. How can that be acceptable?

My JC students have been used as guinea pigs to implement this new JC course I as a teacher would not be able to stand over the same at senior cycle. We did not get adequate training. A DEFINITE SYLLABUS IS REQUIRED FOR SENIOR CYCLE.

The template being used at Junior Cycle level is simply dreadful. The specification consists simply of a list of learning outcome with no details of depth of treatment. In a recent article in the Irish Times on 26 February 2019, the teacher who wrote the article described Junior Cycle reform as resembling "an IKEA-style flatpack but with no accompanying instructions". I fully agree with this sentiment. At the JCT courses a lot of time was spent telling us how to "unpack the learning outcomes". It is not the job of the teacher to interpret the learning outcomes. It is not our job to try to read the minds of those who designed the specifications. It is the job of the NCCA and its committees to draw up syllabi of international standard as outlined in the Hyland Report. It is the duty of the NCCA to provide proper syllabi as we have at present in Leaving Certificate biology, chemistry and physics. Leaving Certificate syllabi need to be properly designed and fit for purpose.

It involves a lot of guess work and I am bombarded with so many initiatives that I am seriously considering retiring early. Just tell us what to teach and let us get on with it.

Many teachers commented on the unsuitability of the template for a **high stakes examination**.

No depth of treatment provided, will lead to complete lack of standardisation and quality of teaching and learning will plummet. Until NCCA are willing to give a proper syllabus with depth of learning provided, this specification approach will not meet the needs of students or teachers. It has already been demonstrated through Professor Aine Hyland's report that a proper syllabus is needed. Stop wasting our time with this ambiguous document ("specification").

The specifications are far too broad and open to too many different interpretations. The courses that are highly regarded by international standards (e.g. the IB) have much more specific syllabuses so that the students are very clear about what they need to know. In order for a system to be fair and well regarded there needs to be a clear understanding of exactly what a student is expected to be able to do. The depth to which each topic needs to be taught has to be clear, otherwise it could leave some students at a disadvantage depending on how their teacher interpreted each learning outcome. Changing the Leaving Cert

to be like the Junior Cycle would have a hugely negative impact on how the standard of the Irish education system would be judged and would make the process much more unfair on the students. It would be a tragedy.

Vague learning outcomes will lead to further dumbing down and a decrease in the quality of the Irish education system that will have serious long term negative effects on the education system and economy.

Students' futures should not be down to interpretation of woolly vague specifications.

Far too vague for such a high stakes exam.

Having dumbed down the Junior Cycle we now intend to dumb down the Leaving Cert. also? We will end up destroying the Irish education system.

They would know very little content at a very vague level and would not be able to cope with science courses at university level. We are being constantly told we have to share learning intentions with students but how can I do that when I don't know exactly what they need to know. How can they have a high level of science required for university with such a wishy washy foundation. Totally unacceptable. The only hope universities have of decent science students is if we undo the damage Junior Cycle has done.

I feel at present the LC Chemistry syllabus is generally good. I believe it provides a good all round foundation for life/ future chemistry careers. I would be extremely unhappy with the learning outcome approach with a lack of depth of treatment.

It would be a destruction of the current excellent syllabi, a further dumbing down of the subjects and very hard to teach without clear learning outcomes.

There was a strong emphasis placed by teachers on concern that vague syllabi at Leaving Certificate would lead to **increased stress** being placed on students and teachers.

Teachers are left to work out what's on the syllabus for themselves. The stress of this is frightening. A disaster if brought in at Leaving Cert.

The new JC science is a disaster. Students hate it and as teachers we are completely stressed with the lack of guidance. Science is a factual subject and students need to learn the basic facts before they can plan investigations etc.

The non-defining of the Junior Cycle syllabus has led to increased stress for both pupils and teachers. The contents of the textbooks vary so much that it is impossible to know how best to advise students on learning. This level of uncertainty is detrimental to wellbeing. I would hate to put our Leaving Cert students through a similar process.

I honestly feel if the LC changed in the same manner as the new Junior cycle that it would be to the detriment of the Irish education system and standard of students presented to higher education. The students would be incapable of actually learning important pieces of information. The

*absolute vagueness of the learning outcomes would put a strain on teacher-student relationships, where I wouldn't even have confidence in myself as a teacher that I would be pointing them in the right direction.*

*I think the way the new Junior Cycle was bought in was disgraceful. Very little information, very little thought behind the assessments. Assessments that take up a lot of class time but have no real importance. A slow dribbling release of resources.*

*I couldn't face another 2/3 years of teaching the unknown. Please no!!!!*

*Student anxiety might be an issue as it is unfortunately a high stakes exam.*

*The level of anxiety experienced by LC students would have detrimental effects to all.*

*It needs to be clear what has to be taught. Cannot afford the ambiguity or guess work at Leaving Certificate level.*

*With students' futures directly affected by their LC I could not work with the ambiguity of the learning outcomes system as it stands. It would cause extreme stress and anxiety for both students & teachers I believe. For example 'a range of separation techniques'.....how many? What if I do 4 but the exam paper asks about the 5th we didn't cover. It is too vague.*

*We need to know exactly what to teach. This becomes vital given the significance of the Leaving Cert exam to our students' futures.*

*Specification is far too vague, "unpacking" very stressful, time consuming and open to interpretation...*

*I would be horrified!! I need a syllabus that is understandable and written in plain straightforward English which clearly states what the students precisely need to know (just like the current Leaving Cert. syllabus) and what experiments they need to have done. I also do not want to see any reduction in contact time with classes as I struggle as it is to cover the course in the time allowed.*

### **The new Leaving Certificate Biology, Chemistry and Physics specifications**

In the NCCA draft background paper and brief for the review of Leaving Certificate physics, chemistry and biology syllabi, it is stated that "new specifications for Leaving Certificate physics, chemistry and biology are scheduled to be introduced in 2021. The curriculum specification for each subject will be published a year earlier in September 2020" (NCCA 2019). In short, the current Leaving Certificate syllabi in biology, chemistry and physics are due to be revised over the coming months and new specifications will be published next September 2020 for implementation the following year.

Drafts of the proposed new Leaving Certificate specifications were completed in 2014. These draft specifications caused alarm among several members of the subject development groups with responsibility for developing the new specifications. Members of the subject development

groups were told that it was NCCA policy that specifications would be presented in the template that consisted simply of a list of learning outcomes. The reports of the ISTA convenors were discussed at ISTA Council which expressed its concern to the NCCA as far back as 2013 when it wrote to the NCCA as follows:

"In terms of structure and clarity of depth of treatment, the Leaving Certificate syllabi in biology, chemistry and physics currently being taught in schools are far superior to the proposed draft syllabi recently circulated. The essential problem with the proposed draft syllabi is that they simply contain a list of learning outcomes with no indication regarding depth of treatment or range of subject knowledge associated with these learning outcomes. **We request that this depth of treatment and range of subject knowledge be integrated into the draft syllabi (as is the case with the syllabi currently being taught) before they are finalised by the Council of the NCCA.** It is vital that this important material is embedded into each of the syllabi and not made available as separate documentation at a later stage. Even highly experienced science teachers at our ISTA Council meeting found problems with interpreting many of the learning outcomes. It is clear that there is still a considerable amount of work to be done in order to reduce the "fuzziness" of these draft syllabi and thus bring them up to the standard of the current Leaving Certificate biology, chemistry and physics syllabi.", Figure 2.

The views of the ISTA were ignored by the NCCA which stated in a written reply that "We don't intend to include 'depth of treatment' and/or 'range of subject knowledge' in the new specifications for the sciences or for other subjects in senior cycle.

As no progress was made with the NCCA, it was decided by ISTA Council to commission Professor Áine Hyland, Professor Emeritus of Education, UCC, who is an international expert in the area of curriculum design and assessment. In addition, Professor Hyland is an expert in the area of learning outcomes as it was she who introduced learning outcomes into Ireland in the early 2000s, Figure 3.

Since the Bologna Agreement of 1999, learning outcomes have been chosen as the international language for drafting curricula throughout the European Higher Education area and at international level (Kennedy, Hyland and Ryan 2006; Kennedy 2007; Kennedy, Hyland and Ryan, 2009). Learning outcomes are defined as statements of what a student is expected to know, understand and be able to demonstrate after completion of a process of learning (Morss and Murray 2005, ECTS 2015). The definition of learning outcomes given in the Junior Cycle Science specification ("Learning outcomes are statements that describe the understanding, skills and values students should be able to demonstrate after a period of learning") is incomplete as there is no reference to knowledge in the definition (NCCA 2016). An extraordinary error! Without knowledge, one cannot have understanding, application or any of the higher order thinking skills in Bloom's Taxonomy.

In the recently published *Draft Background Paper and Brief for the review of Leaving Certificate Physics, Chemistry and Biology* (NCCA 2019) the following is stated:

“Given the concerns expressed by many stakeholders about the enactment of the specifications following the consultation on the draft specifications in 2014 (Hyland, 2014), it is clear that many stakeholders in Ireland do not easily see the potential of learning outcomes to support them to design and deliver appropriate programmes for the students in their contexts”. (NCCA 2019 p.24)

This statement is both erroneous and misleading and shows a fundamental misunderstanding of the concept of learning outcomes by the author of the Draft Background Paper. Learning outcomes on their own are of little value unless accompanied by depth of treatment to clarify what exactly is meant by the learning outcome. For example, one could write the same learning outcome for a student in primary school, secondary school or third level. Thus,

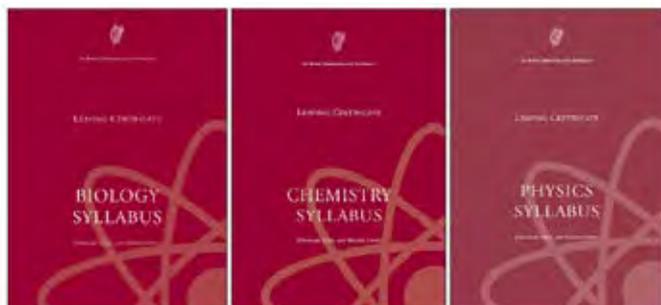


Figure 2. The current Leaving Certificate biology, chemistry and physics syllabi are detailed documents which contain depth of treatment, social and applied aspects as well as details of student and teacher activities and laboratory practical work.

learning outcomes are meaningless without additional information on the depth and range of subject knowledge being examined. The ISTA report *Listening to the Voice of Teachers* provides ample evidence for this fact as teachers struggled to try to make sense of many of the learning outcomes listed in the specification.

Professor Hyland was asked by the ISTA to address two fundamental research questions about the 2014 draft Leaving Certificate specifications:

- What is international best practice in the drafting of syllabi for second-level curricula?
- Is the current reform of Leaving Cert syllabi in Ireland in line with international best practice?

In order to address the above research questions, Professor Hyland examined a wide range of science syllabi for a similar age group as the Leaving Certificate and a centralised (i.e. not school-based) mode of assessment (similar to the Leaving Certificate) at international level. From the data gathered, she identified the characteristics of international best practice in the design of science syllabi and focused on Scotland, Australia and also on the International Baccalaureate system as exemplars of good practice. The Hyland Report was launched in 2014 at the ISTA Annual

Conference in NUIG, Figure 4.

The full report (Hyland 2014) and a three-page synthesis of the report (Kennedy 2014) may be downloaded from



Figure 3. Professor Áine Hyland, Professor Emerita of Education, UCC.

the ISTA website. A short summary of the Conclusions and Recommendations of the Hyland Report is now given.

## Conclusions of the Hyland Report

The six main conclusions may be summarised as follows:

**1. Depth of treatment.** The lack of depth of treatment in the proposed Leaving Certificate biology, chemistry and physics specifications is not in keeping with best international practice. After carrying out her analysis of curricula at an international level Professor Hyland states that “in every public examination system identified for this report, the syllabi for the end of senior cycle examinations include considerable detail about depth of treatment, examination specification, practicals and laboratory experiments and other advice for teachers and pupils. While learning outcomes are specified in all the syllabi, they are only one element of the detail provided. (p. 5 Hyland Report).

The problem with lack of depth of treatment is highlighted in Table 1 (p. 21 Hyland Report).

	Current syllabus	Draft specification
<b>Biology</b>	38 pages (p.7 – 44)	13 pages (p. 19 – 30)
<b>Chemistry</b>	35 pages (p. 37 – 71)	18 pages (p.20 – 37)
<b>Physics</b>	20 pages (p. 25 – 44)	12 pages (p. 21 – 33)

Table 1 Comparison of syllabus lengths

**2. More work required on the draft specifications.** Professor Hyland points out that more work is needed on the draft specifications in biology, chemistry and physics in order to bring them up to international standard: “While the current NCCA draft specifications may be a valid first step in outlining the syllabi, this researcher agrees with the ISTA that it is not sufficient to describe a high-stakes examination programme in terms merely of topics and learning outcomes. More detailed information about the depth of treatment of subjects and the requirements for examination must be provided at national level in Ireland to bring the syllabi into line with international good practice.” (p. 42 Hyland Report)

**3. Fundamental flaws in template being used by NCCA for syllabus design.** It is clear from the reports of the ISTA representatives working on NCCA subject development groups that considerable frustration was experienced as a result of all three science specifications being forced into a template consisting of nothing more than a list of learning outcomes. The fundamental flaw in the template being used by the NCCA is highlighted in the Hyland Report. Professor Hyland points out that the practice of the NCCA

Figure 4. Professor Aine Hyland's report was based on the drafts of the 2014 Leaving Certificate biology, chemistry and physics specifications. These drafts are currently under discussion by the NCCA subject development groups and the specifications are due to be finalised in 2020.



in designing syllabi that consist solely of a list of topics and learning outcomes is not good practice in syllabus design and that "this researcher has not come across any centralised or public examination syllabus at this level which provides only a list of topics and learning outcomes. (p.5 Hyland Report). In addition, Professor Hyland points out that "while learning outcomes are a very valuable tool for identifying what learners should know and be able to do at the end of a course or programme, it is not appropriate to use learning outcomes alone to define a syllabus and its assessment." (p. 5 Hyland Report).

**4. Problems identified in NCCA benchmarking exercise.** Professor Hyland expresses concern with the benchmarking exercise carried out by the NCCA in designing the Leaving Certificate Science syllabi: "It would appear that for international benchmarking purposes, the NCCA has used the curriculum framework Curriculum for Excellence of Education Scotland, and the national curriculum framework for the whole of Australia, set by the Australian Curriculum, Assessment and Reporting Authority (ACARA), rather than the examination syllabi provided by the Scottish Qualifications Authority (SQA) and by the Victorian Curriculum and Assessment Authority (VCAA), which in the view of this researcher are the more relevant benchmarks." (p. 41 Hyland Report). Having expressed concern at the benchmarking exercise, Professor Hyland provides very good evidence to support her concern at the quality of the benchmarking exercise carried out by the NCCA. She compares three chemistry syllabi (Scotland, Australia and International Baccalaureate) with the NCCA draft

Leaving Certificate Chemistry syllabus: "Comparing these three chemistry syllabi with the NCCA draft specification for Leaving Cert chemistry, one notes a significant difference in approach between the three systems chosen and the approach of the NCCA. While the NCCA document resembles, to some extent, the national curriculum and assessment guidelines of Education Scotland, or the curriculum and assessment guidelines of the Australian Curriculum and Assessment Authority it does not resemble the detailed examination syllabi provided by the examining and awarding bodies in Scotland (the Scottish Qualifications Authority), in Victoria, Australia (the Victorian Curriculum and Assessment Authority) and the International Baccalaureate Organisation (IBO)." (p. 41 Hyland Report).

**5. Fall in standards of science syllabi.** Professor Hyland warned of the dangers of writing syllabi solely in terms of a list of topics and learning outcomes as this could lead to a fall in standards: "Learning outcomes are statements of essential learning, and as such they are written at minimum acceptable or threshold (pass / fail) standard. If teachers focus only on learning outcomes, there is a real risk that the teaching and learning targets will be at a minimum rather than a maximum level, that the bar will not be set high enough for student learning, and that as a result, standards will fall" (p. 5 Hyland Report). Professor Hyland also points out that the design of the Leaving Certificate biology, chemistry and physics syllabi currently being taught in schools are of a high standard with a format that is "consistent and clear across subjects" (p. 12 Hyland Report). The report also states that "the current Leaving Certificate physics, chemistry and biology syllabi, which have been implemented since the early 2000s, are highly regarded by teachers and have contributed to a reversal of the decline in the numbers of pupils taking science subjects at senior cycle" (p. 40 Hyland Report).

**6. No justification for keeping syllabi vague.** One of the reasons put forward by NCCA representatives at NCCA syllabus committee meetings for not including depth of treatment was that over-specification of syllabus design contributes to rote learning. In Chapter 4 of the Hyland Report, it is made very clear that there is no link between giving detailed depth of treatment and rote learning: "The international comparisons in Section 2 of this report show that it is possible to provide syllabi or examination programmes which include detailed guidelines; teachers' notes; assessment specifications etc. while at the same time devising an approach to assessment which does not reward rote-learning and ensures that higher order skills are recognised and rewarded. To my knowledge, it has never been suggested that the detail provided by the IBO Diploma syllabi or the Scottish Highers or the Victorian Certificate of Education has led to or leads to rote-learning." (p.39 Hyland Report).

### Recommendations of the Hyland Report

The three main recommendations of the Hyland Report may be summarised as follows:

**1. Syllabi need to be brought up to international standard.** Professor Hyland points out very clearly that “more detailed information about the depth of treatment of subjects and the requirements for examination must be provided at national level in Ireland to bring the syllabi into line with international good practice.” (p. 5 Hyland Report). Professor Hyland also recommends that the depth of treatment of the draft Leaving Certificate biology, chemistry and physics syllabi should at least be brought up to the standard of the current syllabi being taught in schools at present: “It is the considered view of this researcher that the final versions of the proposed new syllabi for physics, chemistry and biology, should contain at least the same depth of treatment as is available in the current syllabus documents, as well as detailed examination specifications and Teachers’ Notes. When approved by the Minister, the full range of documentation in relation to each syllabus should be published online and in hard copy under the logo of the Department of Education and Skills, prior to the implementation of the syllabi.” (p. 44 Hyland Report).

**2. Full range of documentation available before implementation of the syllabi.** Professor Hyland recommends that “the full range of syllabus documentation (including teachers’ notes, examination specifications etc.) should be officially published at the same time as the syllabus itself, under the logo of the DES as has been the case in the past. This elaborated documentation should be available well before the syllabus is due to be implemented, to enable teachers to become familiar with the new material and to undergo appropriate professional development and up-skilling” (p. 5 Hyland Report). Details of examples of syllabi documentation in Scotland (200 pages approx), Australia (200 pages approx.) and the International Baccalaureate (150 pages approx) are included in the report (see p. 26 -36 and p. 40-41).

**3. Depth of treatment embedded within the syllabi.** Professor Hyland points out the importance of having depth of treatment embedded within syllabi developed by NCCA: “From 1989 to date, the advice provided by the NCCA to the Minister has included the level of detail that teachers expect and need to enable them to prepare their students for the Leaving Certificate public examinations. That level of detail has also been used and will continue to be required by the SEC to enable them to set and mark the Leaving Certificate examination papers. It is the considered opinion of this researcher, that the issue of depth of treatment and clarity of examination specifications will become an issue for all Leaving Certificate subjects as the revision of Leaving Certificate syllabi proceeds. It is almost inevitable that the concerns raised by ISTA will be echoed by other subject teachers and associations as well as by third level representatives if the matter is not addressed now.” (p. 43 Hyland Report).

## Conclusions

It is important that we treat our teachers with respect and act on the serious concerns expressed by them about the current template being used by the NCCA for developing

new specifications for Leaving Certificate biology, chemistry and physics. It is clear from the report *Listening to the Voice of Science Teachers* (ISTA 2019) that it would be intolerable and a source of great stress and anxiety to teachers and their students if teachers themselves have to interpret or “unpack” learning outcomes to try to work out for themselves the depth of treatment relating to each learning outcome.

It is alarming that, despite the concerns raised in the Hyland Report in 2014 about the template of syllabus design being used by the NCCA, the same template was used in the Junior Cycle science specification introduced in 2016. Clear evidence in areas such as difficulties in interpreting learning outcomes and “dumbing down” of standards have been highlighted by large numbers of science teachers in the ISTA Report *Listening to the Voice of Science Teachers* (2019). This is clear evidence for what was predicted in the Hyland Report has now come to pass. The fact that science teachers have overwhelmingly stated that it would be unacceptable for the same template of specification design to be used in the proposed new Leaving Certificate biology, chemistry and physics specifications must be taken into consideration. The solution to the problem is straightforward: the recommendations of the Hyland Report must be implemented in order to bring the specifications up to international standard. This matter will be one of the central themes in the ISTA Conference to be held in the Explorium on Saturday 8 February 2020. Please attend and show your support to ISTA in its efforts to ensure that the new Leaving Certificate specifications in biology, chemistry and physics will be of international standard.

## References

- ECTS Users’ Guide (2015). Available at: [https://europass.cedefop.europa.eu/sites/default/files/ects-users-guide\\_en.pdf](https://europass.cedefop.europa.eu/sites/default/files/ects-users-guide_en.pdf)
- Hyland Report (2014). Available at: <https://www.ista.ie/the-hyland-report-2/>
- ISTA (2019) Listening to the Voice of Science Teachers. Available at: [www.ista.ie/jc-science-report/](http://www.ista.ie/jc-science-report/)
- Kennedy D, Hyland A and Ryan N (2006) Writing and using Learning Outcomes, Bologna Handbook, Implementing Bologna in your Institution, C3.4-1, 1 – 30.
- Kennedy, D (2007) Writing and Using Learning Outcomes – A Practical Guide. Quality Promotion Unit, University College Cork. Available from <https://cora.ucc.ie/bitstream/handle/10468/1613/A%20Learning%20Outcomes%20Book%20D%20Kennedy.pdf?sequence=1>
- Kennedy D, Hyland A and Ryan N (2009) Learning Outcomes and Competences, Bologna Handbook, Introducing Bologna Objectives and Tools, B2.3-3, 1 – 18.
- Kennedy, D (2014) The Hyland Report - Implications for Science Education in Ireland. *Science*, 49 (3 ): 11- 13
- Kennedy, D (2018) Junior Cycle Science: Syllabus or Specification? *Science*, 53 (2 ): 36- 38
- Morss, K and Murray R (2005) Teaching at University. London: Sage Publications ISBN 1412902975
- NCCA (2016). Junior Cycle Science Curriculum Specification. Available at <https://www.curriculumonline.ie/getmedia/f668d804-6283-4d4a-84ab-c71e5b37d198/Specification-for-Junior-Cycle-Science.pdf>
- NCCA (2019) Draft background paper and brief for the review of Leaving Certificate physics, chemistry and biology: <http://tiny.cc/BPaper>
- NCCA Draft Leaving Certificate Biology Specification (2019): <http://http://tiny.cc/BioSpec>
- NCCA Draft Leaving Certificate Chemistry Specification (2019): <http://tiny.cc/ChemSpec>
- NCCA Draft Leaving Certificate Physics Specification: (2019) <http://tiny.cc/PhysicsSpec>

# Astrophotography in the classroom.

Using the National School's Observatory in the second level classroom.

Dr Richard Moynihan.



Astrophysics has always been an exciting and captivating endeavor for humanity. In our earliest ages, our ancestors looked up to the stars in wonder and amazement, with little knowledge of what truly lay above them. They constructed ideas, stories, myths, and religions in which the stars were agents of divine actions. As our understanding of scientific processes developed, and the earliest telescopes were developed, we began to replace these earlier ideas of what lay above, and how the universe itself behaves.

To do astronomy in a classroom can be a challenge, which the two most obvious barriers being the expense of equip-



Two images captured by the author using the NSO telescope that show what can be achieved with the system.



The Liverpool Telescope.  
Source: [www.schoolobservatory.org](http://www.schoolobservatory.org)

students can access this telescope online and request astronomical data from a selection of celestial bodies, including the Moon, the planets in our Solar System, galaxies, nebulae, birthing stars and dying stars. Access to the NSO is free, and teachers and students in the United Kingdom and Republic of Ireland are permitted full access to all the functionality that the NSO provides. All data generated by the remote telescope is interpreted using their custom software package, LT Image. Again, this software is free to use by teachers and students in the United Kingdom and Republic of Ireland.

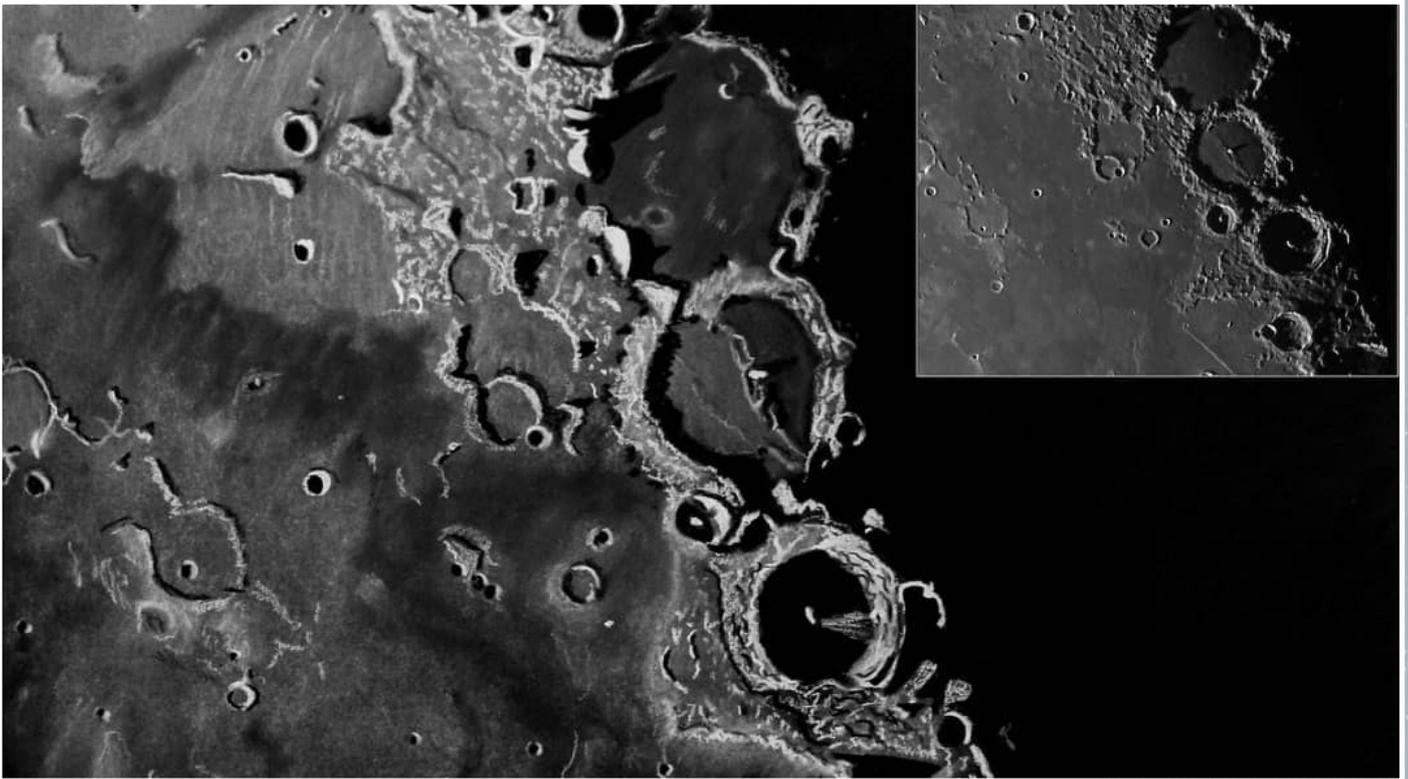
Using the NSO software, it is possible to combine three exposures of the same body (red, green and blue) to generate a 3 colour RGB composite. By adjusting the intensity, the contrast, sharpness and detail of each colour in the composite image, it is possible to generate high quality stunning captures of stars, galaxies and nebulae. Students can also challenge themselves to take zoomed in photographs of the moon and develop a highly detailed composite image of all of them put together as a mosaic image, a "Moonsaic" some might say.

ment and the fact that we teach during the hours of the day when astronomy is essentially not possible for even a well resourced second-level physics laboratory. Over ten years ago, Liverpool's John Moore's University set up a programme to overcome these barriers. They developed the National School's Observatory (NSO).

The NSO operates a remote telescope. Teachers and



Selection of celestial bodies observable with the NSO. Source: [www.schoolobservatory.org](http://www.schoolobservatory.org)



**O**bservation of a section of the Moon's surface with the Liverpool Telescope and a recreation of the observation using pastel pencils on black paper by observer Mary McIntyre. Source: [www.schoolsobservatory.org](http://www.schoolsobservatory.org)

Use of the NSO in schools allows students and teachers to engage with astronomy in ways not afforded in a traditional classroom. Simple tasks can be easily related to the Earth and Space learning outcomes in Junior Cycle Science. The NSO provides a context to explore Leaving Certificate Physics topics such as optics, waves, colour-mixing and nuclear physics. In a short series of lessons or in an extra-curricular STE(A)M club, students can be introduced to the basics of taking RGB data and combining it to develop their own images. If teachers have a longer timeframe to devote to this, such as with the Transition Year pro-

gramme, it could provide the basis for the entire module, bring in extra elements of physics such as measuring the size of celestial bodies, determining the distance between bodies and measure the luminosity of different stars.

In addition to the remote telescope and the software, the NSO website also provides video tutorials, lesson materials and a forum to help teachers and students request observations and interpret the data. Never has such a wide opportunity been provided to schools, and engaging students with near and deep sky astrophotography and astrophysics could potentially increase student engagement and interest in physics in second level schools in the Republic of Ireland.

To access the Nationals School's Observatory, visit <https://www.schoolsobservatory.org>



**M**essier 27, the "Dumbbell" Nebula. Observer: Castell Alun High School. Source: [www.schoolsobservatory.org](http://www.schoolsobservatory.org)

#### About the Author

Dr Richard Moynihan has been teaching Physics, Science and Maths in O'Carolan College for the past decade. He has represented Ireland at Science on Stage 2013 and 2015. He has taken part in numerous workshops hosted by the Irish Science Teachers Association, Institute of Physics and the Centre for the Advancement of STEM Teaching and Learning - CASTeL. He was awarded a PhD by Dublin City University in 2018, for his thesis entitled "Developing and assessing students' conceptual understanding of electrostatics in upper secondary physics." Dr. Moynihan can be contacted at [rmoynihn.occ@lmetb.ie](mailto:rmoynihn.occ@lmetb.ie)



# THE GLOBE PROGRAM

## GLOBE (Ireland)

Understanding of the real-life implications of science

The GLOBE (Ireland) Programme is now inviting Irish schools to participate in its exciting science programme in the coming school year. The programme is run by the Environmental Education Unit of An Taisce, in partnership with the Environmental Protection Agency. Two campaigns, Weather and Air Quality (NO<sub>2</sub>), are being offered again in the 2019-2020 school year. Teachers have found that these campaigns are a good fit with the school curriculum, especially at Junior Cycle and Transition Year, and that students engage in all aspects of the campaign, including the research project. The campaigns also provide schools with the opportunity to participate in scientific studies in partnership with other European schools. A teacher, Oliver Brady, from St. Nathy's College in Co. Roscommon, had this to say about their participation:

*"During the last year the GLOBE programme has been invaluable to me as a teacher. It allows the students to take ownership of the science they are studying- they lead the project, they collect the data, they assign tasks and make timetables. It is the students who decide what to do with the data, how it should be used and what it means. It also allows them to feel connected to the students doing the same thing in Irish schools and other schools around the world.*

*The programme itself covers so many different areas of science that it can inform the lessons you*

*as a teacher give. Everything from pressure and weather patterns to the formation of nitrogen dioxide and the energy of that reaction. It also allows for combinations with other subjects - we were able to collaborate with students studying subjects as diverse as Economics, Geography, History and Art. The ability to show the students in my classes how*

### What is the GLOBE Programme?

The Global Learning and Observations to Benefit the Environment (GLOBE) Programme is an international science and education programme sponsored by NASA that provides school students with the opportunity to participate in data collection and to contribute meaningfully to our understanding of the earth system and global environment. Since 1995, more than 36,000 schools in 121 countries have participated in GLOBE. More than 170 million measurements have been contributed to the GLOBE science database, creating research-quality datasets that are available to all.

In Ireland, the EPA has been working in partnership with An Taisce's Environmental Education Unit for the past two years to pilot the GLOBE programme within Irish schools, engaging 54 schools nationwide.

**P**hoto 1 – Attendees at the 2019 GLOBE Ireland Celebration Event in the Wood Quay Venue (May 2019, Dublin).





**P**hoto 2 – (L-R) Sabrina Moore (An Taisce), Pavel Trigub, Karl Harmon and Mary Conway (Larkin Community College) and Anthony Purcell (An Taisce) attending the 2019 GLOBE Annual Meeting in Detroit U.S.A.

*Physics and Chemistry impact the world and how everything is interdependent was something I never expected.*

*In short, the GLOBE programme is a most interesting 'side project' I think a teacher of Science can undertake. It is well run, has wonderful support from the organisers and transforms the subject from text book into a living, breathing spectacle for the students. Highly recommended."*

### **GLOBE Air Quality Campaign, Spring 2019**

Students from 30 schools across Ireland carried out the GLOBE Air Quality Campaign in the Spring of 2019. Participants measured nitrogen dioxide (NO<sub>2</sub>) – a principal pollutant from car exhaust emissions – during the month of February, at locations around their schools, recording their results and investigating the potential impacts on their health and well-being. Each school has at least two sampling points - one sampler is placed on the road at the front of the school and one in a less polluted area such as the backyard.

Most schools found that air quality around their schools ranged from excellent to good. NO<sub>2</sub> levels were higher for schools situated in major towns and cities than those in rural areas. Students noted a deterioration in air quality at the school gate, where cars congregate to pick up and drop off students, when compared to more sheltered areas such as school yards.

Having analysed their data, the students prepared reports for the celebration event at Wood Quay (Dublin) where they exchanged ideas about further air quality investigations and actions to reduce air pollution. These included: promoting active travel to school, such as cycling and walking; encouraging the use of public transport and private buses to schools; car shar-

ing; and more investment and support for electric vehicles.

### **GLOBE Ireland Celebration, May 2019**

Against the backdrop of the spectacular Wood Quay Venue in Dublin, An Taisce and the EPA hosted the inaugural GLOBE Ireland Celebration event in May. The event was attended by 60 students and teachers from nine schools. At the event, Laura Burke, Director General, EPA, and Michael-John O'Mahony, Director, An Taisce's Environmental Education Unit congratulated the student scientists on the quality of their investigations.

Laura Burke told students:

*"Through your work you are making an important contribution to protecting our shared environment. You are the scientists of the future and you can make a difference".*

A selection of the [individual school posters](#) is available online showing details of the schools' research. A [short video](#) provides a flavour of the day.

### **Annual GLOBE international meeting**

As part of its international programme, GLOBE regularly hosts scientific symposiums for the GLOBE community. In July this year, the 23<sup>rd</sup> GLOBE Annual Meeting was held in Detroit, USA. Larkin Community College, Dublin, represented the GLOBE (Ireland) programme there. The school had participated in the full two years of the pilot-programme in Ireland. Their students Karl Harmon and Pavel Trigub provided the following update after their return:

*"Along with students from many different countries, we took part in presentations, demonstrations and workshops. We also attended the Howell Nature*

**Continued on page 49.**

# SciFest: An opportunity to take STEM from the classroom to the world stage

Hugo Rowsome, SciFest Project Manager



The SciFest programme is by its design grassroots in its organisation. SciFest encourages local schools to host their own SciFest@School fair. This allows a true reflection of the development of the STEM talent pipeline in the country. Most importantly, the programme ensures opportunities for students to develop their ideas further with the regional SciFest@College fairs and the SciFest National Final. The jewel in the crown of the SciFest programme is its affiliation with Society for Science's International Science and Engineering Fair (ISEF) in the USA. Since SciFest first took part in ISEF eight years ago, twelve major awards have been won by participating students. This is a fantastic achievement and is testament to the standard of work by the students, the drive of Irish science teachers and the inclusive and encouraging model of the SciFest programme. SciFest may be grassroots, but it allows top talent to grow and ultimately flourish in the toughest and most competitive of environments on a world stage.

Adam Kelly from Skerries Community College in Dublin took seamlessly to this international platform with his phenomenal project concerning an open source solution to simulating quantum computing that is up to 15 times faster than conventional simulations. Adam won the Dudley R. Herschbach SIYSS Award which is one of the top three awards at ISEF. This means he will be one of 25 students who will participate in the week-long Stockholm International Youth Science Seminar (SIYSS) which includes attendance at the Nobel Prize ceremony in Stockholm in December. His success did not stop there; he also received a first prize in his category, Systems Software for which he will have an asteroid named after him, and a Best in Category Award. Adam received a total of \$8,000 for himself, \$1,000 for his school and \$1,000 for SciFest.

The 2018/2019 academic year represented a year of significant growth for SciFest, with 99 fairs taking place across Ireland and over 10,000 students participating across all levels of the programme. One particularly exciting addition was a new travel award presented at the SciFest National Final, The Broadcom MASTERS Award. This new award saw five junior cycle students, ranging in age from 12 to 14, compete for the opportunity to participate in the Broadcom MASTERS International programme which included a visit to ISEF. The students who qualified to compete for the award were all recipients of the ISTA award at SciFest@College fairs. It demonstrated another great opportunity, particularly for younger students, to blossom and ignite a passion for STEM. The inaugural award was won by Éabha Kenny, from Scoil Muire gan Smál, Convent of Mercy, Roscommon Town. Éabha travelled with her mother to Phoenix, Arizona to take part in the programme in May



Adam Kelly explains his project to a captivated audience at Intel ISEF 2019, Phoenix, Arizona

which ran in parallel with ISEF. The programme included visits to incredible places like Arizona State University and a chance to do some fun experiments at the Desert Botanical Gardens. Éabha counts herself particularly lucky as the programme was limited to only 27 students from around the world and that the Broadcom MASTERS programme is quite literally once-in-a-lifetime, as you can only partake one time. She recounts:

*'I made some great friends who I still talk to and I found a lot more to science than you would get in the classroom.'*

Reflecting on the programme, Éabha believed it transcended her love of Science and above all would be an amazing experience for anyone:

*'Anyone interested in science should definitely compete for the Broadcom Award through SciFest, and even if science isn't your thing, you should still give it a try. What you see at the Broadcom is a whole new world, and completely*



Adam on stage at Intel ISEF 2019



Éabha (3<sup>rd</sup> from left) with her new friends at the Broadcom MASTERS International programme 2019, Phoenix, Arizona

*different to classroom work.'*

An additional travel opportunity the SciFest programme offers is the Berlin Long Night of Science Award at the SciFest National Final. This year's winner, Odhran Brady from Salesian College in Celbridge, travelled to Berlin to witness first-hand the *Lange Nacht der Wissenschaften*, where once per year in June, the Berlin science community opens its doors to the public. Thanks to the support of the Dept. of Foreign Affairs and Trade, Odhran was lucky enough to visit numerous universities, try real lab equipments and even sit in on lectures given to students on the Internet of Things. Odhran reflects that this:

*'Gave me a real feel as to what it was like to actually to be*



Éabha talks about her project at the Broadcom MASTERS International MASTERS programme 2019, Phoenix, Arizona

*student in a busy college. I must admit that I could only understand bits of the lecture and came away knowing that I have a lot to learn!*

In addition, Odhran got a chance to immerse himself in Berlin and visit such incredible sites as the Reichstag and Checkpoint Charlie. Overall Odhran felt the trip was:

*'an action packed four days, and overall a wonderful experience, and one that I will always remember – never know may even end up going back to visit the Berlin universities for real in the years ahead!'*

All of the travel awards ensure unique opportunities for STEM to be brought to life beyond the classroom. Students like Adam, Éabha and Odhran and all participants in SciFest are truly afforded the opportunity to visualize themselves in the world of STEM beyond second-level education. Each of these trips illustrates the global nature



Odhran's trip included a visit to the Irish Embassy in Berlin

of STEM and the fantastic places both figuratively and literally STEM can take us. SciFest offers all students a chance to partake in this journey from local school fairs to the international stage. This journey for our students is an important one, as it is with continuous and long-term engagement with STEM in the classroom and beyond that true passion is cultivated.

And so, the journey continues. This year on Friday 22<sup>nd</sup> November, students will once again be able to compete for the SciFest 2019 SFI ISEF Grand Award, Berlin Long Night of Science Award and the Broadcom MASTERS award and continue that growing tradition of representing Ireland at the highest level in STEM.



Odhran Brady visited a number of universities in Berlin  
Photograph by Olga Jarugski (Free University Berlin)

# explorium

National Sport & Science Centre



STEM fun

interactive school tours



science  
sport &  
junior

e: [schools@explorium.ie](mailto:schools@explorium.ie) or visit [explorium.ie](http://explorium.ie)

# What happened to the Physics & Chemistry course?

Dr. Peter E. Childs



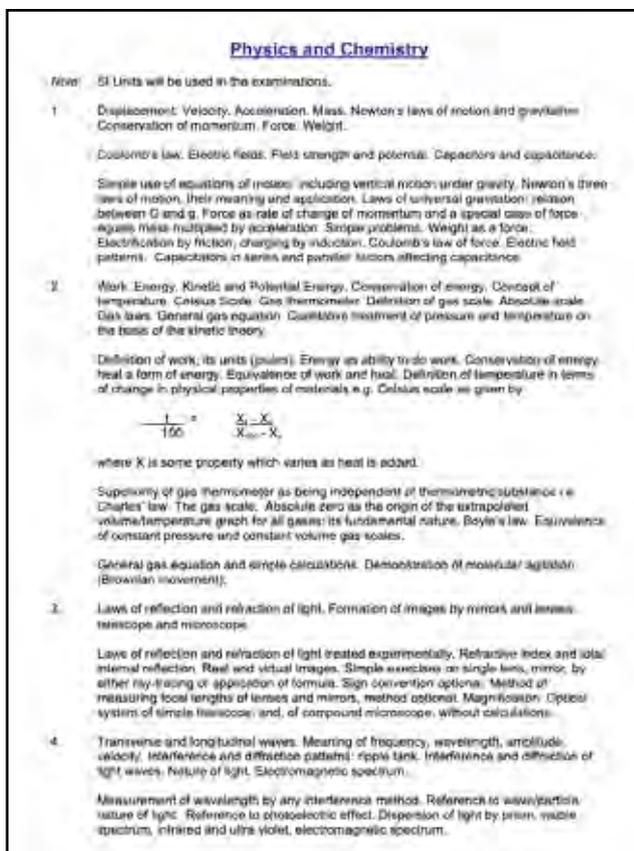
The Physics & Chemistry combined courses has not changed for over 40 years! Take-up each year is very small and it is only offered by a few small schools. Theoretically it offers a student a chance to study elements of Physics and Chemistry, rather than a full subject. The syllabus, the first page of which is shown, is badly out-of-date and out of line in its format and presentation to the current LC science courses, which were revised in the early 2000s. Clearing out my old files I came across the NCCA draft Physics & Chemistry syllabus, with a recommended title Physical Science, published for comments in August 2000 i.e. nearly 20 years ago.

Nothing as far as I know ever happened to this syllabus and it was never implemented. I remember commenting at the time that this was a worthwhile attempt to modernise the syllabus but also to take a new approach to syllabus design. It has the four-column syllabus we are familiar with, but instead of being presented as a Chemistry section and a Physics section, it is presented as 7 units. These are:

- Unit 1: Atomic structure and the Periodic Table
- Unit 2: Waves and Light
- Unit 3: Material Science
- Unit 4: Medical Physics
- Unit 5: Science of the Environment
- Unit 6: Telecommunications
- Unit 7: Astrophysics

I like the practical, applied and social aspects of several of these topics, although 4 are clearly Physics and only three Chemistry. It might have been more equitable to include an eighth unit focused on Chemistry.

What a lost opportunity to revive this subject and make it



more attractive to students! The presentation is similar to context-based courses like the Salters courses and this is a welcome innovation. If it were revised today I would probably include Nanoscience as a unit, which brings in both Physics and Chemistry. If this had been introduced when the other revised courses were introduced (2000 and 2002), I would expect that the uptake of Physical Science would now be higher than the unreconstructed Physics & Chemistry course. There is still a strong case for introducing it and most of the work has already been done.

There is also a case for providing a new LC Science course, including elements of Chemistry, Biology and

Physics. This would provide students and schools with an alternative to the current courses and would suit students who only want one, broadly-based Science course and do not want to specialise. Such a course could be taken with Agricultural Science (as is the case with Biology), but not with the other single sciences. A similar structure to the embryonic Physical Science could be envisaged, with 7 or 8 context-based units, with at least 2 focusing on each of the three core sciences, and 1 or 2 units which were deliberately interdisciplinary. Needless to say, such a new course should follow the existing model of a detailed syllabus and not the NCCAs proposed undetailed specifications for the new LC science subjects. Learning outcomes alone do not make a teachable course; often it is said that 'less is more', but in reality 'less is less'.

## About the Author

**Dr. Peter E. Childs**

Emeritus Senior Lecturer in Chemistry

Director, Chemistry Education Research Group

Hon. Editor, Chemistry in Action!

University of Limerick. [peter.childs@ul.ie](mailto:peter.childs@ul.ie)

# STEMreach Problem Solving & Puzzle Fair:

## Peer Learning Makes Perfect

Dr Cordula Weiss, Calmast.



Problem solving skills are key to succeed in life – academically, professionally and personally. Often strictly related to maths, problem solving skills are essential for all of science. Problem solving requires creativity, communication, initiative, analytical ability, lateral, logical and strategic thinking, and also patience and persistence.

The importance of problem solving has been recognised by its integration in the Irish mathematics curriculum: primary school teachers are required to teach mathematical problem solving using a constructivist approach in the classroom to encourage the development, understanding and application of problem solving strategies. In support of this, Calmast and Maths Week Ireland have developed an exciting programme for primary and post-primary pupils.

The STEMreach Problem Solving and Puzzle Fair Programme is a 6-week structured maths programme in which transition years from post-primary schools work with primary schools pupils on a series of maths problems and logic puzzles.

The secondary school students must learn about the problems and through a four week problem solving module develop their own problem solving skills. They develop a means to explain the puzzles and logic games to 10 to 12 year olds and make a physical model of the puzzles and games. The programme culminates in a Maths Fair where all the puzzles and games are on show and primary school pupils come to the fair and work through the puzzles guided by the secondary school pupils.

The programme aims at improving students' understanding of mathematical problem solving, developing creativity, lateral thinking and communication skills. Together with an experienced team of maths lecturers and researchers at Waterford Institute of Technology, the post-primary students discover approaches and strategies to tackle different problems, puzzles and logic games in a playful way and learn how to transfer these skills to a variety of apparently unrelated situations. They gain confidence and become aware of difficulties they are likely to encounter when working with their younger peers. This is the first step to devising their own physical models and games based on text problems.

The creation of such a hands-on puzzle in the second step must be based on materials found at school or at home.



The puzzle must be suitable to playfully encourage young learners find a solution but should not give away the strategy immediately. Creativity, imagination, craftsmanship but also teamwork, communication and an understanding of the primary pupils' abilities are key to develop and realise suitable models. The post-primary students are also challenged to create puzzles that are adjustable to different levels of difficulty to cater to the abilities of slow as well as fast learners.

In a third phase, the puzzles are then presented to a group of primary school pupils who work in groups to find the solution to each puzzle within a given timeframe, discuss their initial approach and their final strategy with the post-primary students and thus improve their problem solving skills while also practising their communication skills. The pupils are encouraged to find relations between the puzzles presented to them. Calmast's and Maths Week Ireland's joint STEMreach Problem Solving & Puzzle Fair thus promotes lateral thinking, the transfer of one strategy to various situations and the participants' confidence in approaching unknown settings.

The STEMreach Problem Solving & Puzzle Fair was found to **have** multiple benefits **for** primary and post-primary pupils. On completion of the STEMreach Problem Solving & Puzzle Fair Programme, the post-primary students

- enjoyed problem solving (74%),
- felt more confident in problem solving (54%),
- felt more confident in communication (48%),
- felt their problem solving skills had improved (42%),
- enjoyed the teamwork with their own peers (70%)
- and working with the primary pupils (50%).

Participating in the STEMreach Problem Solving & Puzzle



Fair has “opened their eyes to different methods of solving problems that they will be able to use later in school as well and then going on into the future. This peer learning modular approach of STEMreach has proved to be very successful, scalable. Bringing primary and secondary school children together has benefits for both groups” as a post-primary school teacher stated in an interview. The complete video is available on [www.calmast.ie](http://www.calmast.ie)

The primary pupils’ attitude towards maths and problem solving also became significantly more positive (increase of 33%). In the course of the STEMreach Problem Solving & Puzzle Fair Programme, the primary pupils discovered that “maths can be fun and easy” and, as reported by primary school teachers, felt more confident about “the big jump” – starting first year at the post-primary school.

The success of the programme is further illustrated by the fact that all post-primary schools in Waterford City are now running the programme, and there are plans to extend the programme to other towns in the region.

For schools looking for new, exciting and inclusive Maths Week ideas, the STEMreach Problem Solving & Puzzle Fair Programme would be an ideal project to run during Maths Week 2019. If you’re interested in running the STEMreach Problem Solving & Puzzle Fair Programme at your school and for additional information please get in touch: [calmast@wit.ie](mailto:calmast@wit.ie) or 051 30 2942.

**Please get in touch**

Phone: **051 302492**

Email: [calmast@wit.ie](mailto:calmast@wit.ie)

Online & social media:

- <https://www.calmast.ie>
- Facebook [@calmaststemhub](#)
- Twitter [@calmastwit](#)
- Instagram [@calmastwit](#)

- <http://www.mathsweek.ie/2018>
- Facebook [@MathsWeek2019](#)
- Twitter [@mathsweek](#)
- Instagram [@mathsireland](#)

**About Calmast**



Calmast is Waterford Institute of Technology’s STEM Engagement Centre.

Calmast was founded in 2003 and runs several festival and a myriad of activities in all areas of STEM. Calmast’s events engaged more than 20,000 participants in 2018 in the region. The guiding spirit is “STEM for all” with particular efforts to ensure inclusion regardless of gender, socio-economic background, ability or location. In addition Maths Week Ireland was founded and is run by Calmast engages over 400,000 in Ireland and Northern Ireland annually.

**About STEMreach**



The Calmast STEMreach model is an effective way of engaging learners with all areas of STEM where younger pupils learn from and with their older peers. The programme started with a pilot programme in 2017, and due to its success, has now grown to include six different modules with several thousand students and pupils involved. The programme is coordinated by Calmast and is supported by local industry both financially and through volunteer mentors.

**About Maths Week Ireland**



The idea for Maths Week originates in 2005 with Dr Sheila Donegan and Eoin Gill, Directors of Calmast, Waterford Institute of Technology STEM Outreach Centre where the first ever Maths Week took place in 2006. Since then, Maths Week has grown to attract participation from as many as 400,000 people annually across the island of Ireland. It has evolved into a partnership of more than 50 organisations including universities, institutes of technology, teacher training colleges, further education, professional bodies, museums, libraries and visitor centres and other groups, all united with the shared vision of making maths accessible to people of all ages, abilities and backgrounds.

# Implementing ‘Blended Learning’ into Modern Day Science Teaching

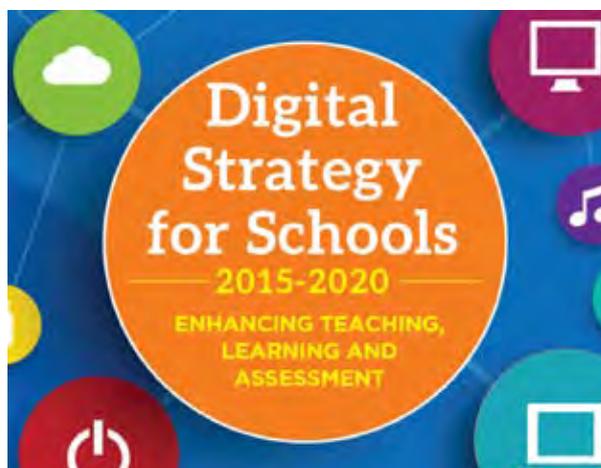
Ryan Gallagher, St Aloysius College, Carrigtwohill, Co. Cork

Over the past decade much emphasis has been placed on the use of technology to enhance teaching and learning. It cannot be doubted that our students live in a digital age. Almost every student we teach is multi-screening on a daily basis with smartphones, tablets, laptops and TVs. In education, the use of the Google, Microsoft or Apple suite of programmes online have made teachers more connected than ever - for better or for worse. Teachers are encouraged to ensure that notes and resources are placed online in the cloud and many are now reporting that their school management want resources online as opposed to printing and using paper. Every post-primary school has a digital policy in place. *The Digital Strategy for Schools 2015 - 2020: Enhancing Teaching Learning and Assessment* is now coming to the end of its lifecycle and will no doubt be replaced by a more comprehensive document to reflect digital learning today. The problem with technology is that it develops so fast that it can feel overwhelming for teachers. No sooner have we mastered the use of one digital resource and the next year we are told it is now redundant because a new ‘much better’ resource is now available. This can lead to a dislike of digital learning as it is now requiring more work on top of an already busy timetable of commitments for the science teacher. Teachers are told that technology is supposed to make their lives easier but in actual fact this can be the exact opposite for some teachers. However, regardless of what side of the technology debate you are on, it is clear to all that the use of technology is here to stay. There are many aspects to online learning and one area of research in which I am currently engaged is the concept of ‘blended learning’.

## Blended learning - The what and the why

Blended learning (also referred to as hybrid learning) has been defined by many different authors. Two definitions I particularly like which give a short and concise view of blended learning are by Panopto - a world leading platform for online lessons at university level - and Charles Graham, a highly respected researcher in the area of digital learning.

**“Blended learning is a method of teaching that integrates technology and digital media with traditional instructor-led classroom activities, giving students**



**more flexibility to customise their learning experiences”** (Panopto 2017).

**“Blended learning systems combine face-to-face instruction with computer mediated instruction”** (Graham 2005).

Blended learning encompasses many teaching possibilities. For example, blended learning can involve the teacher teaching the lesson and students then going online at home to complete assessment activities. Another scenario sees students watch-

ing short video clips or lessons in their own time to complement the learning that is taking place in the classroom. To an extent, many teachers are already using some form of blended learning by using very popular websites such as *The Physics Teacher*, *Studyclix* or *Khan Academy*. However like most teaching initiatives it is up to the teacher to decide the extent to which they will engage in blended learning.

Blended learning offers up some unique advantages for the teacher and student. The key advantages of blended learning are may be summarised as follows:

1. It allows teachers to be more engaging and can provide better support within the classroom.
2. Teachers are empowered and do not feel under as much time pressure to cover content.
3. Students can learn at their own pace while still keeping up with the class.
4. Students are more independent learners.

There has been much research carried out in recent years on analysing the degree of success of blended learning. There are a number of success criteria often referred to in literature such as student engagement, classroom behaviour, learning and student results. Multiple international case studies carried out in secondary schools across New Zealand, Australia, Singapore, England and Finland agree that blended learning allows for much of the learning to be conducted outside of the classroom thus allowing the teacher more time inside the classroom to focus on experiments, assessment and reinforcing conceptual ideas that require understanding. Teachers reported they have greater flexibility in their teaching and were able to provide better support for students. Many of the case studies are highlighted and discussed in *Online and Blended*



*Learning: A Survey of Policy and Practice of K-12 Schools Around the World* by Barbour et al (2011).

One of the more pressing concerns over the last several years for teachers involves the new Junior Cycle and its use of learning outcomes. All teachers are being encouraged to ‘unpack’ these very vague learning outcomes and implement them in their own teaching practice. Teachers find they are under more pressure to cover the curriculum because they are unsure of what exactly is in the new curriculum. The large differences in the new science textbooks reflect this challenge that teachers face. In addition, the issue of the content-heavy science curriculum and a reduced amount of teaching hours seriously impedes science teachers’ wellbeing. The Irish Science Teachers Association (ISTA 2019) recently published the findings of a survey completed by 762 teachers *Listening to the Voice of Science Teachers* on their experience of teaching the new Junior Cycle science. Its findings reported that most teachers found that time restraints were having a major impact on their teaching. Typical comments were:

sociation (ISTA 2019) recently published the findings of a survey completed by 762 teachers *Listening to the Voice of Science Teachers* on their experience of teaching the new Junior Cycle science. Its findings reported that most teachers found that time restraints were having a major impact on their teaching. Typical comments were:

*“I feel that the course is so broad that we are rushing everything. Also I feel as we may lose a class period as the new JC intends that we will not have enough time in the future. Three class periods a week is not enough to ensure we are giving them a good basis in science and also embedding a love of science.”*

*“Unpacking the LOs can be time consuming and a lot of teachers are anxious that they are not doing enough or even doing it right.”*

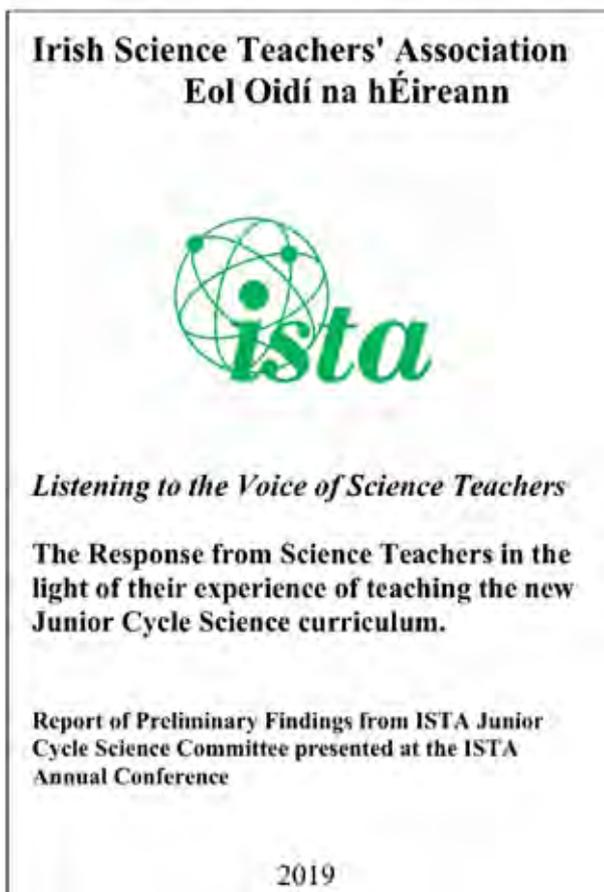
*“My main issue with the Specifications is their vagueness. I seem to be spending a lot of time guessing what is required. For example at the moment we are doing electricity, do I make sure that they set up circuits with bulbs in series, bulbs in parallel, with a resistor, with an LDR, LED?!? I am frustrated in that I don’t know.- and it is the same for every single topic.”*

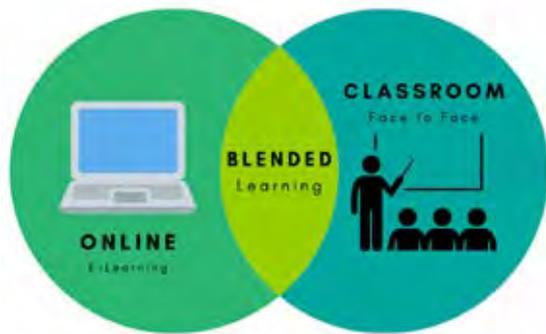
*“I feel under huge pressure to complete the course in general, mainly due to the uncertainty re depth to which various/all topics need to be covered.”*

(ISTA 2019)

The case studies discussed previously have shown that teachers are able to cover content in more depth and at a faster pace than traditional teaching. Could the use of blended learning help ease the everyday pressures for Irish science teachers and allow science teachers more time to carry out more meaningful active teaching methodologies in the classroom?

The final two advantages emphasis the positive learning





experience blended learning has on the student. Results from the international case studies conclude that students are more willing to engage in the content being taught when they are able to claim ownership over the content being taught. I often see this in my own classroom which I will discuss in a later article. The critical component to ensure blended learning is successful is that students are guided in their learning outside the classroom like they would be inside the classroom. Bishop and Verleger (2013) both stress from their *survey of the research* in blended learning that adolescents need some structure or platform to use outside the classroom rather than just being told to research or Google a topic. This is counter productive and can lead to negative learning experiences in blended learning for the student. This leads us to some of the disadvantages in blended learning.

It would be unfair to promote blended learning as being perfect when research has consistently shown that this is not the case. The following four points highlight the main disadvantages with blended learning:

1. Student-teacher engagement is low or non-existent.
2. Success criteria not always clear
3. Quality of lesson/resource may be poor
4. Internet service may be a barrier

The lack of student-teacher engagement is a definite as teachers are not involved in assisting students with their homework. However, similar to homework, students need some guidance before using online resources. Bergmann and Sams, two researchers who arguably are responsible for bringing blended learning to the foreground of educational research, categorically state in their research that blended learning requires specific instruction for the students to ensure the desired outcome is achieved. Success criteria must be established so that the student knows when he or she has completed the work correctly and to the standard expected by the teacher. Both the success criteria and quality of the online lesson/resource are both preventative with a little research on the teacher's behalf. The biggest problem in Ireland is the use of internet service. Many rural parts of Ireland still do not have adequate access to broadband making the use of online learning challenging for students at home. The saying 'if the wind blows, the signal goes' can be very apt for the 42% of

Irish people living in rural areas (McMahon 2016). This is a technical problem outside of the teacher's or student's control but thankfully internet services are improving

The case for blended learning is overall positive. There are, of course, challenges that must be overcome and initially it will require more work from teachers before it begins to make life easier for them. Online learning is something that will continue to develop both here and internationally. The use of technology like any resource or initiative should be to enhance student learning without having a negative impact on teaching. Blended learning is a simple concept that could help reduce the pressures felt by teachers at the present time and enhance teaching and learning in the classroom. The word *enhance* is important here as it is important to realise that the use of online resources are there to complement the learning going on in the classroom, not replace it. My next article will discuss the online resources currently available that are designed for students learning science in Ireland.

#### References:

Barbour, M., Brown, R., Hasler, L., Hoey, R., Hunt, J.L., Kennedy, K., Ounsworth, C., Powell, A. and Trimm, T. (2011) *Online and Blended Learning: A Survey of Policy and Practice of K-12 Schools Around the World*, International Association for K-12 Online Learning.

Bergmann, J. and Sams, A., (2012) *Flip Your Classroom: Reach Every Student in Every Class Every Day*, Washington: International Society for Technology in Education.

Bishop, J.L. & Verleger, Matthew. (2013). The flipped classroom: A survey of the research. ASEE Annual Conference and Exposition, Conference Proceedings.

Graham, C.R. (2003) 'Blended Learning Environments: Definitions and Directions', *Quarterly Review of Distance Education*, 4(3), 227.

Holley, A (2010) 'Student engagement and blended learning: Portraits of risk', *Computers & Education*, 54(3), April 2010, 693-700.

Irish Science Teachers' Association (ISTA) (2019) *Listening to the Voice of Science Teachers: The Response from Science Teachers in the light of their experience of teaching the new Junior Cycle Science curriculum*, available at <https://www.ista.ie/jc-science-report/>

McMahon, A. (2016) 'Ireland's population one of most rural in European Union', *The Irish Times*, 1 June, available: <https://www.irishtimes.com/news/health/ireland-s-population-one-of-most-rural-in-european-union-1.2667855>

Panopto (2017) *What Is Active Learning And Why Does It Work?*, available: <https://www.panopto.com/blog/what-is-active-learning-and-why-does-it-work/>

Parkes, S., Zaka, P., and Davis, N. (2011) 'The first blended or hybrid online course in a New Zealand secondary school: A case study', *Computers in New Zealand Schools: Learning, Teaching, Technology*, 23(1).

Tucker, B. (2012) 'The Flipped Classroom', *Education Next*, available: [http://www.msuedtechsandbox.com/MAE-TELY2-2015/wp-content/uploads/2015/07/the\\_flipped\\_classroom\\_article\\_2.pdf](http://www.msuedtechsandbox.com/MAE-TELY2-2015/wp-content/uploads/2015/07/the_flipped_classroom_article_2.pdf).

# Get Your Writing Right!

Randal Henly



**SCIENCE** is a high-quality journal, full of useful and interesting material and admirably typeset by the present editor. And the same too can be said of previous editors. However, it is a pity that we often nowadays see scientific articles in many publications marred by too many mistakes in English. In the writer's opinion, it was a disaster when English grammar was dropped as a secondary school subject. This has also been brought home to me in the writings of UL student teachers of whom I was a supervisor for twelve years after I retired from school. Query: how many young teachers can name the eight main parts of speech?<sup>1</sup>

To do justice to all aspects of grammar, a lengthy article could be filled, but it is the hope that this short article might clarify and explain some of the most frequently observed errors, two of the main ones being problems with capital letters and collective nouns.

## Nouns or 'Naming Words'

There are different types of noun, viz., the proper noun, the common noun, the collective noun and several others of lesser importance.

**Proper nouns** are those that refer to specific persons, places or events, e.g., Mary, Dublin, Christmas, Irish Science Teachers' Association, Monday, Jupiter, Sun, Earth (when it refers to the planet), Moon (when it refers to Earth's moon), Internet, and so on. Proper nouns have initial capital letters.

**Common nouns** are the names of ordinary everyday non-specific places, things and persons, such as bench, laboratory, street, gas, secretary. Unless at the start of sentences, common nouns have lower-case initial letters. Frequent incorrectly capitalised common nouns include summer, winter, science, physics, chemistry, biology, names of elements (copper, oxygen, etc.), association, chairman/person, vice-chairman.

However, when a common noun is used to designate a particular person or event, it should have a capital letter, e.g., *The attendance at this year's Conference was about 200* (Conference is a common noun, but in the context it refers to a particular conference and so constitutes a proper noun). *The report was read by the Honorary Secretary* (Secretary is a common noun, but in the context it refers to a particular person).

## Collective Nouns

A collective noun describes a group of individuals acting as a single body, e.g., committee, audience, company, class, council. A collective noun is normally singular and correctly

takes a singular verb, e.g., *the committee is meeting tomorrow* (not *the committee are meeting tomorrow*), *the jury has reached a verdict*, *the team played its match yesterday* (not *their match*).

Unfortunately however, it is not that simple, for there are times when a collective noun is more correctly treated as a plural, specifically when viewed as consisting of individuals, e.g., *the committee were discussing it among themselves*. *The jury was all male*, but *the jury were in disagreement about the matter*. One has to consider the context in such cases.

## Capital Letters

There are two main uses of capital letters:

- (i). At the beginnings of sentences,
- (ii). For proper nouns, and words which, in the context, refer to a specific person, (e.g. *At the meeting the Chairman said...*)

## Hyphens

The main use of the hyphen is to link words that are considered as a single unit and to prevent any ambiguity, e.g., *a high-speed train* (it's the speed that is high, not the train), *five-litre containers* (which is very different from five litre containers), *a second-hand book* (this is different from a second handbook), *three-quarters*, *half-term*, *the twenty-first century*, *a first-year pupil*, *water-soluble* and so on.

The second use of the hyphen is at the end of lines where a long word has to be split, and part of it carried over to the next line. Word splits should occur at logical places so that the former part of the word suggests the whole word and does not mislead the reader by suggesting something else, e.g., *therapist* should be split *thera-pist* and certainly not *the-rapist!* Word splitting should be kept to a minimum and most word-processing programs give some control over its frequency of use.

## Apostrophes

An apostrophe is used to signify the possessive case of a noun, or to indicate a missing letter. For a singular noun, the apostrophe comes between the noun and the s; in the plural, the apostrophe comes after the s. Examples: *the boy's book is on the desk*, *the officers' meeting is tomorrow*. A very common error here is to add 's to form a plural rather than just s. The plural of book is books, not book's.

And another very common error involves confusing *its* and *it's*. The former word is the possessive adjective; the latter is short for 'it is'. For example: *It's coloured on its left-hand side*.

1 Noun, pronoun, adjective, verb, adverb, preposition, conjunction, interjection

Continued on page 40.

# Sea of Desolation

Paul Holland



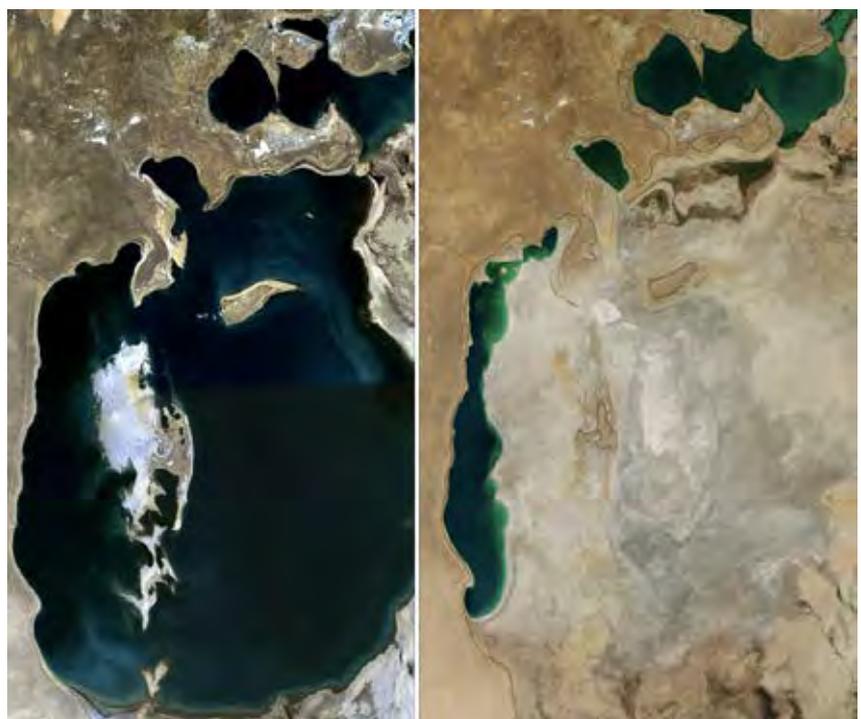
I came for a swim in the Aral Sea of Central Asia, the site of probably the greatest human-made environmental catastrophe in history. (Global warming is a work in progress). One time an inland sea with an area 80% that of the island of Ireland, it was sacrificed by the planners of the former Soviet Union. Irrigation projects, mainly for cotton but also other crops for a growing population, involved the abstraction of water from the Syr Darya and Amu Darya (the classical Oxus) – the Aral's main feeder rivers. Much of this water seeps uselessly into the ground from unlined canals, forming sterile salt marshes. In a hot climate with little rainfall, the inevitable happened. Since 1960, a sea has largely evaporated and been reduced to a few scattered salt lakes. Biodiversity, already limited, suffered in the whole area. The absence of the sea's cooling effect in summer and warming in winter has led to more extreme climate. Salt and sand storms blow frequently, compromising human and animal health.

In Uzbekistan and approaching the Aral from the south, I was apprehensive. Daily temperatures of up to 55 °C were making me (and worryingly, my guides) feel weak and disoriented. However, an overnight summer to autumn change – common in continental climates – brought the mercury right down to what felt like a cool 35 °C.

I saw lines of salt-resistant shrubs which

had been planted in an effort to stop sand and salt being whipped up by the winds – success has been limited. We reached where the Aral had begun – unmistakable. A basin surrounded by hills, it had the look of an empty bowl of soup. It was not hard to picture the sea that widened as we proceeded north. We camped by the shore – I watched the sand twisters in the distance and, when night came, saw lights somewhere way out on the empty sea.

A NASA comparison of the Aral Sea in 1989 (left) and 2014 (right)



Next day we saw substantial water. We left the former bank and drove many km down a gradual slope to water's edge so I could have my swim. On the way were metal piers which had been moved to keep pace with the retreating Aral before being finally abandoned. Here and there were pathetic piles of shellfish, long dead from the salinity that rose to lethal levels as the water evaporated. The lake water, hardly surprisingly, is buoyant and very salty. That night, the reflection of the moon on the water and the sound of lapping waves were so idyllic that we could almost forget we were at the scene of a tragedy.



original fish population survived the saline conditions. A dyke was built, and eventually successfully maintained. Water doesn't flow south to uselessly evaporate. Irrigation techniques were improved so that now a "Little Aral" is growing – it will never be large but at least ecosystems and local economies are beginning to benefit.

The Aral was an oasis, surrounded in places by flat or rolling arid steppe which is covered by very low scrub. I visited a meteorological station – a year's posting here would have one begging for Siberia. Indeed there was a chemical weapons plant on an island in the Aral in Soviet times – it's an island no longer. Generally it's a bleak area and, had the Aral been left alone, I don't think there would have been many tour ships here.

The journey continued. Another descent to the residual lake brought us down a very steep path through what were once underwater canyons. No swim for me this time as here there were oozy mud flats. For the first time in days, we saw some clouds – in fact there was a risk of rain. Rains, on the rare occasions they occur, can be severe. In some years, they restore parts of the Aral for brief periods. We got out and up the canyons in very quick time - we could have been trapped for days. That evening, I pitched my tent in a place with a lot of burrows. Snakes inhabit them and I knew this would be a night I would not go out to the bathroom.....

On our final day at the lake, we drove maybe 100 km along vast flat former lake floor. It was sandy. Desert shrubs were very numerous. There were decent tracks here, built by companies exploiting the substantial gas fields. Now I knew the source of the mysterious lights of a few nights before! And I also thought ruefully that the gas companies might not be keen on any idea of restoring the Aral.

Can the Aral Sea be restored? There has been talk of lining irrigation canals, using drip irrigation (wonder have GM crops been considered?) with a view to using less water and getting some of it back to the sea. One forlorn proposal has been a pipeline from the Caspian Sea. North of us in Kazakhstan, at least some of the Amu Darya flow has usually reached the Aral. Against all the odds, a residue of the

In Uzbekistan, the picture is much grimmer. The cotton crops are too important, populations have grown and so have people's expectations. The modern state of Turkmenistan would die of thirst without appropriated Aral-bound water. Moreover, the top-down planning of the Soviet Union is gone and any comprehensive plan at partial restoration would now need the cooperation of a number of independent countries.

We drove into Muynak, the "City of the Fishermen" now a desert town. Ironically there's a large fish pond. The old port has decayed, with boats rusting in the desert. A track in the sand is all that remains of a channel dug to bring boats out to the receding sea for as long as it was possible. Apparently, after the rivers were diverted, there was initially no real change in water level, then a slow lowering and finally a huge retreat of dozens of km.

Stalin awarded Muynak a Hero City designation – its fish catches helped keep the Red Army in the field during World War 2. Thousands of troops embarked here for the port of Aralsk (Kazakhstan) and the trains which took them to the fighting. Many of them lie strung out in lonely graves between Moscow and Berlin. Like the Aral Sea itself, gone and mostly forgotten.

**Author**

Paul Holland, formerly of Presentation College, Galway.



# McCulloch's Musings

Ian McCulloch



Inspiration has proved elusive for these musings. Nonetheless, I have managed to string a few words together - if only to make you appreciate better the quality of the other articles herein.

My units, particularly those for energy/power, crusade is failing miserably. I am disappointed that the opprobrium I have expressed in this regard has not resulted in those writing in the science/technology domain adopting appropriate rehabilitation remedies to redress the situation. The latest to have dismayed me is Peter McGuire in the Irish Times in June in a piece on advances in battery performance. He had two howlers "it stores at least 8 000 mAh (2.5 times the current energy)" AND "battery-powered aircraft could become feasible once the batteries can store 400 watts per hour". In September, also in the Irish Times, Karlin Lillington, writing about a Carbon Disclosure Project, included a reference to the use of a printer and its "kilowatt usage per hour". Aargh! In July in the Sunday Times, Sean Pollock wrote of SSE's hope to develop off-shore wind farms which "would generate a combined 1.6 GW of renewable energy per year". Given the ever-declining reach of the print media, I suppose that this sort of misinformation will not be disseminated too widely. On the

other hand, I suspect that the increasingly pervasive social media might be at least equally culpable in this regard.

If you are not a member of your local library you ought



to be. A relatively recent addition to the resources it provides is RBdigital which offers a large collection of popular e-magazines. You can check out an unlimited number of magazines and keep them in your account for as long as you wish. You can use RBdigital Magazines on your computer or on a tablet/smartphone. To use the service you need to create an account with RBdigital. You will be asked for your library card number when creating the account.

Physics has a "beautiful" equation in Einstein's Energy-Mass Equivalence equation  $E = mc^2$ . I recently came across the mathematical equivalent  $e^{i\pi} = -1$ , Euler's Identity, and, once again, marvelled at its awe-inspiring elegance especially when you consider the abstruse properties of its



..... A social highlight since the last issue was a visit to St. Maries of the Isle Mercy Convent in Cork for afternoon tea with the ISTA's  
 ..... legendary Sr. Mercedes Desmond. M

terms. It really is an incredible equation. How can it be that an irrational number to the power of the square root of  $-1$  (What does that mean?) times another irrational number equal  $-1$ ?

$e$ , Euler's number, is the base of natural logarithms that arises "naturally" in compound interest and calculus. Indeed, it pervades maths, appearing seemingly from nowhere in a vast number of important equations. It is approximately 2.71828.... The compound interest perspective sees it



being defined as  $\lim (1+1/n)^n$  as  $n$  approaches  $\infty$ , while the calculus approach sees it being defined courtesy of its involvement in the only function which is the same as its derivative, to wit,  $e^x = f'(e^x)$ .

The number  $i$  is defined as the square root of negative one:  $\sqrt{-1}$ . The most fundamental of the imaginary numbers, so called because, in reality, no number can be multiplied by itself to produce a negative number (and, therefore, negative numbers have no real square roots). But in maths, there are many situations where one is forced to take the square root of a negative number. The letter  $i$  is therefore used as a sort of stand-in to mark places where this is done.

The number  $\pi$ , is the ratio of the circumference of a circle to its diameter. It is approximately 3.14159...

This marvel is not a recent phenomenon - Leonhard Euler was an 18<sup>th</sup> century Swiss-born mathematician who spent most of his career in St. Petersburg, Russia. Here it is again for you to admire.  $e^{i\pi} = -1$

In the garden we had two "new" sights. A heron visited the "water feature". He didn't stay long when he realised that there were no fish. Luckier on the food front was one of our foxes who had bagged a rat for breakfast. We had our usual crop of mushrooms. This year they looked more appetising than heretofore and we were tempted. Given the pernicious potential we resisted! More recently the example in the photos on the right surfaced. Are there any mycologists out there who would be prepared to offer an opinion on its toxicity?

A social highlight since the last issue was a visit to St. Maries of the Isle Mercy Convent in Cork for afternoon tea with



the ISTA's legendary Sr. Mercedes Desmond. Mercedes was in terrific form and as sharp as ever.

Responding to a recent request by PandaPower to submit gas and electricity meter readings these were the two figures - 17965 and 19576. As you will have instantly noticed, each is an "anagram" of the other. I wonder what the probability of this is. I'm sure someone amongst my extensively esoteric readership will be inspired to take up the challenge of working it out. The level of my esotericism is such that it precludes me from making any sort of attempt, though I am confident that the answer is between 0 & 1.

# Myths, Mistakes & Misconceptions about Respiration

Declan Cathcart



*This year's PDST Biology Autumn workshops are on the theme of respiration. In this article, PDST Associate Declan Cathcart highlights some common misconceptions on the subject.*

## Introduction

Getting to grips with the biochemical processes of the cell is generally considered to be one of the more difficult tasks for students studying secondary school biology. Understanding photosynthesis and respiration as cellular activities is essential to key learning outcomes in Junior Cycle Science (CW7 and BW7). As Leaving Cert biology teachers, we tend to tackle this abstract and complex material by giving over a relatively large amount of class time to it. We use flow diagrams, card sorts, animations, lab investigations, role-play, analogy, stories from the history of science, and anything else we can find or come up with that might help our students gain a clear picture of metabolic pathways and cellular processes. Overcoming conceptual difficulties in this area is challenging and time-consuming for both teachers and students.

In this context, it can be useful to look at the misconceptions (or 'alternative conceptions') that commonly arise around a topic. Misconceptions can impede learning in several ways. They are often deeply entrenched, and students are generally unaware that their understanding is erroneous. A misunderstanding about a fundamental concept can interfere with the processing and interpretation of new information and ideas relating to the subject. For the teacher, being aware of these common misconceptions is obviously essential so that we can develop strategies and interventions to bring about the conceptual change that is necessary for further learning.

When it comes to respiration, there are lots of age-old myths and misconceptions. Some of these myths and misconceptions are straightforward and are relatively easy to address, if not solve. Others may be long-established and deeply rooted and often require several rounds of "cognitive conflict" to successfully explode. In several cases, misleading ideas have been transplanted from textbook to textbook over the years. Given the fundamental importance of respiration in the study of biology, it seems worthwhile to spend some time trying to unravel these bogus notions.

## "Respiration is breathing".

Dictionaries define the everyday use of the word respiration as the act of inhaling and exhaling air: breathing. In medicine, doctors refer to respirations meaning individual

breaths. In biology, respiration refers to the metabolic process in the cells or an organism that convert energy from nutrients into ATP. Some textbooks distinguish between external respiration (breathing) and internal respiration (cellular respiration), but the usefulness of this distinction is debatable. It can sometimes compound the problem, resulting in something along the lines of:

*"External respiration is the exchange of gases in the lungs, and cellular respiration is the exchange of gases at the mitochondria."*

Students can also be forgiven for then thinking (incorrectly) that since we breathe oxygen, we also respire oxygen. Perhaps that is a useful distinction for us to make with our students: you don't breathe glucose, you respire it.

Since it seems that we can't win, perhaps the best approach is to stick to the modern biologists use of the word 'respiration' solely as a cellular process that releases energy from nutrients. If we uncouple the word respiration from breathing, I would suggest that our students will be better off. After all, most organisms don't breathe in any normal sense of the word. Do sulphate-reducing bacteria 'breathe' sulphate ions? We'll come back to that.

## "Respiration involves getting energy from oxygen"

Variations on this are:

- "Oxygen is a source of energy"
- "The reason we breathe is to get oxygen." What for? "For energy."
- "Organisms respire so that they can get energy." Energy from what? "Oxygen"

## "Respiration occurs in animals, not in plants."

A passing knowledge of the carbon cycle can lead to variations of this including:

- "Plants photosynthesise whereas animals respire"
- "Respiration only occurs in plants during the night-time"
- "Respiration in plants involves taking in of  $\text{CO}_2$  and giving off  $\text{O}_2$  during the day, but during the night-time respiration in plants involves taking in of  $\text{O}_2$  and giving off  $\text{CO}_2$ ".
- "Plants use  $\text{CO}_2$  during respiration whereas animals use oxygen"
- "Plants produce  $\text{O}_2$  during respiration whereas animals produce  $\text{CO}_2$ "

**“Respiration only occurs in certain plant cells.”**

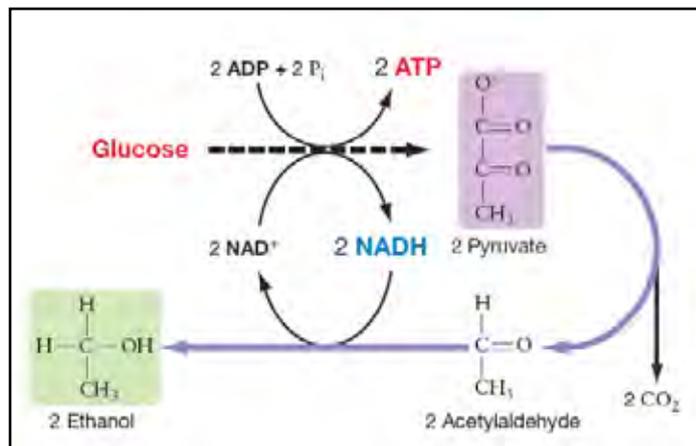
There are variations on this too:

“Respiration only occurs in leaves”

“Respiration only occurs in root cells”

“Respiration in plants is the exchange of gases at the stomata in the leaves”

“Carbon dioxide is necessary for respiration”



**F**igure 2: Ethanol fermentation

out aerobic respiration. For some strict (obligate) anaerobes, oxygen is toxic, and they cannot respire in the presence of oxygen. Many facultative and obligate anaerobes are not fermentative, but they do carry out cellular respiration in the absence of oxygen. They have a functioning electron transport system during which they manufacture much more ATP than can be produced by fermentation. There is a diversity of molecules that these organisms use as their final electron acceptor.

Anaerobic respiration is a crucial part of the global nitrogen, iron, sulphur, and carbon cycles. The cycling of nitrogen, sulphur, and carbon compounds, which depends on anaerobic respiration, has a huge impact on global warming. Anaerobic respiration occurs in freshwater and marine sediments, subsurface aquifers, deep subsurface environments, and biofilms. Even environments like soil have micro-environments that lack oxygen.

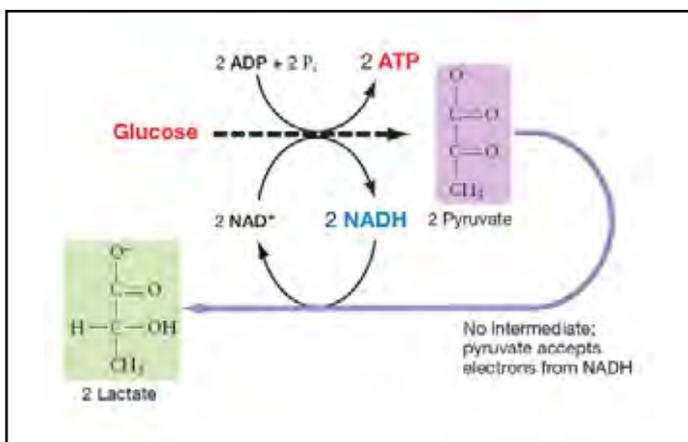
Here are some examples of the ecological importance of anaerobic respiration:

- **Denitrifying bacteria.** These bacteria use nitrate as the terminal electron acceptor. This is the main route by which nitrogen gas is returned to the atmosphere.
- **Methanogens.** These bacteria use carbon dioxide as their electron acceptor, with methane as the product.
- **Sulphate-reducing bacteria** (Fig. 3) use  $SO_4^{2-}$  to produce hydrogen sulphide, which gives the charac-

**“Fermentation is an anaerobes way of making a little more ATP.”**

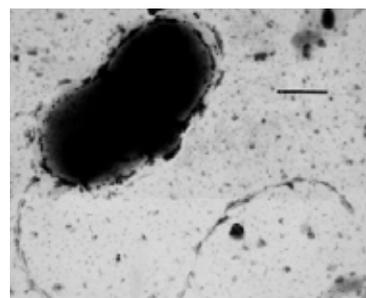
The ATP produced during glycolysis is all that is available to organisms that carry out fermentation, whether that results in the production of ethanol and carbon dioxide, or lactate. Many students don't realise that fermentation functions only to regenerate  $NAD^+$  so that glycolysis can keep running (Fig. 1 and Fig. 2), rather than to generate any more ATP. Without a steady supply of reduced  $NAD^+$ , glycolysis cannot continue, and respiration stops.

**“Anaerobic respiration only occurs when oxygen runs out” & “Anaerobic respiration is also known as fermentation”**

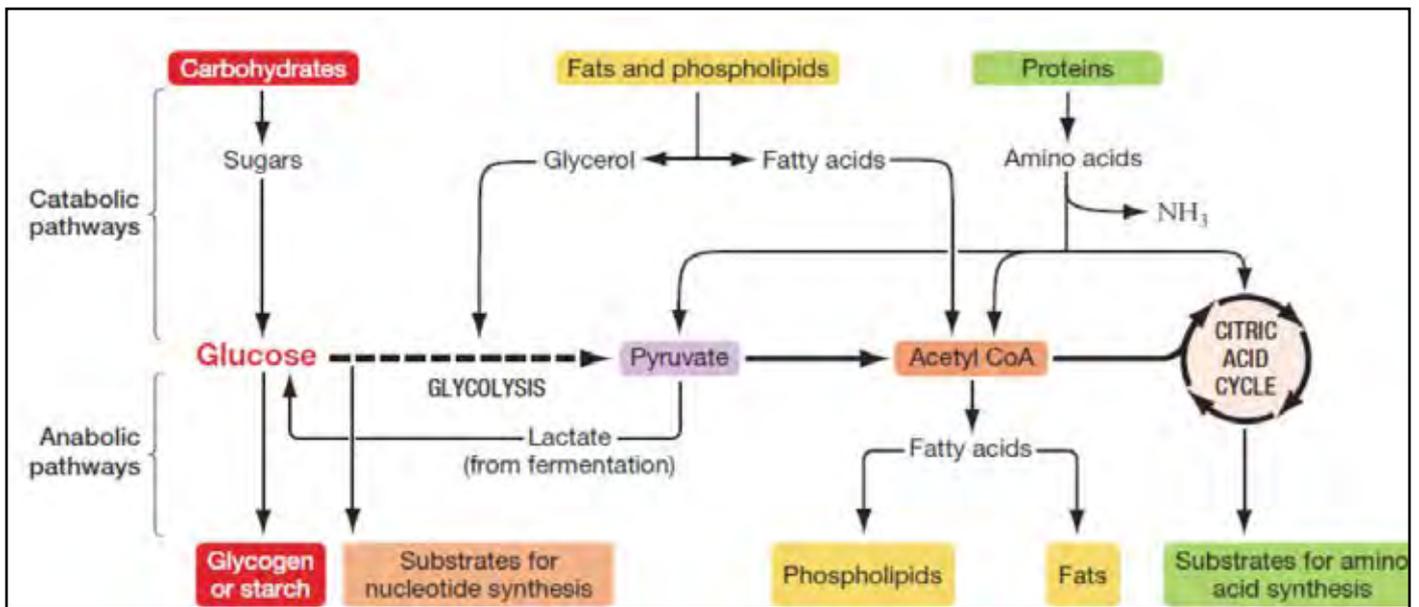


**F**igure 1: Lactic acid fermentation

There are many organisms that do not and cannot carry



**F**igure 3: Desulfovibrio vulgaris, the best-understood sulphate-reducing microorganism. Its genome was fully sequenced in 2004.



**F**igure 4: Respiration pathways for various nutrient molecules.

teristic ‘rotten egg’ smell of many wetland habitats. They are found in seawater sediments and are one of the oldest forms of microbe that can be traced back to 3.5 billion years ago.

**“Respiration is the breakdown of glucose.”**

Many students don’t realise that all or part of the respiration pathways is used not just for glucose, but also for the respiration of other sugars, fatty acids and glycerol (see Figure 4). **Amino acids** are hydrolysed to remove the amino group, which is excreted as urea, while the remaining carbon compounds are converted to pyruvate, acetyl CoA or an intermediate in the citric acid cycle. When **lipids** are respired, carbon atoms are removed in pairs from the fatty acid chains, producing acetyl coenzyme A which is fed into the Krebs cycle.

The reason for this misconception seems to stem from early education about food molecules (Oliviera *et al*, 2003). Even at Leaving Cert level, teaching contrasting roles for biomolecules can reinforce this misconception. For example:

*“Carbohydrates are our source of energy; lipids have structural and insulation roles; proteins are structural, catalytic or signalling molecules.”*

While not incorrect, statements like this may not be helping.

**“Aerobic respiration produces 38 ATP”**

Many Biology textbooks have a table that looks something like that shown below.

Stage of Cellular Respiration	Net ATP resulting from:		Total yield of ATP molecules
	Substrate-level phosphorylation	Oxidative phosphorylation	
Glycolysis	2	6	8
Pyruvate processing	0	6	6
Citric acid cycle	2	22	24

<b>Total:</b>	<b>4</b>	<b>34</b>	<b>38</b>
---------------	----------	-----------	-----------

The numbers vary from source to source. Some sources go for a total of 36. Others say 32. Why all the confusion over the numbers?

Part of the difficulty students will have trying to do some accountancy with ATP is that they may be unaware of the role of FAD in transporting electrons to the electron transport chain, as well as that of NAD. The Complex I protein of the ETC only oxidizes NADH, whereas the Complex II protein deals only with FADH<sub>2</sub>.

Theoretically, three molecules of ATP can be produced from each molecule of reduced NAD<sup>+</sup>, and two molecules of ATP from each molecule of reduced FAD. However, this yield cannot be achieved unless ADP and Pi are available inside the mitochondrion. Some of the available from respiration has to be used for the active transport of Pi, for example. The number of ATP molecules actually produced varies in different tissues and different circumstances, depending on how much energy is used to move substances into and out of the mitochondria. And then sometimes the membranes leak...

Current best estimates range around 29-30 ATP per glucose (Freeman *et al*, 2017).

**“ATP is the energy currency of the cell”.**

This makes it sound like it’s the only one. ATP is capable of transferring less free energy than phosphoenolpyruvate, 1,3-bisphosphoglycerate or creatine phosphate but more than glucose-1-phosphate, glucose-6-phosphate or glycerol-1-phosphate. UTP, GTP, TTP and CTP also serve as energy carriers in many cells. Creatine phosphate, arginine phosphate and carbamoyl phosphate also play a role in energy transfer in animals (Storey, 1992; Rawn 1989; Stryer 1988).

Still, ATP is the *main* energy currency within the cell. So why did it become the biggest player? ATP seems to transfer just about the right amount of free energy needed to

drive many cellular reactions and can connect metabolic steps of high-potential and low-potential energy. (Lehninger, 1982).

**“ATP is an energy storage molecule”.**

ATP should not really be thought of as an energy storage compound of significance within cells because there is a relatively small amount of it present at any time and it turns over constantly (Harold 1986). ATP is too reactive, too unstable to be stored for long periods of time, and there are too many enzymes that interact with it for it to be useful as an energy storage molecule (Storey, 1992). Campbell (1990) suggested that a typical cell recycles its entire pool of ATP every minute and that the turn-over rate is about 10 million ATP molecules formed and hydrolysed every second.

**“ATP is a high energy molecule.”**

Compared to what? We could say that ATP has about one-fortieth of the energy of a glucose molecule. Some fatty acids can yield more ATP than glucose. Yet, we keep going on about ATP being *the* high energy molecule.

**“The energy of ATP is in the phosphate bonds.”**

We often see this “high-energy bond” represented as a squiggly line (~) to represent the high energy bond between the second and third phosphate. Sometimes, the bond between the first and second phosphates is also

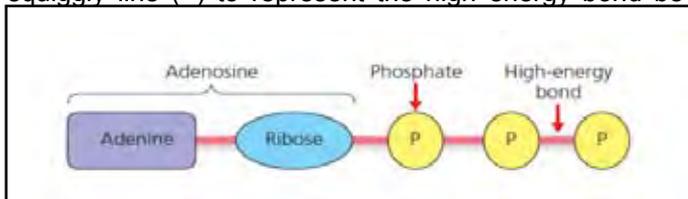
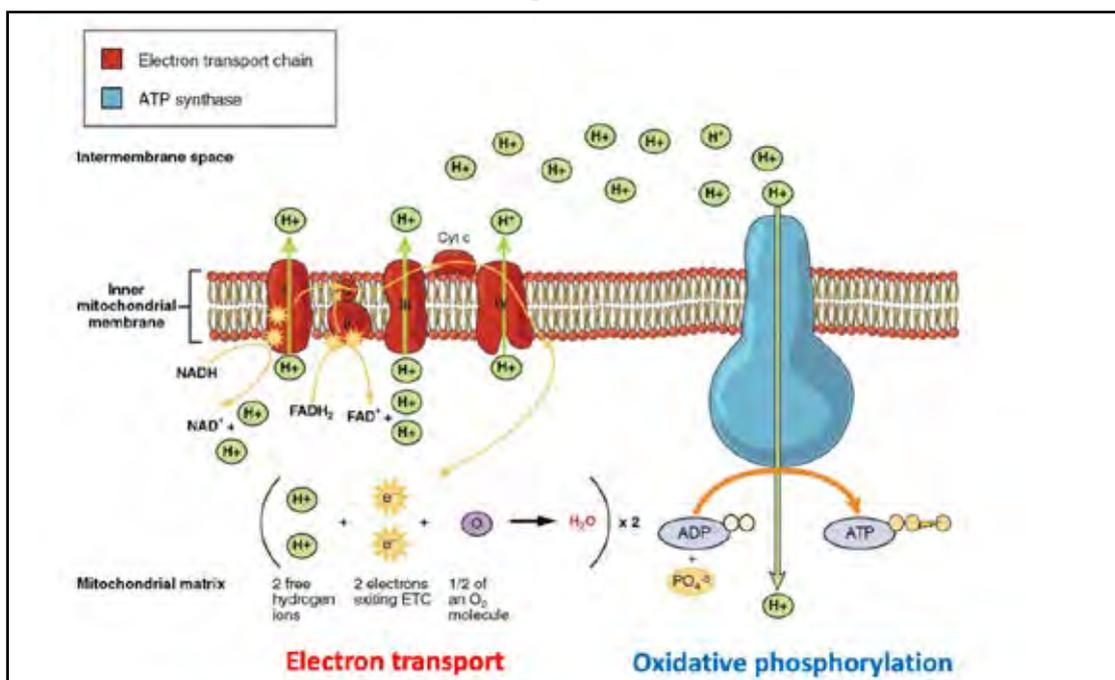


Figure 5: A typical textbook diagram of ATP

between the first and second phosphates is also

Figure 6: The electron transport chain and ATP synthase. The ETC establishes a proton gradient. ATP synthase harnesses the energy from this proton gradient to produce ATP (oxidative phosphorylation).



represented by a squiggly line. Vogel (1987) says that we maintain the “polite fiction of high energy bonds but the energy is neither high nor in the bonds”.

The overworked term "high energy phosphate bond" (Fig. 5) is a colloquial expression long perpetuated by biologists which refers to the transfer of free energy when the phosphoanhydride bonds in the triphosphate unit of ATP are broken and other bonds are formed during coupled reactions. (Storey, 1992). It's really about the transfer of phosphate groups, and the free energy difference between reaction participants in their initial state and in their final state. Storey (1992) suggests we should stop using the squiggly line, and that it is misleading to suggest to our students that the energy is localised in the bond itself. Instead, we should focus on the group transfer potential of ATP. Harold (1986) also says that the energy converting character of ATP is better explained as group transfer potential *i.e.* the tendency of the phosphoryl group to migrate from donor to acceptor.

**“The rate of ATP production during fermentation is slower than it is during aerobic respiration.”**

In fact, the opposite is true. The rate of carbohydrate consumption increases up to seven-fold as oxygen concentration decreases (Stryer, 1988). Under anaerobic conditions, the rate of ATP production can remain high, and carbohydrate consumption is accelerated. This is known as the Pasteur effect. Pasteur found that yeast grown in sufficient oxygen consumed less sugar than oxygen-starved cells. Human cells also show the Pasteur effect.

As Storey (1992) points out, knowledge of the Pasteur effect leads to interesting questions. Can humans lose more weight during anaerobic exercise because glucose consumption is increased? Here students should think about the fact that weight is only lost when CO<sub>2</sub> is exhaled, and that CO<sub>2</sub> from carbohydrate breakdown is released almost

exclusively only after pyruvate enters the mitochondria. Thus, no weight loss can occur unless exercise is aerobic. More important for weight loss, fats are completely oxidized only in the presence of  $O_2$  and carbohydrate (Stryer 1988; Rawn 1989). The  $CO_2$  of fatty acids is released during Krebs cycle activity. There is just no escaping the fact that weight loss in humans (and animals in general) requires aerobic respiration.

### “ATP is produced by the electron transport chain”

The function of the electron transport chain is to provide the energy for the pumping of protons across the inner membrane of the mitochondrion into the intermembrane space. This sets up a proton gradient across the membrane.

Protons then flow back across the membrane through the channel of a nearby ATP synthase, a molecular machine which is not part of the electron transport chain. The flow of protons turns the turbine of the ATP synthase, and the energy produced is used to synthesise ATP.

When Peter Mitchell proposed this chemiosmotic hypothesis in 1961, the prevailing idea that electron transport produces ATP via substrate phosphorylation (as occurs during glycolysis). Mitchell's proposal that real job of the electron transport chain is to establish a proton gradient, so that an ATP synthase would synthesise ATP. According to his hypothesis, electron transport and ATP production are only indirectly linked.

Mitchell's ideas were initially not well-received by his contemporaries, who were convinced that the energy was stored for ATP production was stored in some intermediate compound. No evidence for any such high energy intermediate was ever found. Instead the evidence mounted for the formation of a proton gradient by the ETC, and the flow of protons back into the matrix of the mitochondrion via ATP synthase providing enough energy to form ATP. Mitchell eventually won the Nobel Prize for Chemistry in 1978 for his chemiosmotic theory of ATP synthesis.

### References

- Campbell, N. (1990). *Biology* (2nd ed.). Redwood City, CA: Benjamin/Cummings Publishing Co.
- Cros, D. & Fayol, M. (1988) Conceptions of second year university students of some fundamental notions in chemistry. *Int. J. Sci. Educ.* 10, 331–336.
- Darnell, J., Lodish, H. & Baltimore, D. (1990). *Molecular cell biology* (2<sup>nd</sup> ed.). New York: W.H. Freeman and Co.
- Freeman, S., Quillin, K., Allison, L., Black, M., Taylor, E., Podgorski, G. and Carmichael, J. (2017) *Biological Science*. Pearson. 6<sup>th</sup> Edition.
- Harold, F. (1986). *The vital force: A study of bioenergetics*. New York: W.H. Freeman and Co.
- Lehninger, A. (1982). *Principles of biochemistry*. New York: Worth Publishers.
- Nicoll, G. (2001) A report of undergraduates' bonding misconceptions. *Int. J. Sci. Educ.* 23, 707–730.
- Oliveira, G. A., Sousa, C. R., Da Poian, A. T. & Luz, M. R. M. P. (2003). Students' misconception about energy-yielding metabolism: Glucose as the sole metabolic fuel. *Adv. Physiol. Educ.* 27, 97–101.
- Rich, P.R. (2003). "The molecular machinery of Kellin's respiratory chain". *Biochemical Society Transactions*. 31 (Pt 6): 1095-1105
- Storey, R. D. (1992) Textbook errors and misconceptions in biology: Cell energetics. *Am. Biol. Teach.* 54, 161–166.
- Stryer, L. (1988). *Biochemistry* (3rd ed.). New York: W.H. Freeman & Co.
- Vogel, S. (1987). Mythology in introductory biology. *Bio-science*, 37, 611-614.

### About the author

Dr Declan Cathcart teaches Biology at Temple Carrig School, Greystones. He is also member of the PDST Biology team currently running nationwide Autumn in-service CPD workshops on the theme of respiration.

### Get Your Writing Right! - Continued from page 31.

#### Acronyms

Acronyms are words formed from the initial letters of other words and pronounced as a single word. Common acronyms are DART (Dublin Area Rapid Transit), UNESCO (United Nations Educational and Cultural Organisation), NASA (National Aeronautics and Space Administration), and there are many more. Acronyms are correctly spelled with capital letters.

#### Date Notation

In an English-speaking country dates should be expressed in the English style rather than the American style, i.e., 1st September rather than September 1st. Of course the American style is in all too common use, because of the influence of computers over the last thirty years or so.

#### American Spelling

Again, owing to computer use, American spelling often appears automatically when typing documents. All those 'z' American words need to be changed to their English spelling, i.e., using 's' instead of 'z'. Words such as crystallize (should be crystallise) and the same with ionize, analyze, polarize, catalyze, magnetize and many others.

#### Finally

To finish with, a few more frequent errors:

Data is a plural noun, so *the data are studied*, not *the data is studied*.

The middle of something, or a building where an activity is carried out is its **centre**; center is the American spelling.

Clear and colourless are often confused. Clear is not a colour; it means transparent. Copper sulfate solution is clear but not colourless (it's blue!). Every solution is clear; otherwise it's not a solution. It doesn't help to see glass recycling bins labelled as 'green glass', 'brown glass' and 'clear glass'. All glass is clear.

And finally finally, when you have finished typing something on your computer or on your mobile phone, always read it through before pressing the 'print' or 'send' button!

#### References

When I need clarification of a spelling or whether to use a capital or lower case letter, or confirmation on any grammatical matter, my standard references are: *Oxford English Dictionary*, *Chambers' Concise Dictionary* (a bit of a misnomer this; the book has 1294 pages!) and *Guide to English Usage* (Longmans). Another very interesting and informative volume is *Troublesome Words* by Bill Bryson, a book that you can keep beside your armchair or bedside and dip into any page at any time to learn about things you didn't know!

I am indebted to Elizabeth Mayes, Ian McCulloch and Siobhan Sweeney for proofing this article and for making useful suggestions.

# A Day on The Bog

Nuala Madigan



When you hear someone say they spent 'a day on the bog' your first thoughts may be your own memories of long Summer days spent cutting and footing turf on a bog in your local area. However for the Irish Peatland Conservation Council (IPCC) based at the Bog of Allen Nature Centre in Co. Kildare a day on the bog holds a different meaning. It is an opportunity for students to explore the peatland ecosystem, a living habitat supporting a wide variety of unique flora and fauna, a carbon store, a habitat that regulates water and for the raised bogs in the midlands a 10,000 year journey of formation. Recently members of the Kildare Branch of the ISTA visited the centre and discovered for themselves how the peatlands of Ireland can be used as a habitat to study. Indeed choosing a peatland habitat to study was made possible in the 1990's when the IPCC developed a selection of curriculum linked peatland studies that were approved by the now Department of Education and Skills. Some examples of where peatlands can be included within your own lesson plans are the formation of soil types required within the Agricultural Science curriculum while choosing to focus on peatland flora and fauna compliments the biology curriculum.

The unique flora and fauna of peatlands offer students a host of adaptations to study including lichens that are an example of a symbiotic relationship, insect eating sundews, snorkeling bog cottons and bog asphodels that offer their roots as a host to nitrogen fixing bacteria. The fauna of the bog are no different with students during their field study discovering adaptations including lizards that drop their tails, opportunistic foxes, hares that don't burrow and curlew that depart the bog in the Winter. The bogs of Ireland are often referred to as the harshest landscape in the country but at the same time Ireland's last wilderness. This combination of an open and wet environment provides ideal conditions to record abiotic factors affecting



The common or viviparous lizard (*Zootoca vivipara*) is Ireland's only native species of reptile

bogs including light intensity, pH, temperature and wind. Formal qualitative studies introduce students to the presence of flora and fauna on their study site while a quantitative line transect offers data to be interpreted by students.

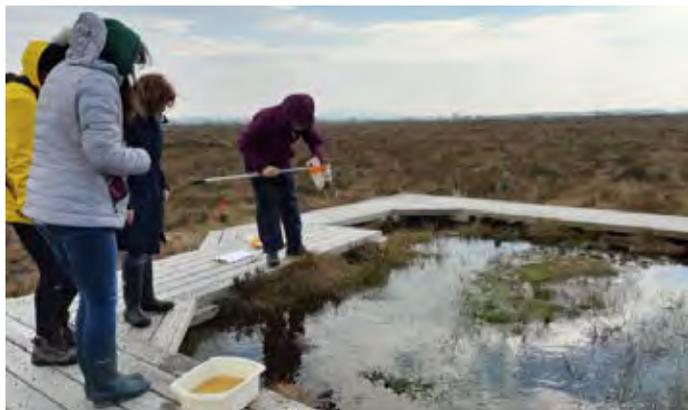
Although undertaking a field study on a bog is different to harvesting turf from a bog something's will never change - wellies or old runners are advised for all visiting a bog,



A qualitative study

bring plenty of sandwiches to keep energy levels up and wear clothes that will work in all weather types. The IPCC would like to Thank the Kildare Branch of the ISTA for choosing to offer a different 'day on the bog' to their members.

The Bog of Allen Nature Centre welcomes groups and further information can be found at [www.ipcc.ie](http://www.ipcc.ie) or contacting the IPCC on 045-860133 or [bogs@ipcc.ie](mailto:bogs@ipcc.ie).



Pond dipping

## The Author

Nuala Madigan, B.Agr.Sc.Env., M.Ed

# Pioneers of Science Education

## #8 William Mayhowe Heller: (1868-1949)

Heurism comes to Ireland

Dr. Peter E. Childs



In this series I will look at some of the pioneers of science education, either in terms of pedagogy, curriculum development or science education research. Some of them have an Irish connection, but all have had an influence on the teaching and learning of science in Ireland. In PoSE #1 we looked at Maria Edgeworth, who was a friend of Jane Marcet (PoSE #3), and in PoSE #2 at Richard Dawes, a pioneer of child-centred science in context. In PoSE #3 we looked at the life of Mrs Jane Marcet, one of the earliest popularisers of science, especially for women. PoSE #4 looked at J.M. Wilson, who served on a Royal Commission with Thomas Huxley (PoSE #5), who also promoted technical education as Br. James Dominic Burke did in Cork, who also used inquiry in science teaching as did Henry Armstrong (PoSE #7). Armstrong's ideas were brought to Ireland by William Mayhowe Heller (PoSE #8), one of his early disciples.

### Introduction

In the last article (PoSE #7) we looked at the work of Henry Armstrong, the father of heurism (discovery learning) in science teaching, and his influence on inquiry-based science education (IBSE). His ideas were spread by his former students who became his disciples in propagating the gospel of heurism in teaching science. One of these ex-students was William Mayhowe Heller, who brought Armstrong's ideas to Ireland in 1900 and who had a major influence on the development of science education in Ireland. We are fortunate in having three studies describing his work: an article by Gerry Beggan (Beggan, 1983), a PhD thesis by Michael Quane (Quane, 2003), and a Master's thesis by Julienne Gallagher (Gallagher, 2007) and I have drawn on these sources and others in writing this article. Until independence in 1921 there was much interaction and exchange between Britain and Ireland in education and so it was natural that the radical ideas of Henry Armstrong, as they then were) should have crossed the Irish Sea, as he himself did.

### W.M. Heller's career

He was born in 1868 and his father was a well-known teacher. He was educated at Westminster School and then went to the City and Guilds Central College where was taught by Professor Henry Armstrong (PoSE#7). Heller was infected by Armstrong's passion for science teaching the virus of heurism and worked closely with him until he left for Ireland in 1900, and thereafter kept in close touch. Eyre (1958, p. 273) said this about Armstrong's heuristic

disciples: *"In this manner a small stream of ardent young protagonists from the chemistry department of the Central Technical College, fired by the enthusiasm of their 'Master', carried the torch of Heuristic teaching into many sections of the community, particularly in the teaching profession, where many of Armstrong's students became highly successful."*

Heller gave evidence with Armstrong to the Belmore Commission (1897-98) which looked into Manual and Practical Instruction in National schools in Ireland (Belmore Commission, 1898). He also submitted a science syllabus (Syllabus H, Box 1) in 1898 which he had developed to use with London schools in his work for the London School Board. This was well received and became the basis of the elementary science syllabus (Syllabus I) used in Irish national schools from 1900. Science was a compulsory subject until 1923 when it became optional due to the increased emphasis on Irish in the new Irish Free State.

He was headmaster of the Municipal Technical School, Birmingham 1887-1900 and thus gained experience in administration and promoting science in secondary education. He was recruited to work in Ireland, possibly through the agency of Professor George Fitzgerald of TCD, who was on the Belmore Commission. He was appointed at the chief organiser of science in national schools and inspector of schools under the new Department of Technical Instruction. After Irish independence in 1922 this became the Department of Education and he remained as Senior Inspector for Scientific and Technical Education until his retirement in 1933. He died in Dublin on 13<sup>th</sup> May 1949 at the age of 81. He married Madame Clossett, a famous singer and musician in Dublin.

Date	Event
1868	Born in London
	Educated at Westminster School, London
1885-1888	Student of H. E. Armstrong, City and Guilds Central College, London
1888-1889	Promoting heuristic approach with Armstrong in St. Dunstan's College, Catford and at Christ's Hospital, Greyfriars
1892-1894	Science master, King's College School
1894-1897	Science demonstrator for the London School Board
1897-1900	Headmaster of Municipal Technical School (now Central Grammar School) in Birmingham

1897	Interviewed by Belmore Commission (1897-1898) on science teaching in Ireland and submitted an experimental science syllabus (1898)
1900-1919	Head Organiser, Elementary Science in National Schools (Ireland)
1903-1908	Committee member, BAAS Report on Teaching Science
1905	W.M. Heller and E.G. Ingold, <i>Elementary Experimental Science – an introduction to the study of scientific method</i> published
1922-1933	Senior Inspector of Technical and Scientific Education in the Department of Education, Irish Free State
1932	President, Foundation Section of the British Association of the Advancement of Science
1949	Died 13 <sup>th</sup> May aged 80

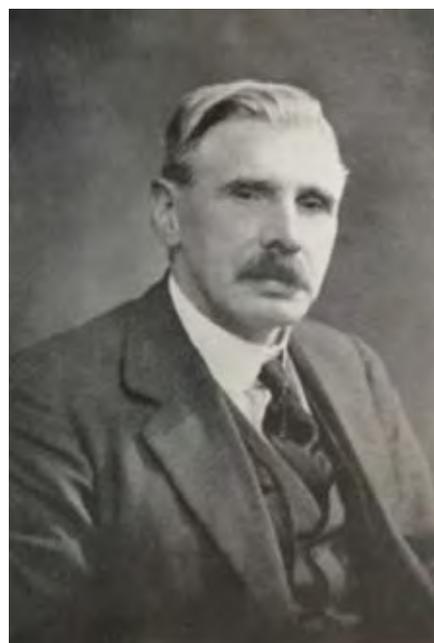


Figure 1: W. Mayhowe Heller, Headmaster Central Grammar School, Birmingham

Table 1 Summary of W. M. Heller's career

### Heller's teaching career in England (1888-1900)

In 1887 Hugh Gordon came to work with Armstrong in the Central College (Eyre, 1958, 272-273), became interested in school teaching and became a peripatetic (travelling) demonstrator for the London School Board (1891-1894). With the help of Armstrong he established a training centre in a deserted rice mill in Berners Street, Whitechapel. He and a band of teachers got together to share ideas and experiments in science teaching, with Armstrong's input and encouragement. In this way Armstrong's ideas on teaching science was adopted in a number of London schools. Gordon went on to be a science inspector of schools and later of training colleges. Heller took over from Gordon and worked from 1894-1897, introducing science into girls' schools as well as boys' schools. *"In this manner a small stream of ardent young protagonists from the chemistry department at the Central technical College, fired by the enthusiasm of their 'Master', carried the torch of heuristic teaching into many sections of the community, particularly in the teaching profession, where many of Armstrong's students became highly successful."* (Eyre, 1958, p. 275). We have a description of Gordon's and Heller's methods (Armstrong, 1903, p. 298-299). In this way science teaching was introduced into around 40 schools in North and East London.

### The Method adopted by Messrs. Gordon and Heller in giving Instruction in Elementary Schools

*The demonstrator usually made one visit to a school per fortnight and gave one lesson of three-quarters of an hour duration to each of Standards V, VI and VII, or to whatever Standards there were in the school. The schools visited may be divided into two classes: first, those in which the assistant teachers had*

*been through a course of training at Berners Street; secondly, those in which the teachers were beginning the subject (Course 4) without previous knowledge of the methods to be used. In the case of those of the former class the demonstrator was free to teach the scholars alone, without considering the class teacher. The monitors of the class usually had charge of and were responsible for keeping the apparatus clean and in order. This was stored in a specially designed lecture table and cupboard combined, fitted with lead sinks and draining-boards, divided drawers, etc., which cost nearly £10; in many cases, however, such a table was not provided and the apparatus was kept in ordinary stock cupboards, the experimenting-table being improvised by placing a blackboard across two dual desks. In many cases a hinged flap table folding down against the wall was found most convenient for experimental work by the scholars. The demonstrator usually spent a few minutes questioning the class as to the work accomplished during the previous fortnight and dealt with the difficulties that had occurred, taking care to emphasise the exact position the experiments already made had left the scholars in ; he then invited suggestions as to what would be the next point to elucidate. Very good suggestions were often made but as a rule the class had to be led to the consideration of the next question to be answered. As soon as it was clearly understood what was to be the particular object of inquiry, two or four boys would get the apparatus out, fit it up and make the necessary weighings. Perhaps other boys would carry through the experiment to the finish. There was seldom any necessity for the demonstrator to handle the apparatus at all and the fact that the demonstration experiments were performed by the boys themselves ensured the closest attention of their fellows. A living interest in what was going on and a condition of enthusiasm was thus aroused, which was reflected*

*in the whole subsequent work of the class. Between the demonstrator's fortnightly visits there were, as a rule, three intermediate lessons, which were utilised in repeating the last lesson, for back work and in writing up notes ; advantage was often taken of writing lessons and composition lessons for note book work. In many schools one or two experiments were kept always going on a table in a corner of the room and a few boys — usually not more than four—were always engaged at experimental work, so that in the course of the fortnight every boy in the class would have performed the chief experiments connected with that portion of the work under consideration. In the second class of school, in the case of a teacher unfamiliar with the work who was, perhaps, at first not willing to take the extra trouble involved in keeping the boys at experimental work, it often happened that the class lost interest and results were unsatisfactory. Apparatus was supplied to the school at the beginning of the year's work, everything that was required for the work being provided and due allowance made for breakages. Did the occasion arise, apparatus was loaned from the central laboratory to schools likely to use it with advance, so that work was never allowed to stand still for want of apparatus. At annual inspections sufficient additional apparatus was sent to schools to enable fifty boys to be at work at once.*

Heller was a member of a subcommittee of the British Association which from 1903-1908 drew up an influential science syllabus, together with H.E. Armstrong, Arthur Smithells and C.W. Kimmins (Jenkins, 1979, p. 42; BAAS, 1908).

His work with the London School Board was picked up in New Zealand who published Syllabus H of the London School Board in an Appendix on Education: Manual and Technical Instruction for the New Zealand House of Representatives (Riley, 1898). This syllabus H was adopted in Ireland as Syllabus I when a new programme of study for national schools was adopted in 1900. Professor Fitzgerald of Trinity College was a member of the Belmore Commission and visited England to see Heller's work in London schools. He was very impressed as the extract below shows and it would seem that he was mainly responsible for recruiting Heller to work in Ireland for the Irish Board of National Education. He moved to Ireland in 1900 and was to spend the rest of his working life there.

*"The 'heuristic method' is a scheme by Mr Heller, formerly demonstrator to the London School Board, and now of Birmingham. The system is strongly advocated by Professor Armstrong, Inspector Gordon, of the Science and Art Department, Professor Fitzgerald of Dublin, and many other educational authorities. With Mr. Heller's permission, I give the following extract from a letter of Professor Fitzgerald's upon the subject of the 'heuristic' syllabus. He says, "I have had a good opportunity of comparing the methods of science instruction in several different places in England during my recent visit to Ireland in connection with the Commission on Manual Practical Instruction in*

*Primary Schools in Ireland. [Belmore Commission] I took keen interest in what I saw, and especially your work in London. I have been more favourably impressed with the methods you are employing, and, from what I saw of its work in schools, am convinced that it is working out in practice what it is designed to do, and is capable of being introduced into any school by intelligent and well-trained teachers. Your methods are intelligible methods, and can consequently be made the basis of an intelligible system which can control all the methods of the teacher, and give him an intelligible clue for developing the methods to suit the varying circumstances of his school and locality. In that respect it seems to me to have an overwhelming advantage over what I may describe as the hand-to-mouth methods of others.... I have been so fully impressed with the advantages and workability of your system that I shall use my endeavours to have this rational system introduced wherever practicable in our Irish schools and I feel no doubt that, wherever science education is practicable, your system, modified as to its details to suit localities etc., but unmodified as to its ideals and essential methods, will be found by far the most practicable of any, and by far the most valuable as regards its results."* (Riley, 1898, p. 8)

<http://centralgrammarschool.org.uk/head-teachers/>

He moved from the London School Board to be headmaster of a school in Birmingham.

*"On the day of my appointment it was agreed that the school should be free from the constraints of external examinations, but would welcome constructive help from Government inspectors. Here I must pay a tribute to George Kitchen -the inspector in charge. He threw himself into the work of the school as if he were a member of the staff. He frequently taught classes and helped with all exhibitions and social functions. With the Art masters he painted most of the scenery for the school plays. His cheerful and inspiring help endeared him alike to masters and boys. He followed me to Ireland where we often made use of our experiences in Birmingham."*

<http://centralgrammarschool.org.uk/head-teachers/>

### **Heller and heurism in Irish science teaching (1900-1933)**

The Belmore Commission (1898) was very influential in shaping Irish science education in elementary (national) schools in the early 20<sup>th</sup> century. McLoughlin (2017) summarises its importance:

*"In 1897, a vice-regal commission was set up, with the Earl of Belmore as chairman, "to enquire and report with a view to determining how far and in what form manual and practical instruction should be included in the educational system of primary schools under the Board of National Education in Ireland". Members of the commission visited Britain, Germany, Holland, Denmark and Switzerland to study the practical work being done in the schools in those countries. Their report, published in 1898, shaped the pattern of education in Ireland for the next quarter of a century. The influence of Henry Edward Armstrong and his "Heu-*

*ristic Method” was to become evident through the work of William Mayowe Heller, appointed to effect the proposals of the Belmore Commission in Ireland. A new primary programme was implemented in 1900. It had proposed that agriculture, since it did not properly belong to primary education, should be replaced by a course of elementary science for rural schools, especially as the experts who appeared before the commission described it as “quite valueless”. The theory of agriculture that had been taught in schools since 1873 was replaced in 1907 by a scheme of nature study which, in turn, made way for Rural Science and Horticulture in 1912. This was followed by changes in the teacher education colleges to train teachers in these new subjects.”*

Walsh (2005) comments on the new programme for national schools:

*“The Revised Programme (1900) advocated the abolition of the Payment by Results system that had been in operation since 1872. In addition, the introduction of a wider curriculum, a focus on kindergarten education, the inclusion of more practical content and an emphasis on schools as an interesting and humane place for children was prioritised. Education was to be enjoyable and discovery-oriented and the inculcation of a disposition for learning was prioritised over actual content. The didactic methodology heretofore used was replaced with a heuristic approach, with an emphasis on practical education (Belmore Commission on Manual and Practical Instruction, 1898).”*

Heller was appointed in June 1900 and took up his post in August 1900 as Chief Organiser and Inspector of Science Instruction for the Commissioners for National Education in Ireland. He immediately got down to work to implement the revised programme which made object lessons and elementary science compulsory for those schools equipped to teach it. He produced his first report for the Commissioners in 1901 (Heller, 1901) and immediately started running courses to train teachers in the new subject matter and methodology (heuristic). He started by visiting many schools and could say: “There was not at that time, nor had there been for many years past in the majority of schools, any teaching of Experimental Science.” (Heller, 1901, p. 93) The scheme of payment by results which operated from 1870 to 1900 had effectively eliminated science from the national schools. Heller was allowed to reshape Irish elementary science education and introduce heuristic into Irish schools from 1900 onwards. From October 1900 he started a 6 week course for 50 teachers in a laboratory in the Central Model Schools, Dublin. This involved 5 hours of laboratory work and 3 hours writing up reports in the evening for a total of 30 days, and during it Heller performed nearly 200 experiments. He commented on this first cohort of national teachers: “*The ability and enthusiasm displayed by teachers attending this first course were beyond all praise and I shall always look back to this course as one of the pleasantest experiences of my professional work.*” (Heller, 1901, p. 94) In November he was allowed to appoint 6 sub-organisers, Mr Ingold, who came from England and the Central Technical College (the Armstrong stable), and 5 local teachers who had attended

the first course. In the rest of the year similar courses were held in Belfast, Cork, Londonderry, Waterford and Killarney. In October 1900 courses started in the primary training colleges and these involved a 3 hour practical exam run by Heller and Ingold, his right-hand man. In the first year 552 teachers were trained and Heller requested a total of 12 sub-organisers in order to meet the demand for courses. He repeated the request for extra staff every year but it was not granted. In fact, he was only given the 6 staff for 5 years and after that only 2 were reappointed, even though it meant that the job of retraining teachers and refreshing them after initial training could never be completed. However, it was not for lack of trying and in Figure 2 we can see how many teachers were trained and how many schools were equipped in the first 5 years, an impressive achievement.

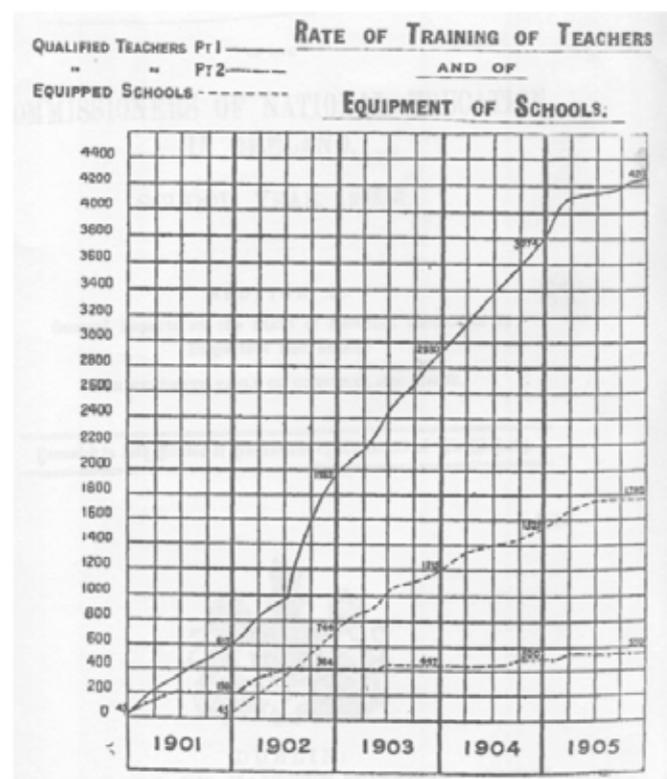


Figure 2: Statistics on teachers trained and schools equipped 1900-1905 (Heller, 1905, p. 153)

At the conclusion of his first course he was commended by the *The Irish Teachers' Journal* (*The Irish Teachers' Journal*, 1900, November, p. 3):

*“Mr. Heller proved himself a very capable teacher, indeed, of practical science. He has shown himself a master of the subject. He is a clear and lucid lecturer; an able and experienced demonstrator, and a most painstaking and successful teacher .. He is filled with enthusiasm for his subject, and has succeeded in infusing some of that enthusiasm into those he had to teach. If Science teaching will not succeed under his guidance we do not see how it can be made to succeed in our Irish schools.”*

From 1902 Heller produced a series of articles for the *Irish School Monthly* on the teaching of elementary science. In 1905 he and Ingold published a book on *Elementary Experimental Science – an introduction to the study of scientific method* (London: Blackie and Son, Ltd., 1905) to support their courses.

The Clare County Library has a copy of a student's notebook, Mary Curry, from her time at Our Lady of Mercy Training College in Dublin, 1902-3, in which she describes 55 experiments. One of the final lessons is stamped: "N.E.I. Examined, W. Mayhowe Heller, Head Organiser, Elementary Science."



Figure 3: Notebook by Mary Curry Training College, Our Lady of Mercy, Dublin, 1902-1903 containing 55 numbered experiments. [http://www.clarelibrary.ie/eolas/claremuseum/acquisitions/olom\\_college\\_dublin.htm](http://www.clarelibrary.ie/eolas/claremuseum/acquisitions/olom_college_dublin.htm)

Armstrong gave his former student an accolade in 1902 when he gave an address at the BA meeting in Belfast. It was during this same meeting that Armstrong had gone down to Cork to visit Br Burke (PoSE #6).

*"Ireland is fortunate at the present time in that far-reaching changes are being introduced into its educational system. A body of men are engaged in this work who are, I believe, in every way specially qualified to promote reforms and earnestly desirous of developing a sound policy. The Irish race have rich powers of imagination such as no other section of the nation possesses: it is only necessary that these powers be trained to considered and balanced action to make the Irish capable of deeds before which the splendid achievements of the past will appear as nothing. Of course the development of a true policy must come about slowly; we must not be too impatient of results but give every encouragement and all possible support to those engaged in the work. It is before all things necessary to remember that the school is a preparation for life, not for the inspector's visit; in the future the inspector will act more as adviser and friend, let us hope, than as mentor.*

*... Nothing could be more gratifying than Mr. Heller's statement in the Report for 1900, 'that the Irish teachers as a whole seem to possess a great natural taste and aptitude for science and the method of experimental inquiry.'*" (Armstrong, 1903, pp 89-90)

Quane (1999, pp 55-56) in Box 1 gives a short summary of the course adopted for Elementary Science, based on Syllabus H adopted by the London School Board. It can be seen that this is a very demanding syllabus for national schools, teachers and pupils, with no tradition of teaching science. I have included the appropriate age ranges for the different Standards, and it can be seen that this overlaps with today's junior secondary cycle.

## Box 1

*Details of the proposed Course I on Experimental Science for the various standards included the following topics:*

**3<sup>rd</sup> Standard.** (10-11 years) *Measurement of lines, areas and volumes. Water displaced by a body immersed in it. The seesaw or lever leading to a knowledge of the pair of scales or balance. Relative weights of different kinds of material.*

**4<sup>th</sup> Standard.** (11-12 years) *Floating bodies. Weight of a body in water. Air has weight. Water pressure. U-tube, barometer, syphon. Measurement of hotness by thermometer. Evaporation, moisture in the air. Soluble and insoluble substances. Experiments to elucidate nature of burning in air. Changes in appearance and weight of various substances heated in air.*

**5<sup>th</sup> Standard.** (12-13 years) *The units of heat and temperature. Revision of relative weight experiments. The rusting or slow changes occurring to iron, copper, lead and phosphorus in air. Active and inactive part of air.*

**6<sup>th</sup> Standard.** (13 years and up) *Revision of heat experiments. Lime, chalk and marble. Effects of heat, water and acids on each. Measurement of gases evolved. Chalk gas proved to be identical with that produced by burning carbon in oxygen. Experiments to show chalk = lime + carbonic acid gas. Hard and soft water.*

Initially the venture was successful and many teachers were trained in the new methods and schools equipped to teach science but after 1906 it faltered. The team of teachers who had been training teachers was disbanded, apart from two people plus Heller, thus making it impossible to train the whole cohort of teachers in the new methods, and teachers inevitably returned to the didactic teaching they were familiar and confident with. Later on Rural Science became more important especially in rural schools and by 1923 elementary science became an optional rather than a compulsory part of the curriculum. Its place in Irish primary schools never recovered until the 1971 curriculum and later the 1999 revised curriculum. (Gallagher, 2007; Quane, 2003) Heller continued as a Senior Inspector in the new Department of Education of the

Irish Free State until his retirement in 1933 but the place of elementary science in national schools never recovered its status. Just as in England, the heuristic crusade in science education faltered and died in Ireland.

The way heurism was introduced into the national schools from 1900 (and also into intermediate and technical schools) was the equivalent of a short, sharp shock. Heller said when he was a headmaster in Birmingham:

*"The change in method must be sudden, complete and revolutionary; no attempt must be made to gradually displace the old by the new for in doing so both must inevitably become ineffective."*(Heller, 1898)

In its time it was the envy of other countries and in the 1909 Annual Report Heller (1909, p. 173) could say:

*"A Committee of the British Association, appointed in 1904 to inquire into the courses of practical instruction most suitable for elementary schools, after considering a large number of schemes from various English authorities, recommended the courses of instruction in operation in Irish National schools, as satisfying the aims and methods that should guide scientific instruction."*

To implement curriculum change requires sufficient financial resources to retrain teachers and provide classroom and laboratory resources, as well as involving teachers in the process. As early as 1901 the new heuristic scheme was under attack from teachers.

*"Life is not long enough for any person to investigate anew the whole body of science, and consequently we must in a scientific age like the present, even when we follow the Heuristic method in our own inquiries, be prepared to accept implicitly the results of others' inquiries."*

*Irish Teachers' Journal*, March 1901, p. 6 (quoted by Quane, 2003)

Walsh (2016, p.4) gives a good summary of the reasons for the failure of the 1900 Revised Programme, and sadly it would seem that these lessons on curriculum reform have yet to be learned.

*"Overall, the Revised Programme fell short of the educational revolution it had aspired to invoke. It was heavily influenced by international jurisdictions and was not sufficiently contextualised for implementation in the Irish context. The supports put in place lacked sufficient cohesion and intensity to instigate change. Moreover, issues around teacher training, insufficient funding, the physical condition of schools, poor attendance rates and the lack of popular support for the reforms also hindered implementation. Key stakeholders were not kept informed or instilled with a sense of ownership of the revisions, an omission considering they were the means to translate the theory of the programme into a practical reality. While conceptually well devised, the Revised Programme lacked a strategic implementation policy and failed to provide an appropriate support infrastructure to ensure successful implementation."*

Heller was totally committed to Armstrong's heuristic crusade and paid this tribute to his mentor in 1916.

*"There is probably hardly a teacher of science today whose*

*methods, consciously or unconsciously, have not been modelled by Armstrong's crusade. As an original thinker on education Armstrong ranks with Huxley; as a constructive reformer he is pre-eminent. It is sometimes difficult to understand how he acquired his keen insight into aims and methods of schoolwork. It is the experience of more than one of his old students who have embraced the teaching profession, that only after some years of schoolwork did they appreciate to the full the fundamental importance of much that he taught them., through years of strife with the conservative forces of educational tradition may occasionally have led us to policies of expediency, our courage has been maintained by the faith that he gave us."*

*The Central: Journal of the Old Students of the College.* Vol. XIII. Birmingham: Percival Jones. 1916, p.20. Appendix 7, p. 129. Quoted in Gallagher, 2007, p. 28

He was involved in the Education Section of the British Association for the Advancement of Science (BAAS) from its inception in 1900 by Armstrong and colleagues. In 1932 he was President of the section and gave the presidential address in York (Heller, 1932). In fact the address was given by his wife following an accident and his continuing ill-health led to his retirement from the Department of Education in 1933. This concluded a long and eventful life in education, largely dedicated to promoting inquiry-based science education in England and then in Ireland.

## Conclusion

W. Mayhowe Heller was a student of Henry Armstrong's and imbibed and implemented Armstrong's ideas in his own teaching and in his direction and inspection of Irish science teaching in national schools from 1900 to 1933. In 1932 in his presidential lecture to the British Association he said this about Armstrong:

*"One name beyond others stands out as its advocate where science is taught - Prof. Henry E. Armstrong - originator of this Section of the Association, To his advocacy of training in scientific method the advancement of science in schools owes whatever progress has been made. His trenchant criticism has been supplemented by copious constructive suggestion. Therein he stands, almost alone, among the small band of scientific men who, during the past fifth years, have helped us to put purpose and method into our work. Like other great reformers, the full appreciation of his tireless efforts may not be reached even in his long lifetime."* (Heller, 1932, p. 215-216)

In this same address Heller could say at the end of his career in Ireland:

*"In the elementary schools little substantial progress has been made; here more than elsewhere the child is dependent upon the school for his educational equipment for life; if he does not get some introduction to natural knowledge at school, he will find few opportunities later. I could not speak so confidently if I had not conducted large-scale experiments in both England and Ireland. That both these*



**GLOBE Ireland - Continued from page 21.**

*Centre for two days where we worked in multinational teams to design, implement and later report on an environmental monitoring project. Our project focused on the relationship between aquatic flora, levels of dissolved oxygen and pH values in a freshwater environment. Our results indicated that living plant life adds dissolved oxygen, but decomposing removes it, thus influencing the amount available for other aquatic organisms. pH levels showed little variation and remained in the range 6.5-7.5 providing a neutral pH environment for flora and fauna.*

*"It was an honour for us to be part of this once in a life time opportunity and to not only represent Larkin Community College but the whole of Ireland at the GLOBE meeting in Detroit. We especially enjoyed our time at the Howell Nature Centre where we did a whole load of activities such as night hiking, kayaking, trail walking as well as our environmental project. For the culture night we sang the Irish National anthem, shared Irish phrases and told campfire stories. We made great friends during our time in Detroit and hope that we can keep in touch with everyone. We have memories that we will never forget".*

A parent of one of the Irish GLOBE students that attended this year's meeting in Detroit USA reflected:

*"I wish to thank you so much for giving my son the amazing opportunity to go to Detroit for the annual GLOBE meeting.*

*"He absolutely enjoyed every single minute of it. It has opened his eyes to the world around him to which I'm delighted. He arrived home at 6am absolutely buzzing with excitement telling me it was the best thing he has ever experienced in his life!"*

**GLOBE Air Quality (Spring) Campaign and**



The GLOBE Air Quality Campaign in Ireland is also part of a wider European citizen science initiative. CleanAir@School focuses on

air quality monitoring to raise awareness of the links between air pollution and health. It is a joint initiative of the European Network of Environmental Protection Agencies and the European Environment Agency (EEA). Along with Ireland, schools from Belgium, Sweden, Malta, Estonia, the Netherlands, Spain, Scotland, Wales, and Italy are monitoring air quality using a common approach, to ensure comparability coordinated by the EEA. Ireland participated in the first part of this project through the 2019 GLOBE Air Quality (Spring) Campaign and plans to run further campaigns in the 2019/2020 academic year.

CleanAir@School uses citizen science campaigns to better understand children's exposure to nitrogen dioxide (NO<sub>2</sub>) in the school environment across Europe. Children at participating schools learn about air pollution and health effects, while the wider school community see how road transport affects air quality. A key question is whether, through this work, there will be behavioral changes to minimize air pollution.

More technically, the initiative explores how data collected by citizens might complement 'official' air quality monitoring to communicate and improve understanding of local air quality. At a European level, this can support the European Commission's efforts to streamline environmental reporting and to promote the wider use of citizen science in support of environmental reporting.

This year's campaigns will include surveys of behavioral change and possibly twin Irish schools with schools in other participating countries. Besides the autumn campaign which is earmarked over the coming months across Irish schools, the EPA is also inviting a GLOBE Irish school to present their research findings from the 2019 Spring Air Quality Campaign at their National Air Event in Kilkenny this October.

**Take part in GLOBE**

If you and your school are interested in participating in the 2019/2020 GLOBE programme, including the opportunity to participate in scientific studies in partnership with other European schools, please contact us at: [globe@eeu.antaisce.org](mailto:globe@eeu.antaisce.org).

**GLOBE (Ireland) Programme Leads:**

- Leo McKittrick/Stephanie Long (Environmental Protection Agency)
- Anthony Purcell/Sabrina Moore (Environmental Education Unit of An Taisce)



# Crossword



Randal Henly

## SCIENCE CROSSWORD 85

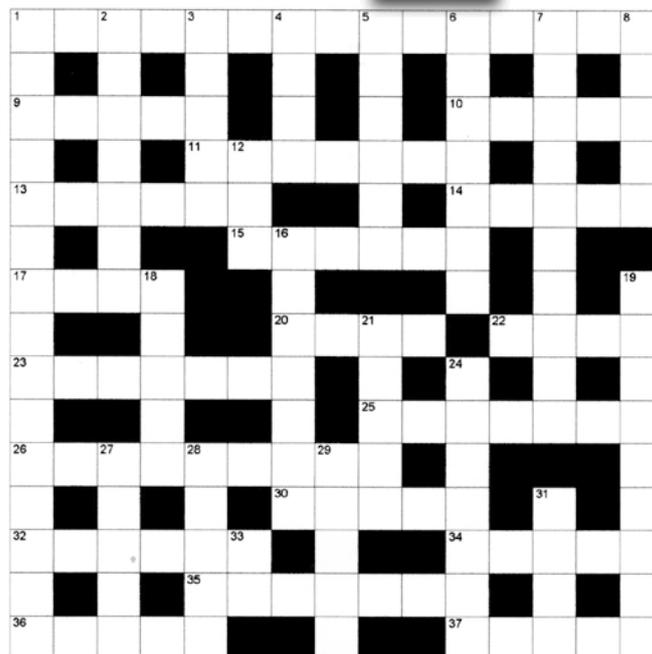
### Clues Across

1. It's designated a centre but it may not be the centre (6,2,7)
9. Thomas, who made notable scientific contributions to the fields of vision, light, solid mechanics and energy (5)
10. Of or relating to the kidneys (5)
11. Six-legged organisms (7)
13. Wormlike bivalve mollusk that does damage to wooden structures (6)
14. Flexible pipes (5)
15. Centres of atoms or cells (6)
17. Heinrich, the 19th-century German physicist (4)
20.  $\text{CO}(\text{NH}_2)_2$ , the main nitrogenous breakdown product of protein metabolism (4)
22. Unit of heredity (4)
23. A very large piece of  $\text{H}_2\text{O}_{(s)}$  (7)
25. Common name of methylbenzene, found in coal tar and petroleum (7)
26. Substance used as an artificial sweetener, chiefly in low-calorie products (9)
30. Imperial length units, each equal to about 1.09 m (5)
32. Non-metallic element (6)
34. Vital body organ (5)

35. A different form of an atom (7)
36. Common condensation polymer (5)
37. Such a compound has the formula  $\text{C}_6\text{H}_{12}\text{O}_6$  or  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$  (5)

### Clues Across

1. The process in which a solution deposits regular-shaped pieces of a solid (5)
2. An uncharged particle (7)
3. Unable to bend or be forced out of shape (5)
4. Organic liquids which may be vegetable or mineral (4)
5.  $\text{C}_2\text{H}_2(\text{OH})_2$ , the main component of anti freeze (6)
6. Early air transport machine (7)
7. A layer in the Earth's atmosphere (10)
8. Egg centres (5)
12. A common prefix in synonyms (3)
16. The capital of this country is Montevideo (7)
18. African wild horse (5)
19. An energy convertor could be a tree organ (9)



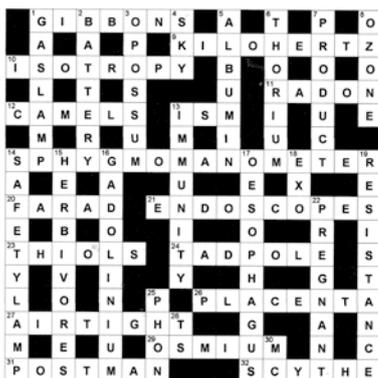
21. Reset the compound formed by reaction of acid and alcohol (5)
24. Sudden quick bursts of light (7)
27. Foot-operated lever (5)
28. Enzyme secreted by and stored in the kidney (5)
29. A devil ray found in tropical seas or a jellyfish when preying (5)
31. An Irish class sounded a bell (4)
33. The other element in manganese (2)

### €20 PRIZE

First ISTA member drawn from correct emails entries received by Friday May 31<sup>st</sup> will win €20. Send your answer to: [snjnfogarty@gmail.com](mailto:snjnfogarty@gmail.com) via your ISTA registered email address.

### Winner - May 2019

Well done to, Declan Finlayson, Kilkenny, whose name was first drawn from the correct entries received by the closing deadline. The correct solution to the May crossword is given below.



### Continued from page 1.

promoting STEM and with which we are delighted to be involved in again. Full details and a poster to display for your students can be found inside. This year's final will take place in March at Baldonnell Aerodrome. Your students can register from now till the 10<sup>th</sup> of January.

A big thanks to all who supplied articles for this issue and to the assistant editors. I must mention Seosamh O'Braonain for his article on the transit of Mercury – due to the slightly later than usual publication I decided to email a copy of his article to members so that you would have it in time for the transit.

Thanks also to Adohagan Ó Súilleabháin who, as well as being chairman, is our 'advertising sales director' coordinating

the ads for the journal. A special thanks is also due to Mary Mullaghy for her news section.

A worrying email arrived to our school principal from the National Animal Rights Association with regard to ending any type of dissection and suggesting digital alternatives. The threatening and worrying bit was the offer to "add you to our 'Cruelty-Free Secondary Schools in Ireland' list" or by implication, blacklist you on an alternative list! This email marks a frightening turn in the control of education, whatever your views on dissection it is the possibility that we can be controlled by such minority pressure groups that is the issue. What next in this PC era? A list of schools that do not teach evolution! In my opinion, we should ignore such

approaches completely. I would be interested to hear your comments

Another email from a retired member contained many very interesting observations, one of which I would like to share with you. "What actually is a 'good teacher'? I would suggest that he (or she) should know his subject well and feel enthusiastic about it, and perhaps be able to think of different ways to excite the pupils and be prepared to discuss things "outside the course" To use the "constructive red herring" as I used to say, which means he should know his subject. All of which means he must have free time to potter about in his lab". It is such a pithy that we now seem to have less and less time to potter! Ed.

# Eolaíochtaí 7 Sláinte Sciences & Health



## Technological University Dublin

Technological University Dublin (TU Dublin), is Ireland's newest University and one of Ireland's largest universities. The new University builds upon a tradition of high quality, practically focussed education in technical disciplines in Kevin St, Cathal Brugha St and elsewhere dating back over 130 years.

The College of Sciences and Health, TU Dublin, offers practical, career-oriented programmes in mathematics, computing, sciences and health.

Our programmes offer a variety of placement opportunities and international opportunities while retaining the small class sizes that enable students to get to know their lecturers and each other.

## New City Centre Campus

From September 2020 the College of Sciences and Health will move all of its programmes from their current homes in Kevin St and Cathal Brugha St to TU Dublin's new campus at Grangegorman in Dublin City Centre. The campus will offer students in the College an opportunity to learn in a modern, state-of-the-art facility designed to create an excellent student experience.

The campus is located close to O'Connell St (10-15 minute walk), and is easily accessed via the Grangegorman Luas stop (Green Line), Smithfield Luas stop (Red Line), and various City Centre bus routes.

## Visit our new Campus

The following are the opportunities available to you and your students to visit our new campus at Grangegorman during the 2019-20 academic year:

**Science Wednesday:** The College of Sciences and Health is hosting two-hour Wednesday afternoon sessions in our new campus where our researchers will present their work to secondary school students.

**Science Camps:** The College of Sciences and Health is running a series of week-long science camps for secondary school students in our new campus during school holiday periods.

**Scifest 2020:** The College of Sciences and Health's Scifest competition (part of the National Scifest competition) will be taking place in early 2020 in our new campus.

**Science Week:** The College of Sciences and Health is hosting a series of events during Science Week where our staff and guests will present their work to secondary school students.

**College Open Day 2020:** The College of Sciences and Health's Open Day will be taking place in early 2020 in our new campus.

**School Visit:** If you would like a member of our academic staff to meet with your students during the next academic year, please contact us to arrange a visit.

**For more information on any of the events email [sciencesandhealth@tudublin.ie](mailto:sciencesandhealth@tudublin.ie)**

tudublin.ie

## Our Wireless Sensor Family has grown even more ...



- Temperature
- pH
- Light
- Pressure
- Conductivity
- Motion **NEW**
- Dissolved Oxygen **NEW**
- Oxygen Gas **NEW**
- Force - Acceleration
- Carbon Dioxide **NEW**
- Voltage
- Current
- Heart Rate - Hand Grip **NEW**
- Blood Pressure **NEW**
- Drop Counter **NEW**
- Magnetic Field **NEW**
- Weather **NEW**
- Colorimeter - Turbidity
- Spectrometer
- Polarimeter
- Wireless Smart Carts
- Rotary Motion **NEW**
- Smart Gate **NEW**
- 3-Axis Acceleration/Altimeter **NEW**

Simplify your lab setup by removing the clutter of cables.

Log data on the sensor and transmit it directly to your Android tablet, iPad, Chromebook and smart phone using PASCO's free SPARKvue App.

Download new **SPARKvue 4.0 App FREE** at Google, Apple and Chrome Stores

Hundreds of **FREE** experiments and lab activities available at [www.pasco.com/digital-library](http://www.pasco.com/digital-library)

## Visit Our Newly Launched Lennox Educational Website

*Please note that, for legal reasons, registered web customers from our old website will need to create a **new account** on our new website*



**NEW SITE Now Live**

LENNOX  
EDUCATIONAL

Lennox Educational  
Website and Resource Site

**ORDER NOW** at [lennoxeducational.ie](http://lennoxeducational.ie)  
to be in with a chance to win a Kindle Fire!

If you need help or have any enquires please contact [schools@lennox.ie](mailto:schools@lennox.ie) or call us on +353 1 460 7600