Science

Volume 55
Number 2
May 2020

Annual Conference Report

Professor Luke O'Neill on Covid -19

AerPrize Finals

STEM in the Transition to Post-primary School

Biobased and Biodegradable Plastics

Pioneer of Science Education - #9 Gordon Van Praagh

Official Journal of the Irish Science Teachers' Association Eol-Oidí na hÉireann

In this issue of SCIENCE

Welcome to the May issue of our journal. This is only the second issue this year, We decided to hold back on the March issue as it was just about to go to press when the announcement of school closures was made. A number of items in it would have been incorrect by the time it would have reached you. Indeed we needed to check if it would have got to you at all, we weren't sure how many members received their copy of Science in school or at their home address. Thanks to an online request, most members have now updated their postal address to their home, so now you will receive this issue long before you get back to school.

Hopefully we will get an extra issue out to you early next term to catch up with items that should have appeared in the March issue. I'd like to encourage any of you out there who have ideas that might benefit other teachers to write a piece for Science. I am thinking especially at the moment about tips and ideas that might be useful for online teaching which it seems may become the norm for quite a while to come. Even if we get back to school in September it looks increasingly likely at this time that it will only be a partial return with classes in on some days and home schooling on others. If this is the case there will be a need for new and novel approaches and resources for science teaching. So if you have anything to share please send it on to me during the summer.

I would like to draw your attention to the excellent resource to help science teachers with online teaching which has been put together by our Chairman, Aodhagán Ó Súilleabháin, bringing together a lot of information about remote learning that can be accessed at https://www.ista.ie/remote-learning-assistance/ on the ISTA website. The page has links to videos and information on all the popular methods for online teaching and learning in one place. So do take a look and check back regularly as I know

Continued on page 54.

Cover photo: A view of the exhibitors area at this years ISTA AGM held in the the Explorium, Sandyford.

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.

Contributors' guidelines can be downloaded from the ISTA website, 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.

President's Reflection

Prof Luke O'Neill

I'm very happy to write my first piece for Science, in my new role as incoming Honorary President. I want to thank the ISTA for asking me to take on this role, which I am delighted to do. We need science more than ever (for obvious reasons…more on that later) and I'm happy to join with you in our critical mission as scientists and educators.

The editor of Science has said I should give a bit of background about myself. Yes! An excuse to show off! As with many of you, I wouldn't be doing what I'm doing without inspirational teachers. I went to Presentation College Bray, completing my Leaving Cert in 1981. Let's just pause and think for a moment about 1981. Those of you who are not old like me will probably have read about what it like in Ireland back then. No smartphones, and in fact not many of us (including me) lived in a house with a phone. It took at least a year to get a phone installed. How did we survive? I grew up in Duncairn Avenue in Bray, and it was our neighbour Mrs Reale who had the phone. She was badgered the whole time, as many of us gave friends her number so that they could contact us. TV only had 4 channels (if you lived on the East Coast). And there were very few computers. My year though was the first to have computer science as part of the Maths course and we were the first to have this as part of the Leaving Cert. Pres had to hold several fundraisers to buy the single computer we had in the school, which was an early Apple. It seems so different, doesn't it? But of course, students haven't changed. Their worries and concerns haven't changed, and some of the pressures may be particularly malign, but overall back then we still had the same needs, worries and of course enthusiasms as the students you all deal with every day. Their concerns about status, social performance and friendships are still there, although as you all know, social media has had a net negative effect which adds substantial extra pressures to all of us, but especially young people. I admire you all tremendously for the job you're all doing in the face of these extra pressures.

In spite of it being the stone age, we still had science. For me, Fran Mooney, who taught us biology was a hugely positive influence. I'm not quite sure why. It's a bit like why do we like one person and not another? I liked his style (in that he was a bit scruffy and reminded us all of Shaggy from Scooby Doo). He was anti-establishment, which of course to a 16-year old is great. And he opened the mystic portal into biology for me. And I wasn't the only one. I remember in the Irish oral exam, I was asked what my favourite subject was. An easy one to relax the student. And I said 'bitheolaicht'. And the examiner said in Irish – lots of us had said that to him. So thanks, Fran, it wasn't just me! My burgeoning love of biology made me think about medicine and in fact I had that on the CAO form, but then filled in a change of mind and went for science instead. Why? Well, I did well enough in the mock exams to get in, but then I thought – I don't want to spend 6 years in College. Little did I know that I would still be there…So I picked science, with a view to doing biochemistry. I didn't really know what biochemistry was (although Krebs cycle was on the Leaving Cert course – I hope it still is!), but I'd seen jobs for biochemists advertised in the back of the Irish Independent. I graduated in biochemistry in 1985, with a First-Class degree. I tell you my grade not for self-aggrandisement (really?). I went into Trinity to get my results. I then rang home…Mrs Reale…and I asked her to get my Dad so that I could tell him. She said 'How did you do?' I said 'I got a First'. She said ' That sounds very nice Luke. When will you get the Second?'

In my final year my project was on Crohn's disease, an inflammatory disease of the digestive tract. The project was about inflammatory factors called prostaglandins, and in the project description it said that the drug aspirin works by blocking their production. I thought hmmm, that's interesting. I also read how Crohn's disease is a very debilitating disease, as it remains to this day, so I thought that would be good to work on. This led me to a PhD in the University of London, at the Royal College of Surgeons, the very place where they had discovered that aspirin (and related drugs like paracetamol and ibuprofen) block prostaglandins. And so I was off.

My scientific career has been all about inflammation. This highly complex process is fantastic when it works right. When you have an infection with bacteria or a virus (yep!), or when you injure yourself, inflammation kicks in. The affected area become sore (to stop you using it so that it can heal), red (blood rushes in to bring in the immune system to fight the germs and repair the damage), hot (because your blood is at body temperature) and swollen (because leucocytes leave the blood and go into the affected tissue, and some plasma leaks out with them). And lo and behold, the immune system does its job, the invaders are killed, and the tissue is healed. You would not be here were it not for inflammation. The only trouble is, it can go rogue. And when it does, it causes a huge number of diseases. Crohn's disease, arthritis, asthma, lupus, psoriasis, asthma, MS and even Alzheimer's and Parkinson's disease are all diseases where inflammation is out of control. And of course, we now have COVID19 which I will return to, the newest disease to be named (11th February 2020).

As I got more and more into the science of inflammation there was no going back. This is what deep study of something can do, as when you do an MSc or even more a PhD. I went to Cambridge for a postdoctoral fellowship and continued my work on Cytokines – working on three in particular: IL-1, IL6 and TNF – now so familiar to most in the term 'Cytokine Storm'. And then in 1991, I managed

to get a real job – back to my Alma Mater for a lectureship. By that stage I had become a fully-fledged Immunologist, because inflammation is critical to the immune response. I've had a lab in Trinity since 1991, educating students (undergrad and PhD students), working with postdocs, and carrying out research into the most fundamental aspects of inflammation, which we still don't fully understand. I have contributed to discoveries that led to new treatments to some of the diseases listed above, but also found new pathways and processes that might be amenable to brand new treatments which are badly needed. I am involved in three companies attempting to do just this and we remain hopeful. It's a huge team effort and I owe a huge debt of gratitude to my lab, past and present, and collaborators all over the world. I've had the joy, as I'm sure you all have, of helping students develop and then go on to pursue careers, with several of the people who came through my lab now running their own labs all over the world.

And now, we have COVID19. The most serious health issue since the 1918 flu pandemic. Touching every part of our lives and society. Who would have thought it? There had been warnings of pandemics, but nobody really thought (or perhaps were in denial about the prospect) of it becoming as bad as it is. I have worked on other viruses and have collaborations with virologists over the years although it wasn't a major focus of my lab. However, the inflammatory process that happens in COVID19 that tragically leads to loss of life involves the very things I work on – macrophages, T cells, cytokines. My lab is now exploring a wholly new approach to block inflammation in COVID19 and lessen mortality. We are working with collaborators in Holland and Belgium, who work directly on SARS-CoV2, the virus that causes COVID19. Our work in another 'shot on goal'. There are upwards of 280 different approaches being tried to beat the virus, from vaccines (83 in development), anti-viral agents (front runner Remdesivier, which stops the virus replicating), antibody therapies (which also kill the virus via the immune system) and anti-inflammatories. If any of these work, the whole scene changes. Hopes will be realised, and the virus brought under control. We can then begin to get back to normal. Keep all your fingers and toes crossed.

COVID19 is having a big impact on education, as with most other things, as you all well know. The Leaving Cert is of course of particular concern, but also issues around equity of access to online teaching and the nature of the online teaching process. There is a chance that when we come out of this, online learning will be more prominent, and why not? You won't of course be able to replace the human contact of teaching in a classroom. Mr Mooney would not have made me think of Shaggy if I had only seen him on my laptop screen (the word laptop wasn't invented then anyway…). I'm looking forward to discussing these kinds of issues, and of course the other topics the ISTA has in its sights, including issues like curriculum changes, which I know are prominent. My aim is to help the ISTA and also hopefully hang out, once lockdown is lifted, which will hopefully be soon-ish.

If science ever had agency, now is the time. The way out of COVID19 is through science. What physics and the atom bomb were to World War 2, immunology, vaccines and anti-virals are to COVID19. Even though I've been communicating science to the general public for years, never have I seen such engagement, for obvious reasons. So, it's a great opportunity for us all to emphasise how important science is, both in terms of research but also educationally. Because people are listening. We need a very strong science curriculum and we need to make sure as many of our students are exposed to science, to as late a point as possible in the education cycle. One reason why the US is in such a mess, and to a lesser extent the UK (at least when it comes to COVID19), is the erosion of science education in those countries. Trump sadly typifies this, eschewing that most important of things, the scientific method. Never in a million years would Angela Merkel (herself a chemist) have recommended bleach, and even if she had the derision from the German public (in part because of their education system) would have been such that she would have to resign. So even though we are deploying science to fight COVID19, we need to make sure our people are educated in what science is as a process. They are then less likely to drink bleach which tragically has been happening in the US thanks to Trump.

What all this means is we need science more than ever, and that includes you and the ISTA. We're all part of the same world of science and every part of it counts. I look forward to our meetings and discussions. This will be in person, when science wins.

Chairman's Report

Aodhagán Ó Súilleabháin

As we approach the end of another academic year I think we can safely say that it has been a year like no other before it! Of all the challenges facing education few people could have predicted back in January that such novel and immense challenge lay in wait for Irish teachers, students and parents. I have heard many heart-warming stories of the great efforts teachers have made to do the best for their students under these new circumstances. I congratulate science teachers on their efforts and am very proud to be part of such a community of teachers over the past few months. Of course congratulations must go to parents also, many of whom have been working from home and facilitating their children's education in whatever way they can. I would like to wish students well with their continued efforts over the next few weeks. It can be very difficult to stay motivated at home without the company of your peers and teachers. June is approaching rapidly for the non-examination students, however! As your teachers are no doubt telling you renewed energy over the next few weeks will see you through.

Finally, the Leaving Certificate students of 2020. This paragraph has been adjusted in light of Minister McHugh's announcement on Friday 8th May regarding the postponement of the Leaving Certificate examinations. The 'long road' ahead I referred to in a previous draft has been so dramatically cut short, or extended as the case may be. One thing is certain, the events of this year have certainly got us all thinking. The classes of Leaving Certificate 2020 will forever be embedded in the minds of their teachers. I wish you all the very best in the future.

ISTA Annual Conference 2020

Congratulations to all involved in what turned out to be a fantastic weekend in early February during the ISTA Annual Conference 2020. In particular, I would like to thank Mary Mullaghy, Dr Brian Smyth and Rory Geoghegan, our Conference Organising Committee, who managed to steer their way through every challenge and enormous amounts of organisational duties with remarkable calm and optimism. Thank you to the staff of the Clayton Hotel for making our weekend so pleasant. A special word of thanks to Tara Fullam, Mark Langtry and the staff of Explorium for sharing all the fascinating exhibits that this venue has to offer with such enthusiasm. I am sure we are all looking forward to returning there someday with the complimentary passes that were so generously provided for the ISTA members attending the Conference. From indoor lightning shows to virtual reality experiences I can highly recommend a visit to all. As well as the insightful and thought-provoking lectures I have many fond memories of the weekend. There were brilliant personal high points: Paul Nugent's fully deserved Science Educator of the Year award (congratulations Paul), Declan Finlayson's presentation of the amazing FUNdamental Biology to Stephanie Henegan (who was about to start her first day's teaching in Firhouse Community College) and driving Dr Oliver Ryan, my former H. Dip. supervisor and a man I admire very much, to the Explorium for the day's events. There were also personal low points: from telling Sheila Porter of Scifest the score of the Ireland Wales rugby international (after she had successfully negotiated the whole day without finding out so she could watch it on television in all its glory… sorry Sheila), to the regret I will forever feel for not personally witnessing Rory Geoghegan's endeavours on the G-force anti-gravity loop bike!

Thank you sincerely to all our speakers and exhibitors who provided such food for thought throughout the weekend. In particular, it was an absolute pleasure to meet Professor Aidan Moran of UCD who delivered a fascinating keynote address entitled "Staying Sharp: Practical tips on improving your memory and concentration". Many in the ISTA were deeply saddened to hear of his passing in March of this year. Professor Moran was a great friend to many within the association and will be sorely missed.

BT Young Scientist & Technology Exhibition

It seems like a lifetime ago now, but I would just like to acknowledge the generosity of ISTA members who volunteered their time at the ISTA stand during the Young Scientist Exhibition in the RDS in January. To allow all ISTA volunteers to enjoy the many wonders of the exhibition on offer it really does come down to the idea that 'many hands make light work'! I really enjoyed finally meeting the many 'faces in the crowd' I had encountered over the years of the exhibition and renewing the acquaintances I have made before. The 2021 Exhibition may need some adjustments in light of recent global change, but we will be there to support the competition in whatever way we can. Many thanks to those who volunteered, in no particular order: Christine Campbell, Louise Canny, Sinead Cheevers Galvin, Declan Cronin, Sean Fogarty, Rory Geoghegan, Alison Graham, James Holden, Shaun Holly, Theresa Kelly, Michael McGrath, Mary Mullaghy, Paul Nugent, Cian O Mahony, Anne O Shea, Fiona O Sullivan, Paudie Scanlon, Siobhan Sweeney and Karen Walsh. If I have forgotten to name anyone who stepped up to the plate during the exhibition itself to help out (there may well be one or two) my apologies.

Policy Forum for Ireland Conference

The Policy Forum for Ireland Keynote Seminar entitled "The Senior Cycle in Ireland - the curriculum review, priorities for successful reform, and next steps for assessment and qualifications" took place online on Thursday, 30th April 2020. After a stimulating introduction by Professor Damian Murchan, Head of School of Education in Trinity College,

Professor Emer Smyth, research professor at the Economic and Social Research Institute, provided a summary of the main findings of the recent Senior Cycle Review. A range of positives were highlighted for the current Leaving Certificate system, among them subject range and choice, the two tier system of higher and ordinary level and the objective nature of external assessment. Notable negatives that were highlighted included the impact on mental health of an over dependence on the short three-week assessment of the Leaving Certificate Examinations themselves and the need for a broader profile of achievement. The ISTA, as invited speakers, presented the findings of Professor Áine Hyland's report entitled 'The Design of Leaving Certificate Syllabi in Ireland: an international comparison'.

Discussion throughout the conference revealed calls for, among other things, a 'change to the current assessment calendar'. The Irish Second Level Students' Union, ably represented by its president, Ciara Fanning, called for discussion that would address the 'pigeonholing of students into one form of learning'. Paul Fields of Laois & Offaly ETB suggested a system where weaker students can gather up their credits along the way. Another saw the issue of rote memorization as 'a distraction from the issue of educational disadvantage'. Many claimed that reform was needed to address the fact that students are disadvantaged due to their socioeconomic backgrounds. Professor Aidan Mulkeen of Maynooth University emphasized the merits of providing breadth and choice in subjects − a range of expertise to provide the main ideas and ways of thinking in different disciplines, in tandem with the development of a specialist expertise in one.

It was clear from listening to the rich discussion among the speakers that the current public scrutiny on the Leaving Certificate, in light of the global pandemic, highlighted the need for change at senior cycle. Avril Buttle, Assistant Principal at Ramsgrange Community College, asked if we can 'create a system where high stakes exams continue to have a place, but in combination with other assessment methods'. Whatever the path forward may be plans must be meticulously examined to ensure as far as possible that a high level of trust is maintained in our assessment methods in senior cycle, with plenty of time allocated for necessary teacher training and upskilling.

Concluding remarks

As with every organisation currently involved in education the ISTA will meet certain challenges in the near future. Alterations will be necessary to maintain social distancing and to ensure safety for all. We will meet the challenges ahead to ensure that normal service resumes as much as possible, but adjustments are inevitable. The dramatic change to teaching and learning over the past few months has seen some incredible innovation and development at school level and teachers have coped admirably. In the near future we will need to turn our attention to the possibility of continued disruption to our classes in September. I urge branch officers at local level to perhaps make an extra effort to communicate with ISTA members over the coming academic year. If any members wish to contribute to events in any way, suggest how the organisation can support you and others in the challenges of teaching or simply wish to share an idea, please get in touch with your branch officers or myself.

Finally, I would like to acknowledge the efforts of our partnering organisations in science education, in particular the TES and the NCCA. Such dramatic recent change in circumstances so soon before the summer has certainly put a lot of pressure on key decision makers. The work of the Subject Development Groups has been temporarily postponed during this crisis, but I am very heartened by the NCCA's response to our Annual Conference and am hopeful that work on the new specifications for the Leaving Certificate sciences will continue in the full spirit of partnership. I would like to take the opportunity to offer a word of encouragement to all our partners in education to continue the great work that they do in this country under these new circumstances. I am certain that the undeniable character within these organisations will prevail to successfully meet the needs of teachers in Ireland and students during this current crisis.

Le meas,

Aodhagán O Súilleabháin

Dates For Your Diary

SciFest Regional Finals
A list of dates and venues on - www.scifest.ie

Virtual Physics Laboratory
online with IOP Regional Branches are hosting VPL in association with IOP – check events on website

8th Annual BASF Summer School
RESCHEDULED - Eureka Centre UCC

Robert Boyle Summer School Lismore
'Women in STEM'. POSTPONED
www.robertboyle.ie

ResearchEd Dublin
26th September: St Columba's College, Dublin

Féilte: The Teaching Council's annual Festival of Education, FÉILTE 2020, will take place on 2nd – 3rd October in The Helix, DCU.
www.teachingcouncil.ie

Recommended:

Rory Geoghgean suggest that members might be interested in Michael Moore's Planet of the Humans, a documentary, available on YouTube, that dares to say what no one else will — that we are losing the battle to stop climate change on planet earth because we are following leaders who have taken us down the wrong road — selling out the green movement.

The link is;
https://youtu.be/Zk11vI-7czE

News & Views

Mary Mullaghy

Science Educator of the Year 2020

Congratulations to **Paul Nugent** who received the **BPCI Science Educator of the Year 2020 award** from Dr Oliver Ryan at this years ISTA Annual Conference. The award, which is sponsored **BioPharmaChem Ireland**, was originally set up by Dr Ryan in 1984.

Paul Nugent who received the BPCI Science Educator of the Year 2020 at the ISTA Annual Conference Pictured here with Yvonne Kavanagh (Chair of Institute of Physics in Ireland) & Paul Hardacker (Chief Executive of Institute of Physics).

UN International Year 2020

The UN has dedicated 2020 to raise awareness about plant health and the impact of healthy plants and forests on food security, poverty, economic development, and sustainability. 2020 is dedicated to global plant health. The UN has proclaimed 22nd May the International Day for Biological Diversity to increase understanding and awareness of biodiversity issues. “Our Solutions are in Nature". https://www.cbd.int/idb/

Education Matters

Minister of Education and Skills, Joe McHugh, T.D., launched the 13th Education Matters - Ireland’s Yearbook of Education in the National University of Ireland on Merrion Square. It is a record and think-tank on education policy, practice and innovation. The current editor is Guidance Counsellor, columnist and broadcaster, Brian Mooney. It is also available to read online https://educationmatters.ie

Features from the Front Line

Education Matters invites professionals working directly with students to write a blog to express their views, tell their story, share expertise, highlight challenges etc.

BT Young Scientist & Technology Exhibition 2020

Thanks to all the teachers who helped out with the ISTA stand at the BT YSTE this year. special thanks to Rory & Aodhagan for organising the stand. Volunteering and sharing best practice are key components of our Association and should be embraced. Congratulations to all the winners especially the overall winners **Cormac Harris and Alan O'Sullivan, Coláiste Choilm, Ballincollig, Co. Cork**, with their project entitled “A statistical investigation into the prevalence of gender stereotyping in 5 to 7-year-olds and the development of an initiative to combat gender bias”. They received the BTYSTE perpetual trophy and the top prize of €7,500. The will also represent Ireland at the European Union Contest for Young Scientists, which will take place in Santander, Spain in September 2020. Cormac and Alan will also get to attend the 62nd Annual London International Youth Science Forum later in the year. Congratulations also to Prof Seán Corish of Trinity College Dublin, on receiving the BTYSTE Founders’ Medal for his contribution for 44 years and as a member of the judging panel for 10 years. He received the award from Dr Tony Scott.

The **ISTA Special Award** went to **Marcin Witkowski & Oscar Gomez Keenan** from Kishoge Community College, for their project entitled: Creating an Intuitive simulation for modelling Laws of Light

New Science Technology in Action

The 15th edition of Science Technology in Action was launched and hard copies were delivered to all schools. There are PDFs of all lessons along with PowerPoint presentations available on line. Many lessons are suitable for TY and might inspire project ideas for SciFest, BT Young Scientist Exhibition and other competitions. www.sta.ie

The Irish Lab Awards

The Irish Laboratory Awards recognise excellence and achievement in the laboratory environment, covering management, innovation, collaboration, personnel development and laboratory equipment supply. Just making the shortlist for the Irish Laboratory Awards ensures that the scientists involved receive national recognition for their achievements. A full list of this year’s winners on www.labawards.ie

All-Ireland Pollinator Plan

One third of our bee species are threatened with extinction from Ireland. This is because we have drastically reduced the amount of food (flowers) and safe nesting sites in our landscapes. The All-Ireland Pollinator Plan is about all of us, from farmers to local authorities, to schools, gardeners and businesses, coming together to try to create an Ireland where pollinators can survive and thrive. The first Plan covers the period 2015-2020 and a new version will be developed to cover 2021-2025. To see what can be done by each sector, click on the appropriate link below.

Science for Development Award

Irish Aid sponsors the Science for Development Award at BTYSTE. The prize includes a €5,000 bursary for the winners to travel to an African country (with Gorta Self Help Africa) to test their project. Seán Byrne, Avondale Community College, went on a trip to Zambia sponsored by Irish Aid, where he addressed to students and staff at the University of Zambia School of Agriculture.

https://www.irishaid.ie/…/postprima…/science-for-development

New ISTA Honorary President

Sincere thanks to **Gerald Fleming** as his term office comes to an end, and welcome to incoming Honorary President, **Prof Luke O’Neill**.

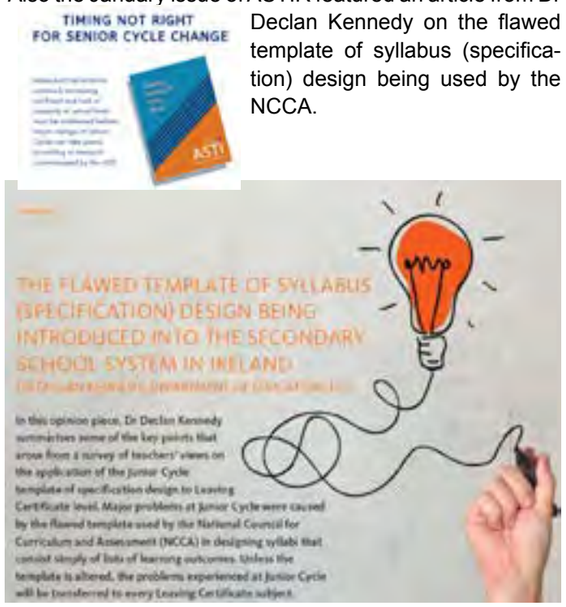
Senior Cycle Change

Read key findings on page 16 of the latest ASTIR (bit.ly/2NGQqCi) or you can read Making Education Policy Work online: www.asti.ie/uploads/media/Making_Educa-

Special word of thanks to **Declan Finlayson** for his **FUNdamental Biology** prize worth €1000, which was won at our AGM by **Stephanie Heneghan**, Firhouse Community College, Dublin 24. Also in the photo is (far left) Mary Mullaghy and ISTA chairman Aodhagán Ó Suilleabháin (right).

tion_Work.pdf

Also the January issue of ASTIR featured an article from Dr Declan Kennedy on the flawed template of syllabus (specification) design being used by the NCCA.



ResearchED at Home

The best and brightest minds in education beamed into your homes every weekday of the Summer term. You can watch live at 11 am (GMT +1) or catch them later on our YouTube channel. No registration, no charge, anyone is welcome. Check the programme here http://bit.ly/2RNI79k

ISTA Annual Conference 2020

Well done to all involved in running this year's annual conference in Explorium in Dublin. A special thanks to **Brian Smyth & Rory Geoghegan**. Thanks to all the sponsors, and also thanks to **Tara Fullam** and her backroom team in Explorium, and the front man **Mark Langtry**. Next year's conference will be run by the Cork Branch and will take place in **UCC on 26th – 27th March 2021**.

STEM Smaointe

Coming soon E-bulletin 'STEM Smaointe'. Lots of distant learning supports to help teachers in planning learning from home. Register at tinyurl.com/STEMSmaointe

ICASE (International Council of Associations for Science Education)

At the 6th World Conference on Science and Technology in Thailand in December 2019 were keynote speaker, Prof. Áine Hyland, Dr Declan Kennedy (President Elect) and Mary Mullaghy (Treasurer). The theme of the conference was 'The Future of Science and Technology Education'.

L to R: Prof. Áine Hyland, Dr Declan Kennedy and Mary Mullaghy

Keep up-to-date:

A comprehensive list of all competitions, news and events is available on our website. www.ista.ie You can also keep up-to-date with our Facebook and Twitter @ IrishSciTeach

Professor Aidan Moran RIP

Mary Mullaghy

I was deeply saddened to hear the news of the death of Prof. Aidan Moran. I first came across Aidan on the Marian Finucane radio show around the time that I was organising our 50th Annual Conference. The interview captured my attention and I decided to contact him to ask him to give a talk at our 50th Annual Conference in Trinity College in 2012. He kindly agreed to give a keynote talk entitled "*Understanding and Improving Memory*", which was captivating. A few years later when I approached him again to give a talk in our Alma Mater in University College Galway, I found out that he was on sick leave. I stayed in touch with him and when he agreed to give the talk at this year's conference he had been in remission. He delivered a super talk at the opening of this year's conference entitled "*Staying Sharp: Practical Tips on Improving Your Memory and Concentration*". Afterwards he told me that he had received a bad prognosis that very week. No one would have known from his generosity of spirit and professional performance on the night.

Prof Moran delivered a super talk at the opening of this year's ISTA conference entitled "Staying Sharp: Practical Tips on Improving Your Memory and Concentration".

A graduate of UCD (BA and MA) and the National University of Ireland Galway (PhD), Aidan took up his position in UCD in 1985. He is remembered as an exceptional teacher and supervisor, an inspirational mentor and supportive colleague, a gifted researcher, and a skilled sportsman and musician.

Kieran Shannon sports editor with The Irish Examiner, wrote a great article entitled "Trailblazer Moran showed us all that the mind does matter".

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Due to coronavirus (COVID-19) he won't get the kind of send-off we're used to or that he deserves. All those students and now field leaders that he taught, mentored and befriended through the decades didn't get to be by his graveside. Household names like Padraig Harrington, Ken Doherty, Ronan O'Gara and John Maughan. Dr Tadhg MacIntyre (UL) said "If sports psychology in Ireland ever had a godfather, then Moran was it; as one of its leading champions and academics". While he lectured on multiple areas of psychology, serving as the head of the department in UCD for numerous periods, and specialised in cognitive psychology, it was how he married it with his expertise in and passion for sport that made him such a pioneer. Throughout the '80s and into early '90s hardly anyone else bar himself and PJ Smyth in the old Thomond College were lecturing and consulting in the field. He conducted his experiments and then took the findings down from the academic ivory towers and conveyed them in an accessible, digestible way to the general public. He wrote:

- About the link between your mental state and your actual physical performance and the importance of preparing for pressure situations.
- About concentration and how to set little performance and process goals to keep your attention focused on the task.
- About the value of having little routines, and the power of imagery because success tended to happen in the mind first before it ever occurred on the field.

Dr Aidan Moran, internationally as well as domestically, was a pioneer. Over a stunning academic career, he had over 450 papers published. Indeed, right up to his recent short illness, at 63 he was still writing, researching, contributing. He co-wrote a paper with UCD colleague Dr Helen O'Shea on motor imagery that was published in the Frontiers in Psychology journal just two weeks before his death.

Where once sport psychology was treated with suspicion even within the academic and scientific community, this country now has three full-time taught Masters programmes, not to mention numerous part-time night courses, many of which are taught and given by protégés of his like Tadhg MacIntyre, Mark Campbell and Olivia Hurley. In virtually all of these courses, the go-to text is one of his 15 books. "Sport and Exercise Psychology: A Critical Introduction". Moran made an impact and through his findings, books and protégés, his star still shines. On 16th March we lost a friend, and our thoughts are with his family. Ar dheis Dé go raibh a anam dílis.

A book of condolences has been opened on the UCD School of Psychology Website.

ISTA Special Annual Conference

Explorium Dublin 7th and 8th February 2020

Seán Fogarty

Members visit the exhibitors.

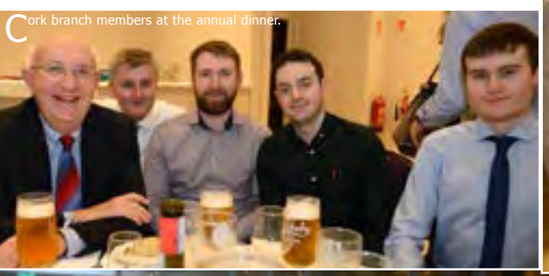
Proff Áine Hyland addresses the conference.

Declan Finlayson's FUNdamental Biology quiz worth €1000 which he raffeled on the day.

Mark Langtry from Explorium who ensured the smooth running of the day.

Paul Nugent & Prof Luke O'Neill at our annual dinner.

Rory Geoghegan's on the G-force anti-gravity loop bike!



Cork branch members at the annual dinner.

ISTA Chairman Aodhagán Ó Súilleabháin address members and guests at the annual dinner.

Our decision to hold this year's Annual Conference at an earlier date than is our norm, the 7th and 8th February arose form the urgency of the topic under discussion. As it happened the decision was fortuitous given all that has occurred since, we would certainly not have had a 2020 AGM if it had been scheduled for the tradition weekend close to the Easter holidays.

This special conference was devoted to the issues and challenges surrounding the prospect of the new Leaving Certificate science syllabi following the same format as the current Junior Certificate science syllabus. Those of you who attended will have heard various speakers outline how some of the recently update syllabi, such as agricultural science and computer science to name but two, have fallen into that trap using vague, ill defined, learning outcomes. Humphrey Jones who has experience of teaching the new Leaving Certificate Agricultural Science specifications gave many examples including in the soil section of the course where the lack of depth of treatment becomes very apparent. One learning outcome included in the specifications is, 'discuss the factors involved in soil formation', however there is no mention of what factors nor even what soil, so teachers are left wondering what do we include and what don't we include. Humphrey went on to give more examples where the lack of depth of treatment of the learning outcomes left teachers wondering how deep to go with the topic or even how to unpack the outcome let alone where to stop unpacking. Other speakers had further examples of the difficulty vague depths of treatments cause. Stephen Murphy spoke of his experiences with the new Computer Science specifications while other speakers like John Lucey gave us an insight into the development of older style syllabi, such as biology, and the criteria that were used developing these syllabi that have served us well in the past. We also had speakers review the curriculum design of the International Baccalaureate as an example of good design of a syllabi and they also gave us an insight of what it is like to teach that syllabus.

Prof Áine Hyland outlined some of the key messages from her report comparing the proposed new Leaving Certificate syllabus style against international comparators. Prof Hyland also called on the NCCA to give even one example of a country that uses this template [as used in the Junior Cert] for an externally assessed public high stakes exam. While we are stuck with the junior certificate specifications for now and while it is not a high stakes exam it is however externally assessed (until now at least) so the suitability of its specifications are therefore questionable. We do need to ensure that the template used in the Junior Certificate is not used in any further syallibi. Asked why the NCCA were not listening to all the evidence. Professor Hyland said that she didn't think it was a political issue nor an ideological issue, unless they misunderstood all the evidence. Prof Hyland had hoped there would have been someone present at the conference to answer this question but they had declined our invitation to attend. She also pointed out that she did not tell the 760 teachers that responded to the ISTA survey 'listening to the voice of science teachers' what to write and doubted that many had had time to even read her report but yet the survey overwhelmingly had the same message for the NCCA. Asked if the reform at JC and LC posed a threat to our economy she said that she is genuinely concerned about standards and suggested that we should be aspiring to the a standard similar to the International Baccalaureate. Prof Hyland was also puzzled as to why the NCCA are going down this line of learning outcomes only. She acknowledged that there was a perception that the EU was pushing learning outcomes, they are, but they never said that you should only use learning outcomes, as far as she was aware.

A glimmer of Hope

There were many more contributors to the debate and the above only gives a flavour of the day. During our Annual Business Meeting, held at the end of the conference programme on Saturday, the following motion was proposed:

- The current Leaving Certificate science syllabi should continue to be used until syllabi that are of a comparable standard to the current syllabi have been developed and not a "specification" lacking depth of treatment as we have experienced at Junior Cycle level.

We also request that

- the draft specifications in Leaving Certificate biology, chemistry and physics be circulated to all stakeholders with realistic and agreed time, of at least one academic year, allowed for feedback to be received before these specifications are finalised and implemented.
- the full range of specification documentation (including sample examination papers) should be officially published at the same time as the specifications under the logo of the DES as has been the case in the past. This elaborated documentation should be available well before the specification is due to be implemented, to enable teachers to become familiar with the new material and to undergo appropriate professional development and up-skilling

This motion was passed unanimously. and was sent to the NCCA. from whom we received the following reply;

"*With regard to the motion agreed at your AGM, I'm happy to confirm that from an NCCA perspective, the current Leaving Certificate science syllabi will continue to be used until syllabi that are of a comparable (if not improved) standard have been developed and agreed for implementation. We also intend that the draft specifications in Leaving Certificate biology, chemistry and physics will be both developed and then circulated to all stakeholders for consultation within a 'realistic and agreed' timeframe. There is no intention on the part of the NCCA to rush the process of consulting, gathering feedback and finalising the specifications. The development of LC science specifications is too important for that*".

This is a least a promising development and hopefully means that the NCCA are listening to the voice of science teachers at last and will not take the same road with the Leaving Certificate as was taken with the Junior Certificate. Work on the development of the syllabi has come to a standstill at the moment due to the current crises and it will probably mean that it will now be 2021 before draft syllabi are ready. Hopefully the extra time will help ensure that the mistakes, like those highlighted at the conference, made in other Leaving Certificate syllabi will not be repeated in the new physics, chemistry and biology syllabi.

The fact that our views are being acknowledge makes the conference worth all the hard work that went into its organisation. Thanks must go to all involved and indeed our Chairman has done so in detail in his report in this issue.

Many other events such as workshops, lectures and of course the exhibitors were also part of this years successful conference but I don't have space to report on them here. I will however say that the venue for this years conference played a huge part in its success and thanks must go to all at the Explorium for their help.

AerPrize Final 2020

Casement Aerodrome Baldonnel 13th of March

Seán Fogarty

The final of the 2020 AerPrize competition was held in Casement Aerodrome, Baldonnel, on Friday the 13th of March, luckily just before the current shutdown. As most of you will know from previous issues this is the competition to promote STEM subjects in secondary schools which sees the two winners go for 6 weeks to California to train for their private pilots licence. The competition is the brainchild of former Wexford man Seosamh Somers who also sponsors the €35,000 prize. We in the ISTA are delighted to be part of the competition and along with the Institute of Physics (IoP) to help th the promotion and organisation of the competition at this end.

This is the second time the competition has been run. In 2018 the initial date for the final had to be abandoned due to the heavy snow accompanying storm Emma that year the final was eventually run two weeks late on the 16th of March. This time the competition very nearly fell victim to the current pandemic lock down. Seosamh and his colleague Lindsay Kast had arrived via the UK only to find that President Trump was about to stop all flights from the EU to the USA very soon. Then came the broadcast from Taoiseach Leo Varadkar about the Covid-19 crisis in which he announced the closure of schools on the eve of the final. Luckily a full lock down was not yet in place on the Friday and we were able to go ahead with the event and all finalists were able to attend. Thanks must go to their teachers for getting them to this stage and also to the parents for their support .

As the Covid crisis was worsening the Aer Corps had taken all precautions necessary for the event and only those needed stayed for the full day. Parents departed and did not return till that evening leaving only one ISTA representative, together with Paul Nugent of the Institute of Physics, and two teachers who accompanied students, to help with the running of the event.

Out of the many entries the finalists were chosen based on the video they had entered for the first round. Nine schools made it to the final with thirteen competitors. All but one of the winning entries from the first round were from individual competitors with only one team entry making it through. A big thanks must go to all the teachers who mentored students who entered the first round of this competition and of course to the teachers of the finalists.

The final itself was very hectic with three stages to the competition as well as a tour of the facilities at the aerodrome. As in the 2018 event, all competitors were interviewed by Seosamh to ascertain their suitability as a student pilot. To further assist Seosamh with his decision they also undertook various computer based aptitude tests which this time was organised by the Aer Corps. The depth and quality of the assessment provided by the Aer Corps was 'nothing short of amazing' according to Seosamh who said it was way ahead of anything he had seen before, either in his own flight school business or others he is familiar with.

As part of their assessment, competitors also had to take the controls of a Pilatus PC-9 simulator under the watchful eyes of Aer Corps personnel. They evaluated students to see how they performed under the stress of flying and landing the aircraft in the very realistic setting of the simulator used to train and check actual Aer Corps pilots. The PC-9 was a very exciting part

The Finalists in this years AerPrizw competition. Front Row Left to Right: Conor Casey, Adam Russell, Peter Judge, Lillian Hickey, Aoife Butler, Adam Quinn. Back Row Left to Right: Patrick Gowran, Cillín Forrester, Stephen Moreau, Seosamh Somers, Alexandru Olariu, Adrain Astalos, Sean Crowe.

A list of the finalists in this years competition.

Finalist	School	Teacher
Adam Quinn	Castleknock College, Dublin	Tom Tierney
Patrick Gowran	Kinsale Community School	John Corcoran
Cillín Forrester	Belvedere College, Dublin	StephenCarey & Liam Hennelly
Adam Russell	St. Andrews College, Dublin	Hilary Rimbi
Peter Judge	Naas CBS, Co.Kildare	Claire O'Brien
Aoife Butler	Loreto Secondary School Balbriggan	Daniel Toomey
Lillian Hickey, Sean Crowe, Adrian Astalos, Alexandru Olariu	Abbey Community School, Waterford	Ruth Hogan
Stephen Moreau	Newbridge College	Jay Kiernan
Conor Casey	Pobalscoil Inbhear Scéine	Sarah Abbott

Aer Corps Officer Colm Keena shows some of the finalists the turboprop engine of the PC- 9 fighter / trainer aircraft during their tour of the aerodrome. They also saw other aircraft such as the Government Jet and maratine protrol aircraft (facing page).

Left: Some of the Officers from the Aer Corps who helped make the AerPrize final such a great day. Left to Right: Colm Keena, Viccent Haigney, Seosamh Somers, Ewward Snowdon, James Northover.

Right: Attendies at the closing formalities of this years AerPrize finals.

Below: Conor Casey tries his hand at landing the PC-9 simulator during the AerPrize finals.

of the competition according to all the finalists I spoke to.

Along with the competition tasks the competitors were also treated to a tour of the facilities and aircraft the Aer Corps has at Baldonnel. This tour was enjoyed by all competitors and those of us who accompanied them.

The day closed with an address by Seosamh who wished the candidates well and thanked all involved in the competition including the ISTA for its role in organising this competition. There were also speeches on behalf of the Aer Corps, ISTA and IoP

Before the end Seosamh presenting the competitors with a framed certificate recognising their achievement in reaching the final. They also received a T-shirt with the Aerprize logo as a memento of the day.

The announcement of the winners was not made until the 3rd of April. On that day Seosamh contacted the teacher associated with the winner to inform them of the news.

The winners of the competition were Patrick Gowran, Kinsale Community School Ballynacubby, Kinsale Co. Cork, and Adam Quinn, Castleknock College, Dublin 15. Both winners will spend six weeks in California training at Angel City Flyers for their private pilot certificate. Round-trip travel, accommodations, and flight training in the U.S. are included in the prize. Due to the current pandemic the exact dates when the winners will avail of the prize is yet to be decided and it could well be summer 2021. Seosamh has assured the winners that they can avail of the prize whenever it is safe to travel and suits their schedules.

AerPrize Winner - Patrick Gowran, Kinsale Community School, Ballynacubby, Kinsale Co. Cork.

AerPrize Winner -Adam Quinn, Castleknock College, Dublin.

On behalf of the Irish Science Teacher's Association (ISTA) and our partners in this venture, the Institute of Physics in Ireland (IoPI) I want to sincerely thank the Minister with responsibility for the Department of Defence, Mr Paul Kehoe, for his help in making the day happen.

I must especially say our sincerest thanks to all in the Irish Aer Corps for being so willing to work with us on this endeavour and for opening their doors to us from the very beginning. A special mention must go to Lieutenant Colonel David Browne, Officer Commanding Air Corps College for all the work he put into organising the actual running of the event, including a practice beforehand which ensuring everything went like clockwork. Thanks also to Comdt Colin Roche, Officer Commanding the Technical Training School, who stepped in to take David's place at short notice, on the day and to Colonel Mick Moran. Chief of Air Staff Support whom I first met back in October to start the ball rolling on this project and who was so willing to listen to my ideas and show me what the Aer Corps had to offer. Thanks must also go to all the officers who brought the students on a tour of the facilities at Baldonnel on the day or who helped them in their tasks such as their flight simulator test and their aptitude tests. Listening to these officers describing the operation of the Aer Corps, along with their own stories about their career paths in the Defence Forces, proved inspirational for all the finalists who were most appreciative and asked us to pass on their thanks also.

Finally, whatever about further rounds of this competition (its run every two year's) the main thing the ISTA and IoPI would like to take away from the event is a newly forged close link with the Aer Corps. We would very much like to develop a strong tie between our organisations to help promote this wonderful organisation among teachers so that they, in turn, can let their students know of the opportunities that are available to them through the Defence Forces as well as continuing to promote STEM subjects. I know the Aer Corps is keen to promote their organisation among second-level students and we feel that contacts with science teachers through our organisations would be a great way to achieve this. Hopefully we will collaborate with the Aer Corps in the future, once things return to normal after the current crisis.

Once again sincerest thanks to the Aer Corps for all the help with the final. Working with the officers of the Aer Corps has shown us that this is an outstanding organisation that the country as a whole should be very proud of and which the ISTA and IoPI would be delighted to help promote in schools nationwide.

Paul Nugent of the Institute of Physics in Ireland addresses those attending the closing formalities of the event.

McCulloch's Musings

Ian McCulloch

The most intriguing product I have come across since I was with you last has to be the Pacum - a portable multifunctional vacuum. For the, I'm sure very, few of you who aren't sure of quite what it purports to do, all will be revealed at the end of the article.

The Pacum

Having been approving of "Reading Labels" in the Irish Times Health section, there was a worrying paragraph on 26th November where there was a suggestion that some credibility be afforded to anecdotal evidence - disappointing. (See below)

Fun

The Mayo Clinic notes that researchers have found no definitive evidence of a link between MSG and symptoms such as headaches, flushing and tingling. There is plenty of anecdotal evidence, however, so it advises avoiding the additive if you believe you react badly to it.

The Sunday Times "In Gear" section in September had a piece about an address by David Connolly, head of the Irish Wind Energy Association, at the Smart Energy Systems International Conference in Copenhagen. It included a couple of gems:

"Ireland plans to produce 350 MW of offshore energy by 2030."

"Ireland's only offshore windfarm is the Arklow Bank development which produces 25MW a year."

I just hope that he was misreported.

On the subject of energy, a 40W filament bulb blew at home recently. Having taken out a mortgage to purchase an equivalent LED replacement I was amused to find its power consumption to be quoted as a very "impressive" 3 kWh/1000h. Why not just 3W?

Before heading off to the Clayton Hotel for the Annual Meeting opening lecture, my departure time resulted in my watching the TV3 (Virgin 1) weather forecast. Storm Ciara's imminence warranted the inclusion of a wave height chart. There was an innovative unit for the height - METERS - the variety of meter wasn't specified.

Prof. Aidan Moran got the Conference off to a flying start with his "Staying Sharp" lecture, from which I offer a few snippets below.

Can't find your car keys? Don't worry, - just organise yourself better. What would be worrying is if you can't remember what a key is for!

A strategy to improve memory is:

- Look - pay attention
- Organise - impose a pattern
- Connect - link new material with what you already know

149162536496481 - This set of digits doesn't have an obvious pattern. However, it is sufficiently simple that even more mature folk like me can recite it, not only L to R but also R to L.

Another tip (well-known) is to repeat the person's name if introduced to somebody new. "Delighted to meet you, Aidan".

There is no limit to the amount of information that can be stored in the brain. Indeed, the more there is, the better is even more absorbed. Does this suggest that the accumulation of "knowledge" in syllabi of yore might actually be a worthwhile endeavor? The gaining of this "knowledge" need not be rote. The "Why is the grass green?" approach can be effective as well as engaging.

The hippocampus is responsible for managing our imagination as well as memory. This can result in our sometimes being convinced that something we imagined actually did happen. There is nothing necessarily sinister in this - we just need to be aware that it can.

Approach problems "differently". For instance, "What is the sum of the numbers 1-1000?" This could take a while but won't! How about 1+1000 + 2+999 + … etc.? (there will be 500 pairs) so 1001 x 500 = 500,500.

With apologies to the XX cohort, multitasking is not possible. We may come close if we can manage the switch from one task to another without losing too much focus. It is definitely most efficient to complete one task before undertaking another one.

One of Aidan's many pearls of wisdom was that a desk is a working space NOT a storage space!

Sadly, since writing the original version of this article, Aidan succumbed to cancer. By chance, I came across his name recently when searching our attic for baby paraphernalia for friends who are prospective grandparents. While conducting the search, I happened to pick up a random ring binder, opened it halfway through and there was Aidan's name at the top of the page. The binder contained our daughter's psychology notes from twenty years ago. I apprised her of the coincidence and she remarked that she really enjoyed Aidan's lectures during her UCD interlude.

Saturday morning and it was off to the Explorium in Sandyford with its stunning views of Dublin Bay making an impression before even getting inside the door. In keeping with the surroundings, there were appropriately hi-tech wristbands to get through barriers. However, they hadn't solved the perennial tendency of the majority of the name tags on the lanyards managing to orientate themselves

Saturday morning and it was off to the Explorium in Sandyford with its stunning views of Dublin Bay making an impression before even getting inside the door.

with the names facing the delegates' chests.

During my tour of the exhibitors - the usual coterie of friendly faces - my morale was boosted by, not just one but, two souls, neither of whom I had met previously, approaching me to say that they looked forward to my "Musings" each term. They were David O'Brien, a great nephew of Sr. Mercedes (obviously genetically pre-disposed to science teaching) and Michael O'Callaghan, biology writer for Edco.

Then it was time for Shane O'Mara to sing the praises of walking. His talk featured a hugely impressive "power-

point" accompaniment. The "screen" was the whole wall behind him. At times, it had a real-life video synched with a related stick insect animation as well as static text. This may sound "over the top" - it wasn't. It was very informative and digestible.

My notes on Shane's lectures suffered because I had to concentrate to "keep up" - reinforcement of Aidan Moran's observations the previous evening! Shane confirmed one of these with his revelation that London taxi drivers have bigger hippocampi than London bus drivers, courtesy of "the knowledge".

Below are some random morsels.

- The skate which lived 420 million years ago shares identical genes with a modern mouse.
- On Valentia Island there is a tetrapod trackway - one of only four in the world.
- A walk is a balm for body and brain. It can be as efficacious for depression as drugs. William Rowan Hamilton had some of his most creative thoughts while walking from Dunsink to Trinity College each day.
- Toddlers take the same number of steps in two hours as adults do in a day.
- In 2017 more than 50% of the world's population lived in urban areas that don't lend themselves particularly well to walking. For instance, negotiating the "Font" junction in Galway involves seven traffic-light controlled crossings and takes 14 minutes.
- The latest Alzheimer's drugs delay entry to nursing homes by ca. three months!
- For the elderly, indeed for all ages, 30-45 minutes walking per day is hugely beneficial physically and mentally. For those walking in groups the social interaction is also valuable.

At this stage I did a quick tour of "upstairs" to explore the perpetually enthusiastic Mark Langtry's diversions for the civilians who come along to Explorium. I was very impressed, not only with the apparatus but also the enthusiasm and expertise of the seemingly ubiquitous young facilitators. I just hope that my eleven year-old granddaughter wasn't a typical visitor. When I asked her if she had enjoyed Explorium (she had gone with her school) she said "Yes - it was huge and great for 'hide-and-seek'"!

I then disappeared to head for Lansdowne Road (I had been offered a ticket for the rugby on Thursday) - it proved to be worth committing truancy for.

Well done to Mary Mullaghy (she discovered that the "clicker" in the lecture theatre worked better when it was switched on!), Rory Geoghegan & Brian Smyth and their team who put together a great conference. I am assuming that the bits I missed were as good as those I didn't!

I meant to mention last time that I enjoy "New Scientist" and "Classic Cars" courtesy of RBdigital.

The Pacum is a compact vacuum pump, which comes with its own bag. It enables you to shrink the contents of your suitcase so that you can best cope with Ryanair's structures. It depends, of course, that volume rather than mass is your weakness.

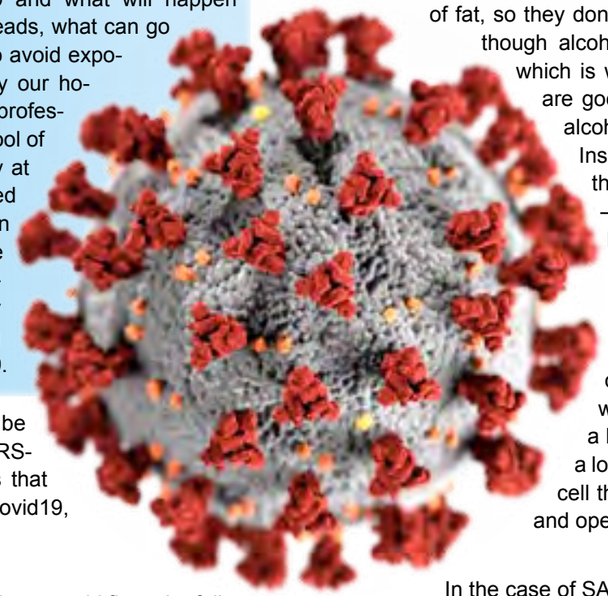
149162536496481 is $1^2 2^2 3^2 4^2 5^2 6^2 7^2 8^2 9^2$

What exactly is Covid-19

and what will happen next?

Prof. Luke O'Neill

What exactly is Covid-19 and what will happen next? how the virus spreads, what can go wrong, and what we can do to avoid exposure. The following article by our honary president Luke O'Neill, professor of biochemistry in the School of Biochemistry and Immunology at Trinity College Dublin appeared in the Sunday Independent on Sunday 1st of March and we reproduce it here with permission as it is a nice summary that may help you when talking to your pupils about Covid - 19.



How can something so tiny be wreaking such havoc? SARS-CoV2 is the name of the virus that causes the new disease Covid19, named on February 11.

It is so small that 500 million of them would fit on the full stop at the end of this sentence. David and Goliath, except David isn't even as big as an ant when compared to Goliath. And yet look what's happening. Economic turmoil. Cities and towns in quarantine. People not travelling for holidays or weddings. Sporting events cancelled. People who feel sick and who have met someone with the virus keeping themselves in isolation for 14 days. And the fear that the worst is yet to come outside China where it all started. That something so tiny can pack such a punch is a testament to how powerful viruses can be.

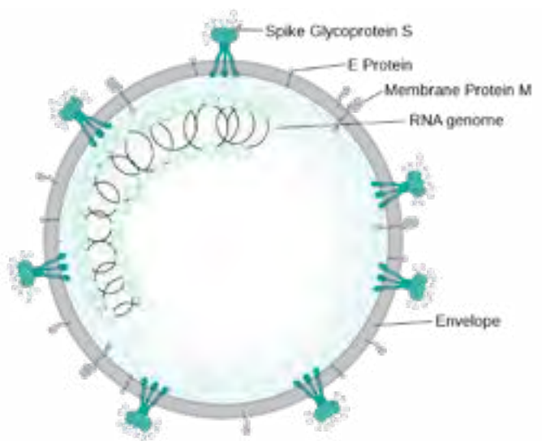
WHAT IS A VIRUS?

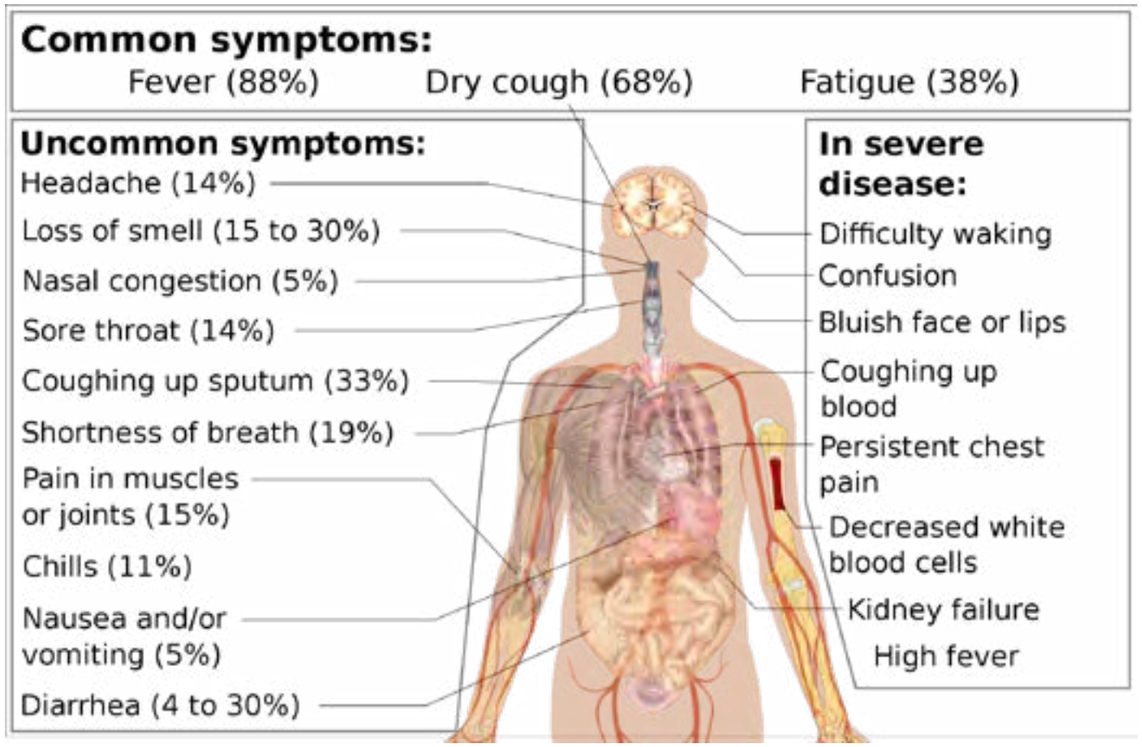
Viruses were first observed in 1948 with an especially powerful microscope called the electron microscope. The first members of the viral rogues gallery to be seen were the viruses that cause polio and smallpox. Both are highly contagious (around three-fold more than SARSCoV2) and wreaked havoc in humans for centuries, paralysing us, disfiguring us and killing us. Then vaccines were developed and that put an end to that, with smallpox being eradicated completely and polio almost beaten.

Apart from being able to see them, scientists also figured out what viruses were made of. They have a coat made of fat, so they don't dissolve in water, although alcohol can dissolve them, which is why alcohol hand rubs are good at killing them. The alcohol dissolves the fat. Inside the fatty bag lies their genetic material — the recipe that can be read to make more virus. They also have proteins sticking out of the bag and they use these proteins to latch on to the cells they want to infect. A bit like a key, the protein fits into a lock on the surface of the cell the virus wants to infect and opens the door.

In the case of SARS-CoV2, the proteins occur on the end of the spikes that make the crown that surrounds them. This is why it's called a corona virus. They stick the spike key into a lock called ACE2 on your lung cells and the virus then gets inside. This is why it infects your lungs: that's where the ACE2 lock is.

It needs to get inside the cell to use it as a factory to make





more viruses.

THE ULTIMATE PARASITE

Viruses are the ultimate parasite. As far as we know they bring no benefits. A bit like unwelcome guests who come to stay, procreate in your guest room having eaten all your food and drunk your wine, and then leave without saying thanks.

The recipe that SARS-CoV2 has to make more of itself is called RNA. This is why SARSCoV2 is a bit like flu — the influenza virus also has RNA as its recipe, as do viruses that cause the common cold and Aids. There are plenty of types of RNA viruses.

Once it's made copies of itself, it leaves and moves on to another cell. The trouble is, it sometimes kills the cell it infected — the guests leave a bomb as they depart — and that's when the trouble can begin. You start to hurt. Influenza will kill billions of cells in your lungs in a typical infection, which causes fluids to build up making it hard to breathe. That can really irritate your lungs. And then you cough it out. The virus makes you cough because it wants to spread. The drops of spit fly through the air and land on surfaces where someone else picks them up and then touches their nose or mouth and the virus enters a new body. The unwanted guests have moved next door.

This is why it's important to wear a mask if you're infected since that traps the virus. And why the number one recommendation of the World Health Organisation is to wash your hands.

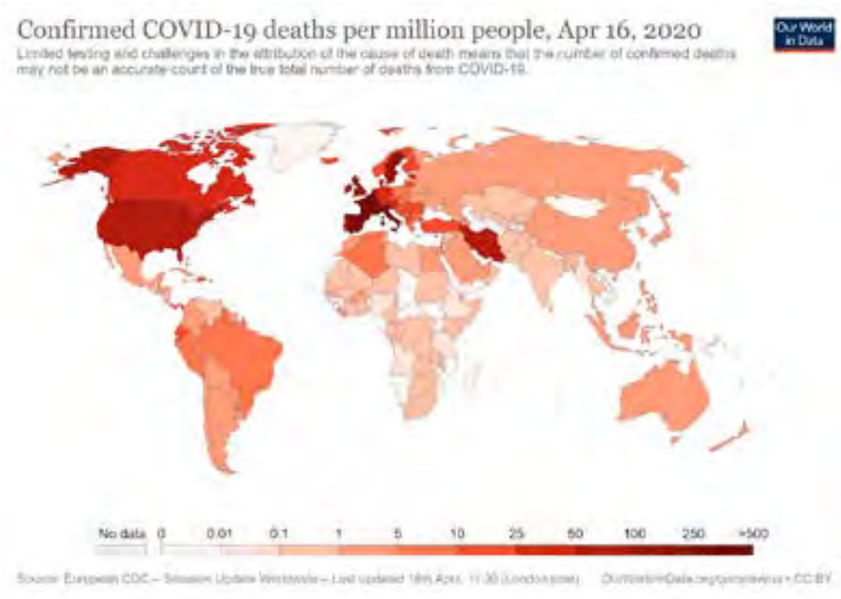
And why it's good to clean surfaces if you've someone in your house who's infected. Wearing a mask doesn't seem to protect people much as they fidget with it or take it off a lot. And the virus can probably get in through your eyes anyway.

NATURAL DEFENCE

But now some good news. Luckily evolution has helped you. Your immune system is on hand to recognise the intruder and bring out the big guns to kill it. It's like you've got on your iPhone and called for the gardai to get rid of your unwelcome guests (if possible, before they have done the deed in your guest room).

The immune system has evolved all kinds of ways to recognise and eliminate the intruder. It has special sensors for the virus's RNA which set off the alarm. It can also detect the spike protein. Your immune system can make antibodies and these latch on and stop the virus getting into cells. A bit like putting blu-tack over the key. The antibodies also help immune cells eat the virus.

Your immune system even has a way of killing the virally-infected cell. This is almost like the gardai deciding to blow up your house. It is worth it because it stops the virus (or your guests) moving into other houses in your neighbourhood. Remember, they've multiplied. So blowing up



one house saves many. If you're healthy, your immune system works a treat. The gardai are well fed, have had a good night's sleep and have the weapons to do their job. And, once the job is done, they are highly experienced. Should the unwanted virus turn up again, they can recognise and kill it on sight. This is how vaccines work. They are weakened forms of a virus, or parts of it, which train the immune system so that when the real culprit comes along, the immune system is ready to attack and you are protected.

SO WHAT CAN GO WRONG?

In the case of Covid-19 (and influenza), people who are sick with other ailments (for example cancer or heart disease) can't mount a proper defense and so the virus runs riot. Their immune systems aren't up to the job because of the other illnesses they have. Sadly, this can mean fatalities which at this stage are around 2pc and mainly involve people with other illnesses. As we age, our immune system does, too, so this puts older people at risk. We therefore need a vaccine and huge efforts are going into that with the real hope that one will be available in nine-12 months.

Doctors are also testing medicines to stop the virus from harming us. Drugs used to treat HIV are showing promise; HIV is somewhat similar because it has RNA too.

A drug used to treat malaria called chloroquine is also showing promise, as are high doses of steroids. What these drugs do is interesting. Although the immune system is failing in people who get really sick, it turns out that one part is over-active. Because the virus is running rampant, it hugely provokes this part (called innate immunity) which causes a process called inflammation to kick off — this makes your temperature go really high and causes your lungs and other organs to fail.

What people actually die of is the friendly fire caused by this over-active inflammatory response which is sometimes called a 'Cytokine Storm'. Steroids and chloroquine put that fire out and so protect you.

It's a bit like where there were two unwanted visitors in your house, there are now thousands and the gardai get their batons out and go to work on them. A melee ensues and sadly in the violence and chaos you die. Not a good result. Steroids and chloroquine are like cold water being sprayed over the gardai.

WHAT NEXT?

SARS-CoV2 is a new virus so we have to be vigilant. The death rate is unlikely to go up and if anything might go down as more people are found to have fought it. It also mutates at a rate slower then say HIV or influenza so it can't change itself too readily.

This means that once your immune system recognises it and eliminates it, it will recognise it again. A change might also mean it becomes more toxic, killing more, but again this is unlikely.

It may well enter the community and become just another virus that causes flu-like symptoms that we learn to live with. It might weaken as it adapts to us. Killing us is in general a bad idea for a virus — it's like those guests... why would they kill you when they want to sponge off you again? Many will develop resistance and refuse the unwanted guests entry. And when we have a vaccine, the vulnerable can be protected.

Right now though, follow the guidelines. Isolate yourself if you have symptoms and have come into contact with someone with the virus and call your GP. No need if you don't meet these criteria. Wash your hands a lot.

Soap and water is fine — work up a good lather as viruses hate soap because it dissolves them. If you're vulnerable, don't travel to places where the virus is. We all just need to keep calm, remain vigilant and wait it out. This too will pass.

Biobased and biodegradable plastics for a greener society

Prof. Kevin O'Connor

Plastic fantastic and not so fantastic

Fossil based polymers (foams, bottles, films) are ubiquitous in society serving many purposes and in many ways underpinning our modern way of life; protecting and preserving food, decreasing the weight of goods thus reducing transport costs, insulating homes, used to make furniture, protecting crops, enabling the manufacture of machinery, cars, and aircraft thus increasing fuel efficiency. These materials have transformed our lives and demand for the is increasing with over 320 million tonnes produced in the year 2015 and production predicted to increase to over 600 million tonnes by the year 2035 (***EU Commission 2018***). For all of the benefits of plastic there are major concerns about the environmental consequences of plastic (***Figure 1***). Plastic is ingested by sea life and affects the viability and reproduction of life in the oceans (Lamb et al., 2018) but it also affects terrestrial life (***de Souza Machado et al., 2017***) and so it can have a devastating impact on the sustainability of our planet. Globally it is estimated that somewhere between 5 and 13 million tonnes of plastic waste enters into the earth's oceans annually (***Jambeck et al., 2015***). Approximately 500,000 tonnes of plastic waste enters European waterways each year which is equivalent of over 66,000 trucks carrying compacted plastic waste and tipping it into the ocean every year.

In addition to the negative consequences of the end of life of plastic the manufacturing system is also not sustainable. The vast majority of plastics are made from fossil based resources i.e. oil and gas, both of which are finite. The burning of fuels to generate the energy required for the plastic manufacturing process contributes to greenhouse gas (GHG) emissions. Furthermore if plastic is combusted for energy at the end of life then GHGs are also released into the atmosphere. It is estimated that plastics production and incineration contribute 400 million tonnes of carbon dioxide (CO_2) to the atmosphere globally every year (EU Commission 2018). Based on a typical car emitting 4.6 metric tonnes of CO_2 per year this is equivalent to the CO_2 emissions of nearly 87 million cars (about a third of all the cars on the road in Europe) (***EAMA 2019***).

Figure 1. Post-consumer plastic waste is a major pollutant of our beaches, seas and oceans. Plastic accounts for over 80 % of marine litter (**EU Commission 2018**). Between 5 and 13 million tonnes of plastics end up in the oceans globally every year (**Jambeck et al., 2015**). Plastic waste in oceans breaks into microplastics which is ingested by marine life. The United Nations Environmental Programme (**UNEP**) estimates that global damage to marine environments is at least $US 8 billion per year.

Solutions for the plastic crisis

The primary solution for plastic waste pollution is avoiding the use of plastic i.e. prevention is better than cure (Figure 2). We need to prevent, reduce and minimise the amount of plastic we use. The plastic bag levy introduced in Ireland in 2002 resulted in a major change in our behaviour with a 90% reduction in plastic bag use in Ireland in one year. This strategy was a major success due to fact that there were alternatives to non-degradable disposable plastic bags such as paper bags, which are compostable and recyclable, and also the availability of reusable bags (e.g. bag for life) that can be used and re-used for years.

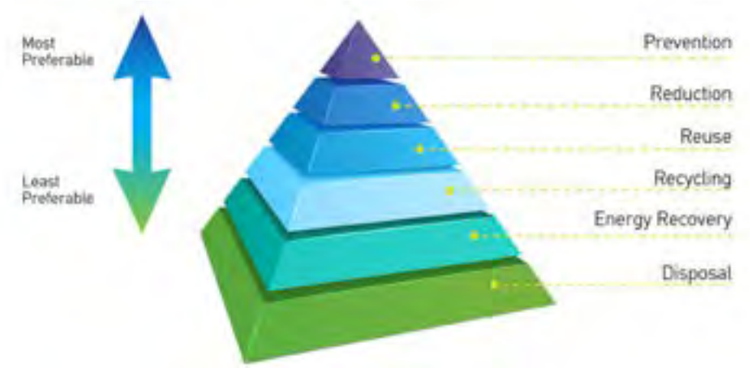


Figure 2. The Environmental protection agency (EPA) waste management hierarchy pyramid. Prevention is the first choice in the EPA waste management plan.

The World Wildlife Fund (**WWF**) recommends the Forest Stewardship Council (**FSC**) certification system to consumers for sustainably sourced paper and cardboard based products.

The removal of plastic from society is not easy as it plays a critical role in our lives. Our food is packaged in plastic to protect it from damage and increase the shelf life of the product. Packaging food and beverages in plastic reduces weight and thus reduces fuel consumption during transport. So we can't switch away from plastic overnight but there are plenty of opportunities to reduce or remove plastic from our lives. When you go the supermarket buy loose fruit and vegetables (there are not enough shelves with loose fruit and veg compared to the shelves with lots of plastic packaging), choose products that use sustainably sourced paper or cardboard over plastic, avoid products with excessive packaging, ask your supermarket to provide dispensing units where you can bring your own re-usable bottles/cans/tubs. Refill shops have opened up in Ireland where you bring your own containers and some supermarkets are selling re-usable net bags for loose fruit and vegetables.

Biobased and biodegradable plastics

If we cannot avoid the use of plastic we should move to replace fossil based plastics with biobased plastics which come from nature. Forest resources, agricultural crops, marine plants such as seaweed are also sources of carbon that can be used to make biobased plastics. Plants are made up of three polymers namely Cellulose, hemi-cellulose and lignin. Humans have been extracting cellulose from plants for nearly 150 years with the first cellulose based plastic made in 1870 (***Figure 3***).

The cellulose can be extracted and used as a material. Hemicellulose and lignin have been viewed traditionally as by products in cellulose extraction with the lignin used as an energy source in the production facility. However research into lignin has revealed its potential for use as a binder in fibreboards in house construction, in asphalt for road construction, in cosmetics, and in carbon nanotechnology. Hemp is a plant high in cellulose and has traditionally been used as a source of fibres to make clothes (Fig-

Biobased plastics come from nature not from fossil resources (e.g. gas or oil extracted from under the ground and sea beds)

Some bioplastics are biodegradable but some are not. So biobased does not mean biodegradable.

Biodegradable plastics are degraded by microorganisms and their enzymes.

Figure 3. Cellulose, abundant in wood, but also in other plant material, is used to make packaging, cups, paper, clothes and even as thickeners/fillers in foods and medicines. Cellulose was used in food packaging and also originally used by 3M in the USA as the plastic backing in Scotch™ adhesive tape. Hemp is high in cellulose and it has been used traditionally as a source of fibres to make rope and textiles and recently it has been in laboratory tests used to make plastics

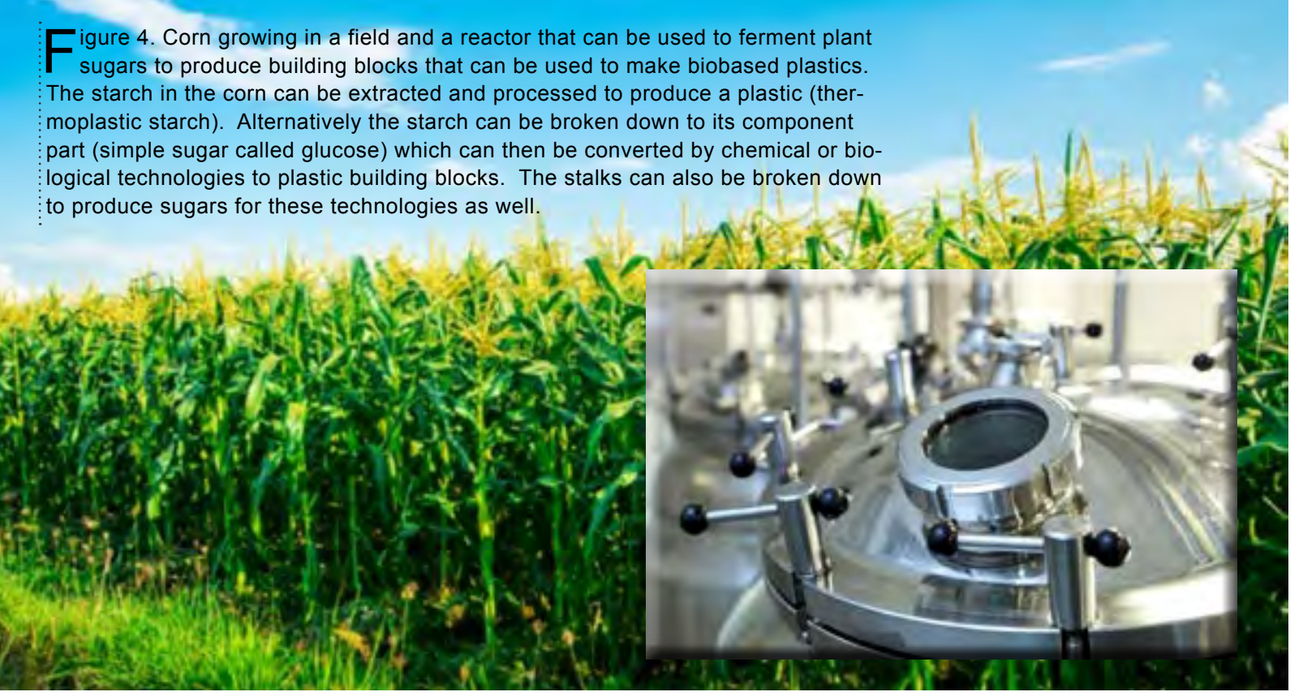


Figure 4. Corn growing in a field and a reactor that can be used to ferment plant sugars to produce building blocks that can be used to make biobased plastics. The starch in the corn can be extracted and processed to produce a plastic (thermoplastic starch). Alternatively the starch can be broken down to its component part (simple sugar called glucose) which can then be converted by chemical or biological technologies to plastic building blocks. The stalks can also be broken down to produce sugars for these technologies as well.

ure 3), furnishings and flooring but more recently scientists have been developing hemp based plastics.

Starch can be extracted from corn or other crops and processed to make a plastic called thermoplastic starch (TPS) (***Figure 4***). Other technologies can use microorganisms or chemistry to convert simple sugars found in plants (e.g. glucose (from starch and cellulose) and xylose (from hemicellulose)) into plastics building blocks (***Figure 4***).

Microorganisms (e.g. bacteria and yeasts) can ferment sugars to produces building block chemicals like lactic acid and succinic acid which can be converted by chemists to plastics such as polylactic acid (PLA) and polybutylene succinate (PBS) both of which are biobased and biodegradable plastics and can be used to make bottles, bags, cutlery and more (Figure 5).

Carbon dioxide and biobased plastic

The growing of plants consumes carbon dioxide (CO_2) and can offset CO_2 emissions from the burning of fuel (to create energy) during the plastic manufacturing process. This is not possible in the manufacture of fossil based plastics which use oil and gas and not plants as starting materials. If renewable energy e.g. wind energy or solar energy, are used in the production process then the carbon footprint of bioplastics production can be reduced further. Scientists are working to make bioplastic production GHG emissions negative (i.e. consuming more GHG than are emitted in its production cycle).

There are now biobased versions of well know fossil based plastics such as polyethylene (PE, often labelled as LDPE and HDPE) and Polyethylene terephthalate (PET). Carbonated drinks companies such as Coca Cola and Pepsi Co are investing in new technologies for the manufacture of biobased PET to address consumer demand. BioPET and fossil PET are identical in their properties and performance but the carbon that makes up the BioPET is coming from plants which are renewable while carbon in regular PET is from non-renewable fossil resources. Carbonated drinks companies favour BioPET over polylactic acid (PLA), a biobased and biodegradable plastic, that can also be used to make bottles, as the PET has much better barrier properties compared to PLA and thus it keeps their product carbonated (fizzy) for longer.

End of life management of biobased and biodegradable plastics.

Figure 5. Examples of products made from biobased biodegradable plastics such as thermoplastic starch (TPS) and polylactic acid (PLA): Cutlery, bottles, netting, filaments for 3D printing, and cups.

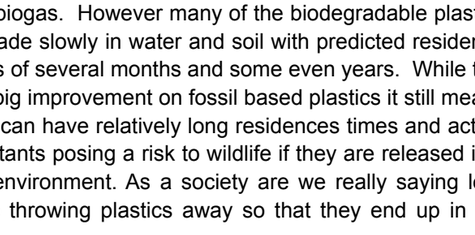
While the production of these bioplastics addresses the start of life of the plastic we also need to address the end of life of the plastic after we have finished with it. We need to manage these bioplastics so that they do not end up polluting the environment. Let's take two examples: A BioPET bottle will be accepted by recycling systems as it is identical to regular non degradable fossil based PET.

Figure 6: An Industrial composting facility (left) and a home compost (right). The temperature of an industrial compost heap will reach over 60°C while a home compost will typically reach less than 50°C. Commercial compost heaps are managed to maintain temperature, moisture and aeration making them much more efficient at decomposing organic matter (including biodegradable plastics) than home compost heaps

What if the plastic bottle is made from PLA. PLA is both a biobased and biodegradable (compostable) plastic. What should we do at the end of life with a PLA bottle? Which bin should this go in? Dry recyclables? Organic waste bin for collection (industrial composting)? home compost? It could go in the dry recyclables, as it is recyclable, but the waste recycling systems in many countries, including Ireland, is not able to manage PLA (and some other biobased plastics) as thus it is seen as a contaminant in the recycling system which is currently set up to manage well known fossil based plastics such as PET. So should you put it in the organic waste bin for collection and processing at a commercial composting facility? (Figure 6) While PLA is compostable and so suitable for the organic waste bin, it, along with all other plastics, is seen as a contaminant in organic waste processing facilities and so it is not allowed. So could you put PLA in your home compost? (Figure 6) Unfortunately, PLA does not degrade in home composts and is only compostable in industrial/commercial composting facilities. Why? PLA has an ordered (crystalline). structure making it strong but this structure also makes its bonds inaccessible to microorganism that want to grow on it and break it down. This crystal structure remains in place up to temperatures of about 60°C. In industrial composting facilities the temperatures reach above 60°C that crystalline structure melts/falls apart and so microorganisms can then access the bonds of the plastic and break it down. .

> Compostable is a standard set by regulatory authorities where biodegradation must take place within a specified period of time. To be compostable 90% of a plastic must decompose in a compost heap within 6 months (not just break up into small fragments but it must actually be digested by microorganisms). The products of biodegradation must not be toxic to plant life in order for a plastic to be certified compostable.

However in home composts the temperature does not reach 60°C and so the PLA remains crystalline, inaccessible and will not decompose. There are also high numbers of microorganisms in the commercial compost heap and this speeds up the biodegradation process. Other plastics can be home composted (e.g. starch based plastics) but you need to look out for the sign on the packaging that tells you if a plastic is home compostable. While the recycling of PET and bioPET is welcome governments and the waste management sector must act now to be able to deal with the full range of plastics on the market otherwise these new bioplastics and biodegradable plastics will not be managed properly and could end up in landfill or in the environment.



Biobased biodegradable plastics in the environment

The environmental damage caused by current plastics is due to the failure of humans to capture that plastic after we have used it. One can argue that we are the problem and not plastic. Biodegradable plastics are viewed as a solution to pollution as they could rapidly degrade in environments such as soil and water (sea and fresh water). We, at BEACON SFI bioeconomy research centre, and partners in an EU funded research project investigated the fate of biodegradable plastics in managed (composting) and unmanaged (soil, sea and fresh water) environments. Our results show that when managed all the biodegradable plastics we tested degrade very well under industrial composting conditions and show promise for use in anaerobic digestion which converts organic waste into biogas. However many of the biodegradable plastics degrade slowly in water and soil with predicted residence times of several months and some even years. While this is a big improvement on fossil based plastics it still means they can have relatively long residences times and act as pollutants posing a risk to wildlife if they are released into the environment. As a society are we really saying let's keep throwing plastics away so that they end up in the

ocean? We need to use less plastic where practical and where we have to use plastic we want that material to be captured in the waste management system (e.g. recycling, composting). Biodegradable plastics offer society the ability to manage plastic waste along with other organic waste and thus offer new end of life routes and solutions for plastic. For example food contaminated plastic is not recyclable or very difficult to recycle. Food contaminated compostable plastic could be managed with organic waste and so should help to increase the capture rate of plastic in the waste management net.

Conclusion

Fossil based plastics underpin our modern lives but they are part of a linear production chain that ultimately means plastics at the end of their life cause environmental pollution. The fossil resources that gives rise to plastics are finite (cannot be renewed), depleting, and their use for plastics production contributes to greenhouse gas emissions. As a society we must move away from the use of fossil based resources (oil and gas) and we must reduce the amount of plastic we use. We can't switch plastic production off overnight and so we need to transition to a circular economy where we change the life cycle of plastics. We should use renewable and sustainable starting materials to make plastic and ensure that the plastic we use is managed/captured to avoid environmental pollution. Biobased plastics allow us to switch away from the use of finite depleting fossil based resources and reduce GHG emissions. Biodegradable plastics address the end of life cycle of plastics. However, the environment in which biodegradable plastics are placed has a big bearing on their biodegradability. The best environment for biodegradation of plastic is a compost heap within a waste management facility and not in the environment. So biobased and biodegradable plastics can offer us a greener society but we have to carefully manage the resources, such as forests and agricultural resources that give rise to these plastics and we have to manage these plastics after we have used them so that they do not cause environmental pollution.

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Seán Ó Donnabháin

Retired Senior Science Inspector, Department of Education and Skills.

The ISTA sends its warmest wishes to our dear friend Seán Ó Donnabháin, retired Senior Science Inspector, on the occasion of his 85th birthday which he recently celebrated.

A Group of teachers who were part of the National CPD team for the Intervention Projects in Physics and Chemistry pictured at a seminar held in 1992. Front row (left to right): Seamus Ó Miocháin, Lillian Fogarty, George Porter, Sheelagh Clowry, Seán Ó Donnabháin, Catherine McDonagh. Second row (left to right) Owen Clancy, Chris Armstrong, Oliver Duggan, Joe Creggy, Noel Brett. Third row (left to right) John Toomey, Tom Bolger, Joseph O'Hegarty, Dan Condren, Brendan Duane. Fourth row: Declan Kennedy, Paddy Hogan, Pat O'Leary, Larry Keating and Oliver Harrington.

During his time in the inspectorate Seán was Chief Examiner for Leaving Certificate Physics and Chemistry and over a period of 38 years as a science inspector, Sean gave outstanding support to the Irish Science Teachers' Association. He faithfully attended our Annual Conference every year and was always very much aware of what was happening in science education at classroom level. He was involved in several projects aimed at improving science teaching in Ireland. He was particularly involved in curriculum development and it was he, as a result of conferences which he attended in the USA, ensured that reference to the applications of science in everyday life – what is now known as Science, Technology and Society - were included in the Leaving Certificate science syllabi currently being taught in our schools.

In 1985 he initiated, and subsequently developed, the *Intervention Projects in Physics and Chemistry*, a programme designed to increase the participation rates of girls in the physical sciences at Leaving Certificate level. Under Sean's direction, physics or chemistry was introduced to the curriculum of over thirty schools which did not have the subject and, as a result, a large number of girls (and a number of boys in co-educational schools) had an opportunity to study one or more of the physical sciences for their Leaving Certificate. As well as introducing these subjects into schools which did not offer them, the programme also provided support to physics and/or chemistry teachers in over seventy other schools which did have these subjects. This support assisted the teachers to develop their expertise in their subjects and also helped to promote the subjects in the schools through presentations to the students and to their parents. The photograph shows many of the teachers who were part of the National Continuing Professional Development (CPD) team for the Intervention Projects in Physics and Chemistry.

Seán believed strongly in the value of continuing professional development for teachers. In collaboration with the ISTA, he facilitated the organisation of numerous CPD courses for science teachers at venues throughout the country. Not only did he support the organisation of these courses but he also attended and presented at many of them.

He was responsible for the production of two very comprehensive handbooks, circulated to every second-level school in the country in both paper and electronic formats, for teachers of physics and chemistry. These handbooks were published shortly before Seán retired and marked a fitting climax to a career dedicated to the development of science education in this country. Sean retired from the Inspectorate in 2000 having being involved in science education for a total of 43 years. Shortly after his retirement, he was conferred with an honorary Master in Science Education degree by UCC to mark his contribution to science education and for his outstanding support for the Irish Science Teachers' Association throughout his career.

His many friends in the ISTA wish him continued good health and happiness. Gura fada buan thú.

SciFest@College 2020 Continues Online

Students Can Still Take Part Despite Covid-19 Restrictions

Sheila Porter

With the closure of the schools and colleges the SciFest@College regional finals that usually take place in 16 venues in the Institutes of Technology, TU Dublin, DCU and St. Mary's College, Derry are now taking place online.

The 3,000 plus second-level students who in March registered to participate in SciFest@College 2020 now need to visit the website www.scifest.ie, complete an online form and submit their project report books as well as any supplementary material for online judging by **Thursday 14 May 2020**. Teachers are asked to encourage their students to continue to work on their projects and guide them through any questions they may have. Students participating in group projects should collaborate with each other online and over the phone and follow all the HSE guidelines.

Margie McCarthy, SFI, Ben Keane, Dublin North East ETSS and Sheila Porter, SciFest at the launch of SciFest 2020 in February.

COVID-19 is affecting not only SciFest@College but also the SciFest students who were due to participate in international events. Flights were booked, forms filled and preparations in place for our SciFest students to attend the Regeneron International Science and Engineering Fair (ISEF), the Broadcom Masters and the Big Bang. Unfortunately, due to COVID-19 all of these events have had to be cancelled. Timothy McGrath and Alice Shaughnessy were to represent Ireland and compete at the Regeneron ISEF 2020 in Anaheim in California in May. Timothy from Killorglin Community College, Co. Kerry was the overall winner of SciFest 2019 and Alice from Calasanctius College, Oranmore, Co. Galway was subsequently selected to participate in ISEF as a result of Regeneron generously offering to cover the cost of sending a second student to ISEF.

Timothy and Alice with their Regeneron ISEF Award certificates.

We are extremely disappointed not only for Timothy and Alice but also for Orna Collins and Miriam Murphy. Orna, from Castletroy Community College, Co. Limerick was selected at the National Final to attend the Broadcom MASTERS, also in Anaheim. Miriam who attends Scoil Mhuire gan Smál, Blarney, Co. Cork won the SciFest 2019 Specsavers Grand Award at the National Final and was to attend the Big Bang in the UK. We know they were all very much looking forward to meeting and competing with their peers from around the world. We would like to take this opportunity to acknowledge their achievement and, all being well, we look forward to meeting them again at the SciFest 2020 National Final in November.

Visiting students participate in a taste test at a SciFest@School in Kingswood Community College, Dublin 24.

SciFest has been running since 2006 and 2020 marks the 15th year of the competition. The programme has grown from a single STEM fair of 170 students to 99 STEM fairs with 10,000 students participating in 2019. This year was set to break all previous records. Up until the schools closed on 12 March 106 schools had confirmed the date for their SciFest@School STEM fair compared to a total of 81 schools that hosted a SciFest@School fair last year. Preparations were in place and we were all looking forward to the SciFest@College regional finals due to start on 28 March in TU Dublin City. This was not to be but hopefully there will be lots of entries to SciFest@College 2020 Online and things will be a bit more normal by the SciFest 2020 National Final in November. The main thing, however, is to stay safe and well until better times. Best wishes from all at SciFest.

Closing Date for Receipt of Entries to SciFest@College 2020 Online is 14 May 2020, see www.scifest.ie.

Interview with a SciFest winner.

Ronan Walsh, Coláiste Choilm, Tullamore, Co. Offaly was the winner of the SFI Best project Award at SciFest@AIT 2019 and went on to win The Society for Science and the Public's Community Innovation Award at the SciFest 2019 National Final. He was awarded a prize of a trophy and $500 and asked by the Society to answer a number of questions.

1. **Tell us about your project, why did you focus on this project? What community challenge were you seeking to resolve with your research?**

'I developed "Beat the Drought" to provide a safe, sustainable, water supply for gardens, especially in times of water shortages and restrictions. Due to rising temperatures and increased demand, ensuring water supply is an increasing challenge. In recent years, changing weather patterns have brought hotter, drier summers to Ireland. The prolonged drought and water restrictions in 2018 damaged many gardens in our community. My mother even reused the water used to wash potatoes for our flowers.

When considering a project for SciFest in February 2019, I remembered this and wondered if I could come up with a way of automatically harvesting and storing greywater for use in domestic gardens.

I set out to show that it was possible to create a domestic harvesting and treatment system that would reclaim our greywater automatically for re-use in irrigation and treat it to a level where it posed no risk to human health. Not only would this ensure a water supply for gardens in time of water scarcity, it would reduce the need to use expensively treated potable water for irrigation and also cut down on the amount of waste water being treated at great expense in over-loaded waste water treatment plants.'

2. **You received the Society's Community Innovation award. What does this recognition mean to you?**

'*Winning the Society's Community Innovation Award is very important to me as it recognises all of the hard work and effort that I put into my project. I have shown that I can identify a problem within my community and work towards finding an innovative solution to that problem. I have successfully brought my "Beat the Drought" system through design, prototyping, manufacture and testing and the system has been judged both worthwhile and successful by the judges at regional and national level. I hope to study Civil Engineering in university and having won this prestigious award will prove to future employers that I can successfully identify a problem and more importantly come up with a an innovative, working solution. Skills which I think are vital for any engineer to have. The recognition that I have received for my project makes me confident that I am choosing the correct career path!*'

Ronan with his award-winning project at the SciFest 2019 National Final last November

3. **How did you first become interested in STEM?**

'I first became interested in STEM in Primary School. We participated in the "Discover Primary Science" Programme every year. This is run by "Science Foundation Ireland" and it gave us the chance to participate in fun STEM activities in school. We did different activities and experiments in class and we also got the chance to attend ecology and science workshops in Discover Centres. We had engineers and ecologists visit our school to tell us about their work and do workshops with us. This is when I realised how interesting the work of an engineer is. During Science week and Maths week we played lots of games and did lots of different STEM activities with our teachers. My favourite time was when we had our annual science fair. The senior pupils prepared fun experiments on topics such as electricity, forces and mixtures and we helped the younger pupils to do them. It was always great fun and really messy! All of our experiments and activities helped our school win Discover Primary Science "Excellence in Science and Maths Awards" every year as well as giving us the opportunity to see how interesting and challenging science and maths could be.'

4. **Why are Science Fairs/Competitions important?**

'I think that Science competitions and fairs are important because they encourage students to find an area of STEM that they would like to investigate or a problem that they would like to solve and work on it over an extended period of time. Often these are areas or topics that are outside our school curricula. Completing a project for these competitions encourages students to work using fair tests and the scientific method and gives experience in completing an extended project over several months which we would not get a chance to do in school. Hypothesising, identifying aims and goals, designing fair tests, meeting deadlines,

completing the report book , presenting results, drawing conclusions and even designing a poster will be really important skills to develop as we move onto college, as will the ability to present and defend our projects to the judges. Although lots of work, competing in Science Fairs is very challenging and satisfying and can bring a great sense of confidence and achievement to the participants. Lastly, they are also great fun and offer the opportunity to meet and talk and share ideas with other young people who are interested in STEM.'

5. **What research areas or educational goals do you have in the future**

'*At present I am studying for my Leaving Certificate exam in 2021. Among my 8 subjects are Maths, Applied Maths, Physics, Design and Communication Graphics and Construction Studies, all at higher level. I am currently designing my construction studies project in "SOLIDWORKS". It's challenging but I'm enjoying it. Following my Leaving Certificate I aim to study Civil Engineering in NUIG (National University of Ireland, Galway) or UL (University of Limerick). I hope to follow the 5-year course leading to an M. Eng. in Civil Engineering. This will fulfil the academic requirements for achieving Chartered Engineer status. Both courses have 6-9-month blocks of paid work experience which should be very interesting and rewarding. I have not decided which area of Civil Engineering I will specialise in yet, but I am really looking forward to investigating the different options available before choosing. I have attended open days and taster programmes in both universities and the options range from traffic and roads engineering to structural engineering to civil engineering for renewable energies and many others*.'

I think that Civil Engineering will be an interesting and dynamic profession which will offer many opportunities for work and study both in Ireland and abroad.'

6. **What would you invent if you had all the money in the world?**

'*If I had all the money in the world I would like to invent a carbon neutral system of treating all waste water, both grey water and sewage from domestic households to produce both water which could be safely reused by householders for non-potable uses and organic fertiliser for use by gardeners. Producing organic fertiliser in this way would help reduce the demand for nitrogen-based fertilisers made in industrial plants using large amounts of energy.*

In Ireland many single rural dwellings are not connected to the public sewer and older dwellings in particular do not have adequate wastewater treatment systems. Wastewater is not always treated to a sufficiently safe standard. This leads to cases of bacterial contamination of both groundwater and the public water supply in small rural water schemes. This results in "boil water" notices being issued by the authorities and people being unable to drink the water from their taps for periods. By developing a system that would treat all domestic wastewater including sewage to safe microbiological standards for reuse, it would reduce the amount of mains water used, the contamination of our groundwater and most importantly the risk to public health.'

Sheila Porter, SciFest Founder and CEO presenting Ronan with the Society for Science and the Public Community Innovation Award trophy

7. **Can you share a story or anecdote in your life that has been pivotal in your work or personally.**

'*I found that winning the SciFest Regional Final was pivotal in both my life and work. I was thrilled because I had worked long and hard and had had many ups and downs in successfully developing my system. Several times I had encountered problems that seemed impossible but by persevering, I always managed to find a way around them. My biggest problem was eliminating e-coli from the treated water. When I started, I hadn't even realised that it was common to find e-coli in greywater! I was satisfied to reduce e-coli levels to below WHO standards by the regional final. I was given such encouragement and praise by the judges that I felt confident that I could redesign the system and completely eliminate the e-coli before the National Final. I actually succeeded in doing this, which played a big part in proving how effective my "Beat the Drought" system was. The whole experience showed me the solution to an engineering problem doesn't have to be one big discovery but rather a series of smaller discoveries that come together successfully to solve a problem and with confidence and perseverance you can eliminate difficulties one by one in reaching a solution.*'

8. **Is there anything else you would like to add?**

' *I would like to thank the Society for Science and the Public for awarding me it's Community Innovation award. It is a great achievement for me and one which I will be very proud to have on my Curriculum Vitae.*

The whole experience of participating in SciFest has been a hugely positive and enjoyable one for me. Though I found the thoughts of presenting my project to the judges who were engineers and lecturers quite off putting, their interest in, and enthusiasm for, my work gave me great encouragement and confidence. The whole experience of working on the project, and the satisfaction of overcoming each difficulty that it presented, has convinced me that engineering is the career for me.'

Supporting STEM Learning

in the Transition to Post-primary School

Mary Immaculate College, Department of STEM Education.

The transition from primary to post-primary is a big step for children and can be an exciting and challenging time. There is a considerable amount of general advice available to parents in supporting this transition, ranging from information on the different types of post-primary level schools and factors to consider when choosing a school. For example, the NPC's information leaflet *Supporting Your Child's Move from Primary to Post-primary School* contains information, advice and considerations prior to and during the transition. However, there is less advice available for primary school teachers and principals to support this transition particularly in relation to STEM opportunities for their sixth class group.

We argue, in this article, that considering and discussing STEM education is an important endeavour at this stage of education. We provide guidance on how teachers, together with parents, can support a child's interest in and awareness of STEM education in the transition from primary to post-primary school.

Why Consider STEM learning at Transition?

The new Junior Cycle Framework emphasises the development of key skills for the first three years of post-primary education: 'Being creative', 'Being literate', 'Being numerate', 'Communicating', 'Managing information and thinking', 'Managing myself' and 'Staying well'. Many associated skills and aptitudes (including problem solving, flexible thinking, and perseverance) are essential for success in further education, professional life and the workplace. STEM subjects (Science, Mathematics, Engineering and Technology) and STEM practices naturally lend themselves to developing many of these skills. Junior cycle STEM subjects provide opportunities to further develop knowledge of and about STEM, building on prior learning from primary school. In addition, STEM disciplines develop other skills and dispositions including:

- Collaboration and creativity, thus giving children opportunities to make friends and work with others in a new school. They also increase students' motivation to learn together and alone.
- Interpretation and analysis of evidence and data to draw appropriate conclusions, thus developing various sought after skills such as problem solving, analytical thinking and communication.
- Deeper learning and understanding of alternative approaches as well as associated risk in addressing the varied needs and wants in the world (through for example STEM debates on issues such as genetic engineering and nuclear energies).

Effective STEM education develops thoughtful, ethical and active citizens who have the capacity to make informed decisions and contribute to society. Studying STEM subjects at junior cycle also facilitates a smooth transition to many senior cycle subjects.

Insights into STEM Subjects at Post-primary level

While the post-primary school open nights may address subject choices, it is also useful to have open discussion on this and other aspects of transition in the final weeks of sixth class in primary schools. This is particularly important where a school requires subject choice be completed prior to commencing first year. All schools offer mathematics as a compulsory core subject throughout post-primary education (both junior and senior cycle). Although science is not compulsory in the new Junior Cycle Framework, the majority of schools offer it. Depending on the school, Science may be offered as a full subject or as a short course. Other STEM related subjects available as junior cycle options (if the school provides these) include: materials technology, technology, technical graphics and metalwork. subjects such as engineering and design and communications graphics (DCG) are only available at senior cycle. However, a school could develop and offer a junior cycle short course in any of these areas, dependent on staff interest and expertise. It is essential that primary students, parents and primary teachers understand the distinctions between these subjects and courses prior to making subject choice decisions.

First year subject choices are important given the implications of junior cycle subject choices on senior cycle choices. A school may deter students from selecting a subject at senior cycle if they have not studied it at junior cycle. For example, *science* supports and diversifies into a range of senior cycle subjects: physics, chemistry, biology, physics/chemistry combined and agricultural science. There are also significant STEM connections in terms of problem solving skills, creativity, and design between subjects such as woodwork, metalwork, DCG and technology. Students and their parents should be informed that studying junior cycle science facilitates a smoother transition to studying science subjects at senior cycle.

STEM Subject Choice and Gender

State Examination Commission statistics (2012) indicate that the majority of students who sat technology, engineering, DCG and physics for Leaving Certificate were male. In contrast, the majority who took biology were female. These statistics not only highlight some gendered subject interests among students, but also relate more broadly to

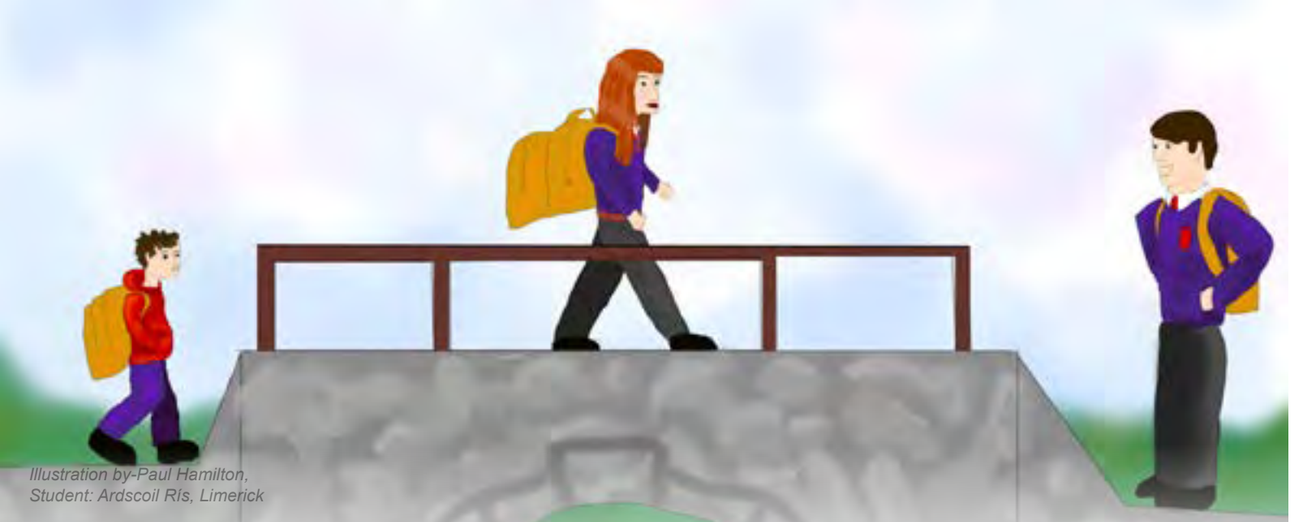

Illustration by-Paul Hamilton, Student: Ardscoil Rís, Limerick

school subject provision and school type.

Some single-sex schools offer a more gendered and/or limited subject choice at both junior and senior cycle. For example, subjects such as Technology, Engineering, Applied Maths, Technical Graphics, Materials Technology, Metalwork, Agricultural Science and Design and Communication Graphics are not available in all schools. In some cases, co-educational schools can offer a broader subject base from which students can choose. The size of the post-primary level school can also affect the range of subjects available, with smaller schools, sometimes, but not always, having a more limited subject choice. It is important that in schools where a range of subjects are available that all students, regardless of gender, have equal opportunities to access and pursue these subjects.

As part of the decision-making process at transition, the primary school personnel might remind children and parents to consider the subjects available in prospective schools at both junior and senior cycle. Some schools offer modules in transition year in subjects not catered for at junior or senior cycle. This can be a good way to access skills and learning in a subject without the pressure of state examinations. Some schools have a compulsory or optional transition year, which is a worthy consideration at transition.

Top Tips to Develop Interest in STEM at Transition

1. Home and School Collaboration

Please note, these suggestions could be communicated via a school newsletter, or at an open night or transition to post-primary school session for parents

Prior to leaving primary school, encourage parents to discuss new post-primary subjects. It may be helpful to use the materials provided at the open night to discuss subjects on offer. The child's particular interests should lead decisions on subject choice but it is useful to encourage a child to consider new challenges and move beyond considering only favourite subjects in primary school. While still very young to make decisions around subject choice, awareness that there may be an advantage to studying certain subjects at junior cycle in order to access related subjects at senior cycle is important. Some post-primary schools offer 'tasters' of junior cycle options early in first year to make more informed decision making.

While some parents may believe that sharing their personal struggles will reassure a child, it is important to avoid over-telling the challenges faced with a particular subject e.g. 'I was never any good at science/maths'. This may negatively influence the child's sense of confidence and personal interest in these subjects. Instead, it is of immense value for parents and teachers to encourage and reassure the child that working hard at subjects they find challenging pays off and to persist when they find content difficult. There is great satisfaction for any child in succeeding through struggle and this approach sends important messages that ability is not fixed but developmental.

It is important that teachers and parents portray a positive attitude towards STEM subjects. Comments such as 'I never understood why I was studying that maths when I was ever going to use it' may have negative implications for a child's beliefs about the value of the subject and in turn their attitudes. Showing a positive attitude towards STEM learning now and into post-primary level will help the child see the benefits of what they are learning. Even if a parent feels they have limited experience of the STEM disciplines, be open to its value and eager to learn with the children. Alongside parents, the child's teacher plays an important role too, and with a dual collaboration and approach to promoting STEM, a child has a much better chance to succeed and enjoy their new learning.

In the general classroom teaching space, STEM research indicates that children learn best when meaningful and relevant contexts are provided. Relating STEM to everyday situations such as budgeting for the weekly shop, troubleshooting a computer glitch, or reassembling a device, all provide valuable skill and knowledge opportunities for children. Children can also be involved in STEM through other everyday activities such as gardening, measuring, baking, using apps to enhance learning, designing and making at Halloween or other festivals. Teachers and parents should be conscious not to reinforce gender stereotypes by inadvertently encouraging boys to see how machines work

with dad, while girls help with planting or baking with mum. Offer a variety of resources to your class that incite questions about how things work and discuss the materials that make up objects. The way in which we structure exposure to toys, possessions and objects can send strong messages about gender expectations for boys and girls, which may later become barriers to STEM learning and STEM futures.

2. Community

Encourage children to engage in STEM related extracurricular activities and school holiday educational programmes and courses. For example, consider a STEM initiative such as 'Coderdojo' as this may develop an interest in other STEM areas. Other examples of STEM learning opportunities include excursions to museums and science centres and getting involved in school-community linked project such as tidy towns.

Knowledge of careers and people working in STEM provides valuable role model support for children. The primary school might organise for a local person working in a STEM-related field to come and chat to the senior primary classes or arrange for a class to visit a local STEM workplace. Many public and private organisations are very open to educational visits e.g. Seed-savers, Ardnacrusha hydroelectric plant.

3. School

Many primary schools and teachers are involved in various national STEM initiatives such as the 'Intel Mini-scientist', 'RDS Primary Science Fair' or the 'Discover Primary Science and Maths' programme. All primary children should be given opportunities to become involved in school projects and their parents invited to show an interest and offer encouragement and support during project development and completion. These events allow children to explore their own ideas and to inquire about the world around them while working with other children.

During the months before leaving primary school, parents should be encouraged to listen and to keep the channels of communication open. Primary teachers should encourage sixth class pupils to be organised, keep on top of their work and prepare them for exposure to the volume of new experiences at post-primary level, across a range of new curricular areas. It is important to reassure pupils that help is available if they need it in their new school and that this will be explained to them in the early weeks of first year. It may be beneficial to invite a past pupil of the school to talk to sixth class about the changes they may experience in secondary school. These general approaches will help prepare the class for changes in curricular or social aspects of life at post-primary school.

Once the child has transitioned into post-primary school, it is essential that a strong relationship be built between students, parents and teaching staff from early on, as this will enhance the sense of support for the child during transition. Alongside this, it is important for the post-primary school to develop a relationship with feeder-schools' primary teachers. For example, post-primary STEM staff could share information on STEM initiatives like science and maths week, scifest and BT young scientist and other STEM related events, with local primary schools. STEM opportunities could also be communicated through the parent bodies.

Conclusion

There is growing support for the belief that STEM disciplines develop desirable skills and dispositions. While much of the child's STEM education occurs within the school system, there is also potential for parents and the home and community environments to support and foster positive attitudes and dispositions towards STEM. Alongside teacher support and inspiration, parents have an influential role. Teacher and parental expectations and encouragement, in addition to exposure to successful role models, contribute to fostering STEM habits of mind, which will have valuable learning and social benefits as children transition into post-primary school and beyond. There is also a need to manage the transition specifically in relation to STEM education. This requires ongoing communication and collaboration between teachers at both sides of the transition in order to guide and empower parents to support their child to make a smooth STEM transition to post-primary school.

Appendix 1: A list of websites related to article for additional information.

- The Department of Education and Skills: www.education.ie
- National Council for Curriculum and Assessment: www.ncca.ie
- State Examinations Commission: www.examinations.ie./
- Junior Cycle at Post-primary: www.juniorcycle.ie
- Special Education Support Service: www.sess.ie
- The National Parents Council: www.npc.ie/
- Vocational Schools and Community Colleges-National Parents Association for Vocational Schools and Community Colleges: www.npavscc.ie
- Community and Comprehensive Schools-National Parents Association for Community and Comprehensive Schools: www.pacs.ie
- Junior Cycle for Teachers/Science Support Service www.jct.ie/science

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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

The primary pupils' attitudes 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 or 051 30 2942.

Please get in touch

Phone: **051 302492**

Email: 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.

Bolivian Biology

Paul Holland

South America's Wild West, northern Argentina and Bolivia, is a string of highlights – mountains, forests, old mines, Martian scenery, red lakes, salt flats, good food, lovely people – but I'll speak of the supernova (or meteorite strike), the dinosaur footprints of Potosi, Bolivia. High in the Andes, it was a city once bigger than London or Paris.

Outside the city is a steep cement face criss-crossed by dinosaur footprints – the record of a day millions of years ago. There are prints, some huge, some smaller – traces left by massive herbivores, groups of animals and light footprints probably left by single agile carnivores. To my untrained eye, those lighter prints conjured up images of giant chickens scampering across a farmyard in a hurry. People can view the prints from an observation region before being guided down a long slope to the base of the cement face – closer up, one gets a feel for the size of these monsters.

This area was once flat and the ground muddy. The dinosaurs went about their business, leaving clear trails. Planetary science did the rest. Sandstorms or volcanic ash covered the prints – quickly and gently. Plate tectonics caused the flat land to fold so that the buried footsteps now went up a wall.

Millennia passed. Weather caused erosion and, bit by bit, the prints were exposed. Bolivia's first inhabitants knew nothing of dinosaurs, no questions were asked. Times changed, science developed, but now, in the 19th century, a conspiracy of silence developed. Christianity had arrived in South America and here was glaring evidence of animals that walked the Earth no longer, evidence for evolution (sacrilege). For a very long time, academic institutions didn't want to know.

Today, visitors are encouraged and welcomed (further prints are being found in more inaccessible places). Problems persist however. The very weather that revealed the prints also threatens to erode them away. There have been collapses on the cement face. There have been arguments over who should get the money to maintain it, with fears of corruption. Moreover, preserving the dinosaur prints in a way that allows people to see and appreciate them poses its own challenge.

Potosi has probably the most extensive and readily accessible set of dinosaur footprints in the world. Look no further. If your purse allows only one trip in search of our ancient relatives, you must come here.

Author

Paul Holland, formerly of Presentation College, Galway.

Chemistry in Action! :

An inspiration for ISTA members

Dr Declan Kennedy, UCC

Introduction

I am delighted to have been asked by the ISTA to write this article to mark the 40th anniversary of *Chemistry in Action!*. The esteem in which Dr Peter Childs is held by science teachers is evidenced by the fact that he was invited to be Hon President of the ISTA in 1995 and was also the recipient of the Science Educator of the Year award for his outstanding contribution to science education in Ireland.

Dr Peter Childs arrived in Ireland in July 1978 to teach chemistry at Thomond College of Education. He got down to work immediately and, over the intervening years, has established himself as a giant of science education in Ireland. In May 1980 he launched the first issue of *Chemistry In Action!* Over the years he has been an outstanding friend and supporter of the Irish Science Teachers' Association. He has always worked in close collaboration with the ISTA and, as a member of ISTA, has identified with its mission as a body dedicated to the professional development of its members and the advancement of science teaching

There are two treasured possessions in the Eureka Resource Centre of UCC. One is a set of bound copies of every edition of *Chemistry in Action!* and the second is a set of bound copies of every edition of SCIENCE - the journal of the ISTA. In *Chemistry in Action!* Peter Childs has captured the development of chemistry education in Ireland over the past 40 years. Not only does the publication chart the development of chemistry in terms of curriculum reform but it also contains a wealth of resources that are used in the teaching of chemistry by our student teachers and those undertaking research at masters and PhD levels in UCC.

The great usefulness of C*hemistry in Action!* to all of us involved in science education is that its content ranges over such a wide variety of topics. In this short article, I will endeavour to try to give a flavour of where I see the strengths of having this outstanding publication available to all of us.

1. Topics in Chemistry in Action!

ChemEd conferences are among the finest CPD programmes that I have ever attended. I vividly recall as a young science teacher the excitement that I experienced year after year as I headed off early on Saturday mornings to Limerick and being so warmly welcomed at the registration desk by Peter Childs and Marie Walsh. I still retain that same excitement when heading off to ChemEd each year. I applaud Peter and his team for always organising excellent ChemEd conferences where I learned so much chemistry content and came home with lots of top class teaching ideas to help me in the classroom. The fact that the proceedings of these ChemEd conferences were always published in *Chemistry in Action!* added greatly to the quality of the publication.

Some of the topics which I recall as being among the great ingredients of ChemEd conferences and subsequent articles in *Chemistry in Action!* are:

Overview of marking of the Leaving Certificate examination paper.

Chemistry Demonstrations and Chemistry Magic Shows.

"Hands on" practical laboratory activities.

Resources available from PDST.

Ideas on approaches to teaching a range of topics on the Leaving Certificate chemistry syllabus, e.g. bonding, environmental chemistry, development of atomic structure and organic chemistry.

Technical tips for teachers in the area of laboratory organisation and management.

New topics such as nanochemistry, potential for use of hydrogen as a fuel, the use of new technologies for carrying out laboratory practical work.

RSC Resources and Spectroscopy in a Suitcase.

Teaching Transition Year chemistry.

Laboratory practical work and its assessment.

How to motivate and engage chemistry students.

Science, Technology and Society. This is an area in which I have always been interested and found the articles on famous scientists gave me great background information to help me explain the scientific method and interest my students in chemistry, e.g. Amedeo Avogadro, Robert Boyle, Justus von Liebig, Dmitri Mendeleev and Linus Pauling,

Industrial chemistry. I recall attending several industrial visits organised by Peter during the summer, e.g. visiting Tara mines, IFI Arklow and Premier Periclase in Drogheda. Details of these industrial visits were subsequently published in *Chemistry in Action*! and served as great resources for teaching this part of the syllabus.

In addition to covering topics at Leaving Certificate chemistry level, *Chemistry in Action!* also covered issues related to Junior Cycle science, e.g. the issue of teaching science at a common level (Childs P.E. 2019)

In shoes and clothes one size does not fit all. The move to a common level course and examination in Junior Cycle Science implies that one size does fit all when it comes to education. This is clearly not the case as any parent or teacher will tell you. Children vary widely in their ability and interests. In the past teachers had problems teaching Higher and Ordinary level students together. Trying to fit a course and an examination to all students over the whole ability range inevitable means aiming at the lowest com-

mon denominator. (Childs P.E. 2019)

Peter also points out in the above article that a common level at Junior Cycle science "exposes the weakness in Irish curriculum development that everything is controlled by one body, the NCCA, which has not shown itself very response to criticism, e.g. by the ISTA and the Hyland Report on the new LC science specifications. No other body is allowed to design or approve or offer a school course or introduce a new syllabus". He also gives some examples of very innovative and imaginative courses that have been developed in other countries in order to give teachers a variety of curricula that they can choose to teach, e.g. the Salters courses and 21st Century Science course in the UK. He comments that "these were all the produce of what we might call private initiative, funded by charitable bodies, and competing in the marketplace with other syllabi for students. Even then teachers and schools have a choice of multiple science syllabi from four examination boards, giving schools great freedom to tailor their subject offerings to their own needs". (Childs P.E. 2019).

Peter was one of the first to express concern about the fact that chemical bonding is not mentioned on the Junior Cycle science specification and commented that "it is an essential idea in chemistry and one of the key ideas that should be covered in introductory chemistry". In an excellent article entitled *Chemists love making bonds*, (Childs P.E. 2015) he showed how this foundation stone of chemistry can be easily taught in an introductory chemistry course.

2. The international dimension of Chemistry in Action*!*

Chemistry in Action! keeps us informed of interesting research projects taking place at international level, e.g. the *TEMI* (Teaching Enquiry with Mysteries Incorporated) project; the *PROFILES* (Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science) project; the *Chemistry is All Around Network Project* to encourage lifelong learning in chemistry. All of these projects are EU-funded and have produced excellent resource materials to help chemistry teachers in the classroom. By highlighting these and many other international projects, Peter has made us aware of the fact that many of the chemistry topics we teacher are similar to those found in other countries and that many of the teaching strategies developed abroad can also assist us in teaching chemistry in Ireland.

3. Role of Practical work in teaching chemistry

There has always been a great emphasis in *Chemistry in Action!* on the important role that practical work plays in chemistry education. I can clearly recall outstanding demonstration lectures at ChemEd conferences by Randal Henly, John Daly and Victor Obendrauf as well as great chemistry workshops run by Brendan Duane and his PDST team. I am saddened to see evidence emerging from the recent ISTA survey (ISTA 2019) of some teachers expressing concern that the lack of clarity on what practical work should be carried out by students is leading to less practical work being done by students in the new Junior Cycle specification compared to the old syllabus.

This is my biggest frustration with the course - all of the practical work that we used to do I'm no longer doing but I haven't replaced it with anything.

The new JC science needs to address the lack of practical work and become clearer in the outcomes it wishes us to teach.

We as a department feel that we are doing less practical work than before.

(ISTA 2019)

This concern was also expressed in a letter written to the Irish Times (Childs P.E. 2020)

The lack of specifications for required practical work in junior cycle science appears to have led to a reduction in practical work in some schools, and a list of mandatory experiments was brought in previously to guard against this. (Childs 2020)

Clearly one of the great advantages of a mandatory list of practical work is that it ensures that all students carry out a minimum amount of practical work and this develop a common set of basic laboratory skills. I look forward to seeing this topic discussed in future issues of *Chemistry in Action!*.

4. Key articles on curriculum reform in Chemistry in Action!

Throughout the 40 years of publishing of *Chemistry in Action!*, Peter has always attempted to ensure that chemistry teachers in Ireland were kept in touch with developments in chemistry education at international level.

Through his editorials and articles in *Chemistry in Action!* Peter shows a fundamental understanding of the importance of carrying out curriculum reform in a structured and transparent fashion as recommended in the Hyland Report. In his very analytical comments on the Hyland Report (Childs P.E. 2014) Peter pointed out that curriculum development involves much more than listing learning outcomes and emphasised that there are four main components of the curriculum (Figure 1):

Content - what is taught

Pedagogy - how it is taught

Learning Outcomes - what it is expected that the student will be able to do

Assessment - how we assess students' learning to see if they have achieved the learning outcomes

In a subsequent editorial (Childs, 2015) entitled *How not to do curriculum reform* he summarises some lessons to be learnt from the way curriculum reform has been done in the past. Among the list of key lessons that he lists are:

Don't take account of what has been learnt from science education research over the past 30-40 years.

Don't pilot new ideas or content or methods and when there is a pilot study, don't wait for it to be fully evaluated before implementation.

Don't listen to the views of and criticisms by science teachers on the draft curriculum.

Don't issue sample exam papers until the last year of the course. (Childs, 2015)

Figure 1 The curriculum components (Childs P.E. 2014)

Peter has not confined his talents and expertise to writing solely for *Chemistry in Action!* and other academic publications. I was greatly impressed by Peter's ability to summarise and synthesise the key points of the current debate about curriculum design in Ireland in a letter recently published in the Irish Times (Childs P.E. 2020)

Prof Hyland showed in her 2014 report for the Irish Science Teachers' Association that a "syllabus" based only on learning outcomes (statements of what students should know), does not reflect best international practice and does not provide an adequate framework to allow teachers to teach the course.

It is like trying to build a house based only on its desired features, but without an architectural drawing and detailed plans. Teachers need a detailed syllabus, like the ones currently used, in order to teach effectively – this includes detailed content specification, depth of treatment for ordinary and higher level, suggested or mandatory experiments, as well as clearly stated learning outcomes.

If the same mistakes are made with the Leaving Certificate sciences that were made with the junior cycle science course, I believe it will have serious consequences for the health of STEM (science, technology, engineering and mathematics) education at second level, with a knock-on effect on STEM enrolment at third level.....

It is a recipe for disaster when teachers do not know what they are supposed to teach and to what depth, where each teacher becomes the arbiter of the curriculum.

This is not a good basis for a rigorous STEM foundation for future courses and careers.

The Government and industry rightly want to promote STEM courses and careers, to underpin our successful STEM-based industries.

Allowing outcomes-only Leaving Certificate science specifications to be introduced, without the necessary supporting materials – and against the advice of science teachers, science education specialists and scientists – is a recipe for future failure.

The foundations of a STEM-based economy are in real danger of being weakened and undermined.

(Irish Times 28/1/'20)

Peter has been a pioneer in using *Chemistry in Action!* to keep teachers informed of developments in chemistry education throughout the world. In this short article it is not possible to even give a summary of the many such articles but one article, in particular, springs to mind as being highly relevant to the development of new syllabi in Ireland. This article *What are the big ideas in Chemistry?* (Childs 2014) gives an overview of international studies on the range of fundamental concepts that should be contained in second-level chemistry courses. This is highly relevant to the present circumstances in which a new Leaving Certificate chemistry specification is being developed and should be recommended reading for all members of Leaving Certificate chemistry and Junior Cycle science subject development groups

Conclusion

Words fail me when I try to describe the enormous contribution that Peter Childs has made to science education in Ireland for over 40 years. I have always been in awe of his wisdom, common sense, boundless energy and breadth and depth of knowledge of chemistry possessed by him. Through his close contacts with practising teachers he has shown himself to have a crystal clear understanding of the concerns of teachers regarding curriculum reform. Through his lectures and writings he has openly demonstrated that he is on the side of teachers in their efforts to ensure that we have science curricula in Ireland that are comparable with international syllabi around the world. I know that Peter is a man of great faith and my greatest wish for him is that God will continue to bless him with good health so that we will all celebrate with him the 50th anniversary of the publication of *Chemistry in Action!* .

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Minimising energy loss in power transmission

Rory Geoghegan

Saving energy

Today we are becoming increasing aware of the need to make more efficient use of non-renewable energy resources. Traditional fossil fuel power stations are less than 40% efficient. In other words, more than 60% of the energy in the fuel is lost as heat to the environment. By combining district heating with power generation efficiencies of 60% to 80% can be achieved.

Before we can use it electricity must get to the end users. This is done through the transmission and distribution systems. Metallic conductors, such as copper and aluminium, carry the electric current to our homes and places of work. However, some energy is lost along the way as heat because even the best conductors have some electrical resistance. These losses have been reduced from about 13% in 1960 to about 7.5% in 2016. Can we reduce these losses even further?

Some background

In a letter dated 20th March 1800 Alessandro Volta (1745–1827) described the construction of a battery. He demonstrated his invention in Paris and news of the device spread quickly. For the first time a continuous electric current could be generated and scientists in Europe and America began experimenting with their own versions of the battery.

Before long they had discovered two effects of electric current:

- a heating effect and
- a chemical effect.

That year (1800) Nicholson and Carlisle decomposed water into hydrogen and oxygen — a process known as electrolysis. Around 1808 Humphry Davy discovered several new elements using electrolysis: potassium, sodium, barium, calcium and magnesium. It is somewhat surprising that the magnetic effect of electric current was not discovered until 1820.

Although the heating effect of electric current is more obvious it was not studied in detail until the 1840s. Part of the reason for this was the rather poor understanding at that time of the concepts of heat and energy — concepts that we take for granted today.

Joule's Law

James Joule (1818–1889) spent much of his life studying these two concepts. In 1840 he replaced steam engines in his brewery with recently developed electric motors. He began to study the heat loss from conductors. Even the best conductors (silver and copper) show some resistance to electric current and may become quite hot if they carry a large electric current.

In 1841 Joule discovered that the rate of heat loss from a conductor was proportional to its resistance multiplied by the square of the electric current. Today we express this relationship mathematically as follows: P = R × I 2 where P is the power (that is the energy produced per unit time), R is the resistance and I is the electric current. This was an important discovery.

An example

The electrical resistance of a piece of copper wire 100 metres long and 0.7 millimetre in diameter is approximately one ohm (R = 1 Ω). If this wire carries a current of 2 amperes then the heat loss per second is given by:

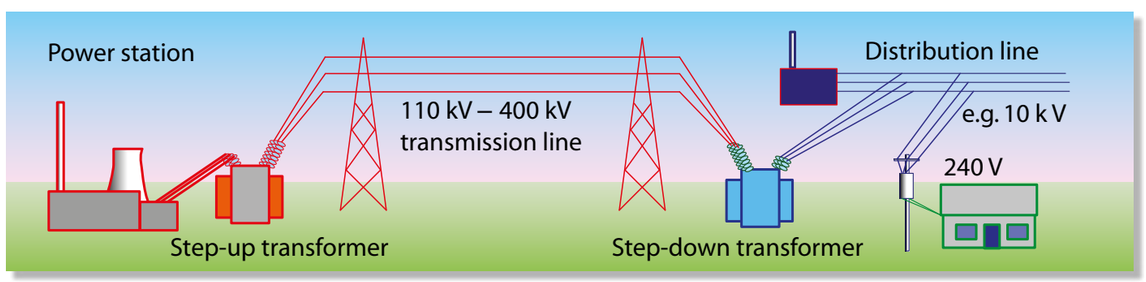
$$(P) = (1)(22)\ \mathrm{J/s} = 4\ \mathrm{J/s}.$$

If the length of the wire were ten times greater (i.e. 1 km), then the resistance would be ten ohms and the rate of heat loss would be (10)(22) or 40 J/s.

However, if the electric current were now made ten times greater the rate of heat loss would be a hundred times greater:

$$(10)(202) = 4000\ \mathrm{J/s}.$$

So, energy loss can be minimised by keeping the electric current low.



Electric power

The power transferred over electric cables depends on the voltage and the current. This can be written as follows: $P = V \times I$, where P is the power (that is the energy per unit time), V is the electric potential (or voltage) and I is the electric current.

In Ireland, and in Europe generally, the domestic electricity supply operates at about 240 volts. On this system a jug kettle with a current of 10 amperes would have a power of: 240 V × 10 A = 2400 watts. In other words, it would transfer 2400 joules per second to the water in the kettle. It would raise the temperature of a litre of water by more than half a degree every second, since the specific heat capacity of water is about

$$4200\ \mathrm{J\ kg^{-1}\ K^{-1}}.\ (2400 \div 4200 = 0.57)$$

Why we use high voltage in transmission

The main power transmission lines in Ireland use alternating current and operate at 110 kV to 400 kV. For simplicity let's assume that these lines used direct current. In that case, if a 220 kV line can safely carry a current of 1000 amperes then the maximum power that can be transmitted by it is 220 MW.

$$P = (220{,}000\ V) \times (1000\ \mathrm{A}) = 220{,}000{,}000$$
$$W = 220\ \mathrm{MW}$$

To transmit the same power at 110,000 volts would require a current of 2000 amperes; this would exceed the limit of that conductor. Power can be transmitted much more efficiently by using high voltage.

As we saw earlier, the energy loss is proportional to the square of the current, so by halving the current the energy loss would be reduced to 25% of it previous value. Distribution lines operate at lower voltage and so the total current in them is much greater than in transmission lines. Also, distribution lines are shorter but there are more of them. For this reason distribution losses are typically 3 to 6 times greater than transmission losses.

Quantity	Quantity Symbol	Unit	Unit Symbol	Meaning
Electric current	$I = Q/t$	ampere	$\mathrm{A = C/s}$	the rate of flow of electric charge in coulombs per second
Electric charge	$Q = I\,t$	coulomb	$\mathrm{C = A\,s}$	the electric charge transferred by one ampere in one second
Electric potential (voltage)	$V = E/Q$	volt	$\mathrm{V = J/C}$	the energy carrier by each coulomb; one volt is one joule per coulomb
Energy	E	joule kilowatt-hour	$\mathrm{J = N\,m}$ $\mathrm{kW\,h}$	energy is the capacity to do work, so work and energy have the same unit (the joule); 1 kW h = 3,600,000 J or 3.6 MJ

Choice of conductor

Apart from superconductors, silver is the best conductor of electricity, followed by copper (95% of the conductivity of silver), gold (69%) and aluminium (60%). If 1 kg of silver were made into a wire 1 km in length its resistance would be 168 Ω. If the same were done with 1 kg of copper the resistance would be 150 Ω. For gold and aluminium the resistances would be 440 Ω and 72 Ω respectively. The reason for this is that the area of cross section of the aluminium wire would be much greater than all the others because of its low density; this would give it the lowest resistance (and best conductivity) per unit mass. Aluminium is also the best choice in terms of cost. However, in practice an alloy of aluminium is used in transmission lines to give it greater strength, although it has about 10% more resistance.

Relative of size of silver, copper, gold and aluminium conductors of equal length and mass

Other losses

Energy can be lost in transmission in other ways, apart from resistive heating of the conducting cables. Alternating currents in power lines produce alternating magnetic fields which induce currents in nearby lines. These inductive effect can be reduced by separating the conductors as much as is reasonably possible.

Any pair of conductors that are near one another can act as a capacitor, storing energy in an electric field. In AC systems inductive and capacitive effects are unavoidable but they reduce the power delivered to the end user.

These effects can be largely overcome by using direct current transmission. However, stepping DC up or down is

Continued on page 53.

Online Teaching and Learning:

the Flipped Classroom and The Conical Flask

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

The pursuit of ideal teaching and learning methods has challenged educators for centuries. Many teaching methodologies and philosophies have been put forward on the most appropriate format for teaching. Didactic methods have been criticised for failing to emphasise practical problem solving and critical thinking (Brown, Collins, & Duguid 1989; National Science Teachers' Association 1993 [cited in Hannafin & Land 1997]). Are students actually learning effectively? How students learn best has always been a hot debate among educators. In what way has technology influenced teaching and learning? We live in a digital age and our dependency on technology has become very apparent with the recent lockdown due to Covid-19. Many students have at least two smart devices. Teachers are encouraged to ensure that notes and resources are placed online and every post-primary school has or is implementing a digital policy. *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. In recent times there has been considerable discussion on where the student is in respect to learning and teaching. Is the learning student-centred? Is the teaching student-centred? (Hannafin & Land 1997). This shift in thinking and questioning is a very relevant one because as teachers we often ask ourselves "why on earth do they still not know the material? I've taught it twice now". In recent times there has been a drive to promote student-centred learning (SCL) and, as a result of the Bologna Process (1999), there is now an increased emphasis on learning outcomes in educational systems throughout the world.

What is student-centred learning and how does it differ to traditional direct methods of teaching?

SCL, while being discussed regularly now, is not an overly new concept. Gibbs (1995) describes student–centred courses as those that emphasise: learner activity rather than passivity; students' experience of the course outside the institution and prior to the course; process and competence, rather than content; where the key decisions about learning are made by the student through negotiation with the teacher. O' Neil and McMahon use a simple yet communicate effective image to the contrast between TCL and SCL.

Teacher-centred Learning	Student-centred Learning
Low level of student choice	High level of student choice
Student passive	Student active
Power is primarily with teacher	Power primarily with the student

For many years, SCL was seen as idealistic and simply not feasible in an everyday post-primary classroom. There is only one teacher present, the numbers of students in our classes is increasing and if anything there has only been an increase in responsibility on teachers. Teachers today are expected to be educational strategists, akin to war strategists, that are capable of using the correct teaching methodology, applying the most appropriate type of questioning, implementing differentiation techniques while managing discipline and performing like the sage on stage. Teacher burnout in Ireland is at an all time high (Foley and Murphy 2015). There are a number of factors contributing to this such as increased demands, lack of a well-defined Junior Cycle syllabus and expectations from management bodies in schools. In truth, most teachers realise that students are very capable when they decide to work for it, but we are somewhat stuck in a rut. To adopt a SCL approach, we must first be in a position to allow the student to learn by himself or herself. This requires time and resources. It is hard for teachers to prepare resources when most of us do not know the depth of treatment for Junior Cycle science topics. The question remains, can SCL reduce pressure on teachers and is it actually feasible in a secondary school classroom?

The Flipped Classroom and The Conical Flask

The flipped classroom is a novel approach to implementing SCL. There are many definitions and ideas of the flipped classroom but the description by Tucker (2012) is among

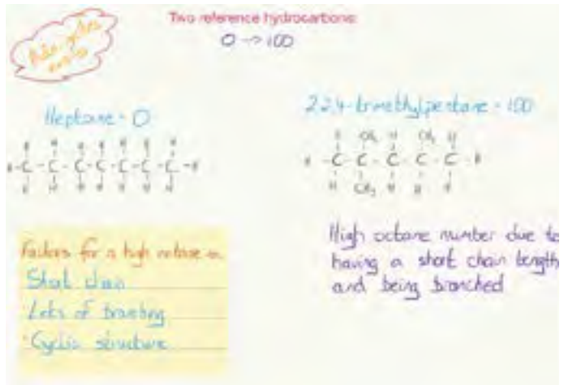
the clearest and best:

> While there is no one model, the core idea is to flip the common instructional approach: With teacher-created videos and interactive lessons, instruction that used to occur in class is now accessed at home, in advance of class. Class becomes the place to work through problems, advance concepts, and engage in collaborative learning. Most importantly, all aspects of instruction can be rethought to best maximise the scarcest learning resource time. (Tucker 2012)

Student-centred learning has gained much traction in recent years due to improvements in technology. Technology has shaped our classrooms and it is more than capable of shaping our teaching methodologies for the better if we let it. In this article will discuss my personal experience in adopting a flipped classroom approach and my transition to incorporating a student-centred learning approach in my teaching using the website www.theconicalflask.ie which I have created.

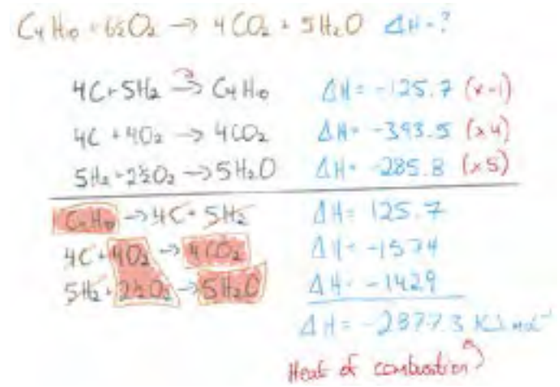
The use of online video lessons and tutorials are one of the focus points in the flipped classroom. Many maths teachers use the Kahn Academy as a resource for students to use at home to learn about a particular topic. This online video resource has a serious shortfall in that it is not specific to the Irish maths curriculum. There are currently very few resources available that are specific to the current Irish syllabi. The Conical Flask is an online resource tailored for J.C. science students and L.C. chemistry and biology students. It is primarily designed for L.C. chemistry students and teachers. There are a number of reasons for the creation of the website, one of them asking can the website be used for teaching chemistry? And if so, what level of success can be achieved? For the past two years I have been using and upgrading the website where appropriate. If students are to be encouraged to learn by themselves then there needs to be a student-friendly resource available to them. Books are simply not enough for students to rely on these days.

Initially the website only featured videos, but feedback from teachers and students has meant that the website now includes notes, exam specific videos, online assessment and interactive presentations. Online video lessons on their own are not enough. Admittedly I did not dabble a huge amount in flipped classroom practices in the first year of the site, and while my students and I did not see many benefits of it, I could see the potential if used correctly. The second year, I began using the flipped classroom weekly and have seen far more benefits. Not every topic in chemistry is appropriate for students to learn by themselves but many are suitable. For instance, I never teach the topic of octane numbers and the different methods of increasing the octane number in class. I expect students to



study this online and in their textbook. However I do assess the topic in class. Students do the work at home and quite often they do additional work also. Homework is now more meaningful. Students have the option to watch a video lesson, and use the presentation or the notes. Often they do all three coupled with the online assessments. In addition, students rarely 'forget' to do their work as they know they're going to be assessed on it the next day. An important factor is to realise that the role of the teacher is not diminishing or being replaced but hopefully being enhanced.

The flipped classroom comes under the umbrella of 'blended learning' which 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). The data collected so far indicates that it is certainly feasible for teachers to adopt the flipped classroom approach in their teaching. There have been mostly positive responses cited in feedback received from teachers such as 'moving through the course quicker', 'more time for assessment and experiments' and 'improved student confidence in chemistry'. I certainly have a greater opportunity for more active forms of learning. One of the biggest areas of improvement is the maths side of chemistry. This year I let my 5th year students attempt a heat of combustion equation at home without me even describing the question or solution. I gave them the final answer but no workings out.



They had model video lessons etc and almost every one of the students got the correct answer. Arguably they are a good class but when I spoke to them about it they said that they enjoyed the challenge of it. Many of them developed notes or answer keys to help solve the question. I'm told that there was a lot of discussion and videos in their chemistry group chat. I genuinely thought it would be a disaster so I was astonished at the level of student engagement. My workload is also decreasing as we have time to mark homework during class opposed to me doing it at home.

Covid-19 and The Flipped Classroom Clarification

Some educational articles state that this pandemic is increasing the use of the flipped classroom and other online approaches for student-centred learning. However this not is not strictly correct. The flipped classroom requires both learning at home and traditional teaching in school. Learning does not strictly have to be online but the use of online resources certainly makes things easier. The lack of a classroom setting with a teacher means that students are simply learning online opposed to learning by means of the flipped classroom.

Closing remarks

While online courses are popular among college students we must remember that these students are adults. We cannot expect the same mindset from teenagers. Secondary school students need guidance however they are more capable of learning for themselves than we give them credit for. Student-centred learning can be achieved, providing that there are dedicated resource from which students can learn.. The teacher is crucial in assessing and deepening the students understanding of the topic being taught. In other words, the teacher is irreplaceable and is an integral part of the student learning experience.

Author's note

The Conical Flask was designed, created and developed by me. It is a free website with over 3,000 resources attached to it. My only form of quality control is by means of student and teacher feedback. I am asking that if you see something that may not be accurate or a technical issue etc to please email me at ryanconicalflask@gmail.com.

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AstroLands: Exploring the Universe from Birr

The AstroLands Education Programme is based at the I-LOFAR Education Centre in the Irish Midlands. Located in Birr Castle Demesne, Co Offaly, home to the historic 19th Century Leviathan Telescope and the 21st Century I-LOFAR, a visit provides a unique opportunity to discover more about Ireland's scientific past, as well as delve into the new discoveries at the forefront of astronomy today.

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Pioneers of Science Education #9 Gordon Van Praagh (13/3/1909 30/9/2003):

Christ's Hospital's role in transmitting heurism

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 populariser 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 did Br. James Dominic Burke did in Cork (PoSE #6), 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. In England Christ's Hospital school was important as a test-bd in putting Armstrong's ideas into practice, and through the work of Gordon von Praagh (PoSE#9) learning by discovery found its way into the Nuffield chemistry courses.

Introduction

Anyone who has heard of the Nuffield science projects in the 1960s will have heard of Gordon Van Praagh. He was a member of the chemistry team which produced the Nuffield O-level chemistry course, and later the A-level course, and as such was influential in ensuring that Henry Armstrong's heuristic ideas were resurrected as the underlying philosophy of the new course (see PoSE #7). Armstrong's ideas were most fully worked out and implemented with large classes at secondary level in Christ's Hospital School, Horsham, of which Armstrong was a member of the Council of Almoners for forty years. This was first through his disciple Charles Browne, whose work was continued by John Bradley and then pre-eminently by Gordon Van Praagh. Through example and their writings, these chemistry teachers kept the flame of heurism burning, even when it fallen out of fashion and even into disrepute. The embers of heurism burst into flame again in the Nuffield science projects and continue to burn brightly in the 21st century in the emphasis on inquiry-based science education (IBSE).

Edgar Jenkins wrote about the wide-ranging influence of Christ's Hospital (Van Praagh, 2003, p. 34). *"The influence of the approach to science teaching associated with Armstrong, Browne and Christ's Hospital was not confined to England and Wales. In Armstrong's own time heuristic ideas were taken up in Japan and, a century later, all contemporary world-wide attempts at school science curriculum reform take it as given that pupils must spend some time in investigative work as an integral component of their school science education. If the heuristic intention is frequently frustrated, not least where resources are scarce or non-existent, the commitment to 'finding out' in school science remains strong. That perhaps is the enduring legacy of the work that Charles Browne and his successors promoted at Christ's Hospital."*

In this article I will look mainly at the work and legacy of Gordon Van Praagh, but I will also touch on the contributions of Charles Browne and John Bradley and the role of Christ's Hospital.

In his obituary of Van Praagh in *The Guardian*, Martyn Berry wrote: *"It is unusual for anyone to remain enthusiastically and vigorously active in their chosen field for 70 years, but the teacher and chemist Gordon Van Praagh was signing copies of his latest book about science education just ten days before his death, at the age of 94."* (Berry, 2003)

Not many teachers, let alone science teachers, warrant obituaries in national newspapers like *The Guardian* and *The Times*, but Gordon Van Praagh did, and that he did is a measure of his influence and standing in the world of science education.

Armstrong's heurism at Christ's Hospital

Henry Armstrong (PoSE #7) looked for a test-bed for his educational ideas in schools, which he had already tried out in his own college. They were tried out in St Dunstan's College, Catford but particularly in Christ's Hospital School. Christ's Hospital School was a fee-paying private school initially located in London but later moving in 1902 to a custom-built campus in Horsham, Sussex. Armstrong became involved with the school when he was asked to join the Council of Almoners (the school's governing body) in 1891, representing the Royal Society. From the start he served on the Education Committee and he was later its Chairman. He was to remain in this role for over 40 years until his death. Christ's Hospital is still proud of its long science teaching tradition (see https://www.christs-hospital.org.uk/about-ch/ch-pioneering-science-education/). Armstrong, with Charles Browne, had a major input into the design of the science school at the new site when the school moved from London to Horsham. When these opened in 1902 they were the best science teaching facilities of any school in England.

Charles Browne (1865-1961) took an external degree in science at the Birkbeck College, University of London in 1893 at the age of 28, after being an unqualified teacher from the age of 15, and Armstrong was his chief examiner. He later in 1897 went to be a research student under Armstrong at the Central Technical College for a year, from where he went to teach Robert Gordon College, Aberdeen in 1898. He was dissatisfied by the didactic approach taken there, having seen Armstrong's ideas in practice in London. Armstrong was influential in recruiting Browne as science master at Christ's Hospital in 1899, where he stayed until his retirement in 1926, and it was Browne who introduced Armstrong's ideas into the teaching of science into Christ's Hospital. (Browne, 1966; Van Praagh, 2003)

Figure 1: An early picture of Christ's Hospital, Horsham

William Fyfe was headmaster from 1919 and he coined the term '*Virus heuristicum Armstrongii*' to describe the effect of Armstrong's ideas in the school, which spread beyond science into technology, art and the humanities. He said of Browne: *"Browne organised the teaching of science, trained his assistant masters and inspired his pupils at Christ's Hospital for twenty-seven years. His appointment was one of Armstrong's most notable services to the school."* (Browne, 1966, p. xi) Armstrong had tried out his ideas at home with his children and Browne was invited to see what they were doing. Later he said: *"The work of Armstrong's three children made a great impression on me. It was rational and simple, it appealed to them as important and worthwhile, with a well-defined purpose. It illustrated very well the possibilities of training in scientific methods from the earliest stages as well as the proper function and attitude of the teacher. Then and there I decided to adopt the scheme for the preliminary science course at Christ's Hospital in London, modifying it to meet the very different and more difficult circumstances of working under ordinary school conditions with large classes of some thirty boys."* (Browne, 1966, p. 13)

In his notebooks Browne describes his approach in more detail (Van Praagh, 2003, p. 9).

Figure 2: An early heuristic science lesson at Christ's Hospital (Source: Christ's Hospital)

"The courses he envisages are based on practical work by the boys, not formal lessons; work benches, not class rooms. The boys must have a reason for doing something, based on curiosity to solve by experiment a problem, clearly understood and simple enough to require very little experience and no elaborate apparatus. The teacher is to afford guidance and suggestion mainly by questions – no telling – and should adopt the attitude of a co-enquirer, not an authority… These and similar notes … reveal a man with a faith in his mission and determination to succeed … There is no doubt that the heuristic approach makes greater demands on the forethought and patience of the teacher than the formal, didactic method aptly termed chalk and talk'."

Where did Browne get his pedagogy from? He was exposed to Armstrong's teaching methods at the Central Technical College and during his visits to see Armstrong's children, and his few months teaching in Aberdeen, where he saw the poverty of teaching based only on cramming facts.

On retirement in 1926 at the age of 60 he went to be a tutor at the London Day Training College (now the London University Institute of Education) where he taught from 1926 to 1935. Gordon Van Praagh trained to be a chemistry teacher in 1931-32 under Browne where Van Praagh imbibed his heuristic ideas. In 1933 Van Praagh was appointed to teach science at Christ's Hospital and remained there until 1964, minus a period from 1943 to 1946 when he did scientific war work. In a real sense Armstrong passed on the torch of discovery learning to Browne, who in turn passed it on to Van Praagh.

John Bradley (1908-1967) also taught at the school after Browne from 1935 to 1938, overlapping with Gordon Van Praagh (1933 to 1964) and he also adopted the heuristic method enthusiastically. Bradley wrote a series of articles in the *School Science Review* from 1933 to 1967, in which he explained how a heuristic approach could be incorporated into a chemistry course at school, using what he called 'heuristic patches.' He later went on from 1945 to become a science education tutor at the University of Hull, but he seems to have largely vanished from the history of

science teaching. Bradley attacked the new Nuffield science courses as not being heuristic enough!

Edgar Jenkins (Van Praagh, 2003, p. 32) gives an assessment of Browne's influence.

"He was as seminal influence on all those whom he taught, whether pupil or student, and he helped to promote the view that any science teaching worthy of the name must allow pupils to spend at least some of their time in investigative work appropriate to their age and abilities."

Gordon Van Praagh's career

Table 1 gives the main dates in Van Praagh's life. He was active in science education from 1933 when he moved to Christ's Hospital until his death in 2003. He was educated at University College School, London and then did a BSc in chemistry at University College in 3 years. After a year's research there he moved to Cambridge to complete a PhD with Sir Eric Rideal. He decided he wanted to be a teacher and so he enrolled at the London Day Training College, where his chemistry tutor was Charles Browne. After a short time at Perse School Cambridge he moved to Christ's Hospital, Horsham in 1933 where he remained (on and off) until 1964. He was absent on war duties from 1943 to 1946. From 1961 he was seconded to the Nuffield Foundation Science Teaching Projects, fulltime from 1964 to 1967. He made a major contribution to the O-level Chemistry course (Figure 3), much of stage 1 coming from his influential book *Chemistry by Discovery*, and also contributed to the A-level chemistry course.

1909	Born 13th March
1925-29	BSc, University College, London
1930-31	PhD, Cambridge
1932	London Day Training College
1933	*An introduction to the calculus*
1933-64	Christ's Hospital (less war service 1943-46)
1950	*Physical Chemistry, Experimental and Theoretical*
1949 (1960)	*Chemistry by Discovery*
1961-67	Nuffield Science Teaching Project
1967	Nuffield O level Chemistry books
1967-97	Worked overseas for CREDO then CEDO
1969	*The Experimental Basis of Physical Chemistry*
1973	*H.E. Armstrong and Science Education: Selections*
1976-80	Senior Lecturer in Education, University of Penang, Malaysia
1988	*Seeing it Through*
2001	*Encounters with stuff*
2003	*A fire to be kindled*
2003	Died 30th September

Table 1: Chronology of Gordon Van Praagh's life (books in italics)

Van Praagh was encouraged to write a book describing the chemistry course at Christ's Hospital and this became the influential *Chemistry by Discovery*, first published in 1949, much of which reappeared in the Nuffield chemistry course. In the book Van Praagh said:

"The course has been evolved from the heuristic method of teaching science, according to which the pupils were not to be taught from textbooks or from the blackboard but were to be allowed to discover science for themselves by the wayside and in the laboratory. A wholehearted adherence to such a method is not practicable today, even if it were desirable, but the heuristic method embodied certain ideas which have widely influence the teaching of science for good, and this course attempts to recapture these and adapt them to present circumstances." (Van Praagh, 1960, Preface)

In 1954 Van Praagh spoke about the legacy of Armstrong and Browne at Christ's Hospital (Van Praagh, 2003, p. 13).

"A frequent theme of many of Her Majesty's Inspectors is that pupils should learn science at first hand in the laboratory, not only from text-books, and this emphasis permeates the vacation course they run for science teachers. However, it would be wrong to give the impression that the heuristic approach is practised today as Charles Browne practised it earlier in the century. It is an attitude that has survived, a manner of approach to science teaching – the realisation of the importance of allowing the pupils to take part in a quest. The emotion aroused by some little discovery makes memory effortless and releases energy which carries the explorer on to fresh fields of investigation."

The evidence of the success of science teaching in Christ's Hospital is shown by the large number of Oxbridge scholarships won by pupils, but more so by the large number of successful scientists, engineers and doctors produced by the school, of whom Barnes Wallis (of the bouncing bomb) is a good example. Many examples are given in the book *A fire to be kindled* (Van Praagh, 2003).

Nuffield Science Projects

Figure 3: Cover of the Nuffield Chemistry Teacher's Handbook

The Nuffield Foundation science projects, which started in the early 1960s, have had a disproportionate influence on the way science is taught in UK schools and around the

Figure 4: In 2002 Dr Van Praagh returned to Christ's Hospital to teach a 1950s science lesson (Photo Christ's Hospital)

world. Staring in 1962 the Nuffield Foundation has funded the development of 27 science courses (see https://www.nuffieldfoundation.org/curriculum-projects#Science). The first courses to be developed were O-level (age 11-16) Biology, Chemistry and Physics. IN 1962 the Nuffield Foundation agreed to fund the development of new courses in science, based on requests from the Science Master's Association (forerunner of the Association for Science Education) and distinguished academics like Lord Todd. They agreed to give £250,000 (in the end spending £1.5 million, £30 million in today's money). This allows the creation of fulltime teams in each subject from 1963 and Gordon Van Praagh retired from Christ's Hospital to join the chemistry team. His book, *Chemistry by Discovery*, first published in 1949, had a major influence on Stage 1 of the chemistry course. The course consisted of a number of publications, but not a conventional text book, and two films 'Chemistry by investigation' and 'Exploring chemistry'. The materials were trialled in 67 schools and then revised, and were finally published in 1967. New examinations were devised in spirit with the new courses. Courses were run for teachers to introduce them to the new course and the discovery approach. The teams developed new experiments and also designed new pieces of apparatus to teach the new course, for example, top pan balances and gas syringes. The course was revised 11 years later. The approach taken with the Nuffield science projects is a good illustration of how curriculum development in science should be done. The publications included *The Sample Scheme*, *Laboratory Invetsigation Sheets*, a *Teacher's Handbook*, *Background Readers* on chemical topics and a *Data Book*.

In his appreciation of the Nuffield science projects Jonathan Osborne (Osborne, 2012, p. 6) says this about the influence of Van Praagh.

"[Nuffield] have supported the idea that there has to be a better argument for the goal and purpose of science education. In short that there has to be more to science than content. You see this in the writings of Gordon Van Praagh, an early Nuffield pioneer, who in describing a lesson on the oxidation of copper says that he begins his lesson not by stating the bare facts – something which is so mind numbing to young students – but by asking a question – why does copper go black when it is heated? What could this be and why?"

Starting with a question rather than a statement is the essence of inquiry, as in the TEMI project, and this emphasis on guided discovery popularised through the Nuffield projects, went on to inspire curriculum development in many countries e.g. in East Africa (see below). Robin Millar (Millar, 2004) gave this assessment of the Nuffield projects and guided discovery.

"In the UK, the idea of 'the pupil as scientist' underpinned the influential Nuffield Science Projects in the 1960s, which initiated a period of science curriculum innovation and reform that has continued to the present day. Though less prominent in subsequent developments, it has remained an influential notion in the UK and elsewhere. It is not difficult to see why it is attractive to science educators. Encouraging students to pursue their own enquiries taps into their natural curiosity. Finding things out for yourself, through your own efforts, seems natural and developmental, rather than coercive, and may also help you to remember them better. It seems to offer a way of holding up evidence, rather than authority, as the grounds for accepting knowledge. It is enabling, rather than dismissive, of the individual's ability, and right, to pursue knowledge and understanding for her/himself. Indeed one of the great cultural claims of science is its potential as a liberating force – that the individual can and may, though his or her own interaction with the natural world, challenge established tradition or prejudice, by confronting it with evidence. An enquiry-based approach may also encourage students to be more independent and self-reliant. In this way it supports general educational goals such as the development of individuals' capacity for purposeful, autonomous action in the world."

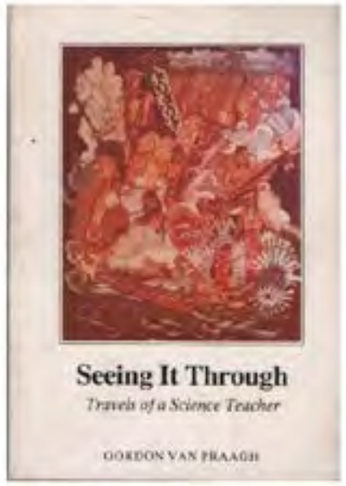

Figure 5: Cover of Van Praagh's autobiographical book, Seeing it through (1988)

Overseas work

When Van Praagh finished working for the Nuffield Foundation in 1967 he was encouraged to apply for a job with the Curriculum Renewal and Educational Development Overseas (CREDO), later called the Centre for Educational Development Overseas (CEDO). This led him to work for many years in science curriculum development overseas, from East Africa to East Asia. His first project was in East Africa from 1967 in the East African School Science Project (EASSP), which produced an O-level science project in chemistry, biology and physics modelled on the Nuffield courses but designed for the East African countries – Kenya, Uganda and Tanzania, which at that time were in a federation and had a common examination system. I worked in Uganda at that time at Makerere University, Kampala in the Chemistry Department, and I met many of the teachers involved in this project, although I can't remember meeting Van Praagh. A new A-level chemistry syllabus was also introduced in 1971 and this led to my involvement in school chemical education, producing a teacher's newsletter (*A Modern Approach to Chemistry*), the precursor of *Chemistry in Action!,* and setting A level chemistry papers for a couple of years.

In his books *A Fire to be Kindled (*Van Praagh, 2003) and *Seeing it Through* (Van Praagh, 1988) Van Praagh describes his overseas adventures. In Malaysia his work was recognised by the award of the equivalent of a knighthood. He also wrote a popular science book *Encounters with Stuff* (2001), where he discusses the importance of various types of stuff (his word for chemicals), from paper to glass, diamonds to copper. It is sprinkled with his limericks including this one:

We live in a world full of stuff

I have chosen some bits – just enough

Which I'll use to display

In a light-hearted way

That Chemistry's fun – and not tough.

Conclusion

In his appreciation of Van Praagh in *School Science Review*, Mike Nott called him a 'Firestarter Extraordinaire' from Plutarch's quote "A child's mind is not a vessel to be filled but a fire to be kindled". In it Nott says (Nott, 2003, p. 125); *"He taught chemistry and developed, preached and disseminated worthwhile chemistry education from the 1930s to the end of his life through his teaching, his textbooks, the Nuffield Science Teaching Projects, his overseas work, and not least his constant correspondence with a worldwide network of friends, acquaintances and colleagues in science education."*

His educational philosophy was described *Adventures with Stuff* (Van Praagh,2001, p. 168) in advice to prospective science teachers:

"Your job is to do all you can to help your pupils to learn, to stimulate their interest, encourage them to want to know and understand more, provide them with the facilities to do it, and be there to encourage, explain and help, and finally give tests to enable them to identify their weak points."

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About the Author

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Continued from page 43.

more costly and so DC transmission is economical only for long, uninterrupted cables such as the sub-sea East–West Interconnector between Ireland and the U.K.

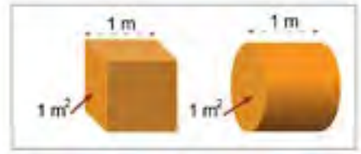
Skin effect and corona discharge

When large conductors carry large alternating currents (e.g. 2000 A) much of the current is confined to the outer layer or 'skin' of the conductor. The skin depth depends on the material and on the frequency. At 50 Hz the skin depth is around 8 mm for copper and around 10 mm for aluminium. The net effect is an increase in the apparent resistance of the conductor. The effect is reduced by the use of multicore cable; such cable is also more flexible and durable.

At very high potentials (e.g. 500 kV) the air near the cable may become ionised and capable of conducting electric current to other cables or to pylons. Apart from a loss of power the resulting 'arcing' or 'corona discharge' creates noise and electromagnetic interference and may damage cables and insulation. The larger the diameter of the cable the less the effect. The corona effect is also reduced by the use of multiple smaller cables (typically four) instead of one large cable. Their larger surface area keeps them cooler and they are commonly used today in transmission lines (below).

Exercise

1. The resistivity (ρ), or specific resistance, of a material is the resistance of a uniform sample of the material of unit length and unit cross section, i.e. 1 cubic metre. (In practice this would be virtually impossible to measure directly.) The resistivity of copper is 1.68 × 10^{-8} Ω m.



Show that if a cubic metre of copper were formed into a uniform wire with a cross section of 1 mm^2 it would be 1000 km in length and its resistance would be 1.68 × 104 Ω or 16.8 kΩ.

2. The table shows the densities of silver, copper and aluminium. Show that the volume of one kilogram of these metals would be 95, 112 and 377 cm^3 respectively.

Silver	10.49 × 10^3 kg m^{-3}
Copper	8.96 × 10^3 kg m^{-3}
Aluminium	2.65 × 10^3 kg m^{-3}

3. The table shows the resistivities of silver, copper and aluminium. If one kilogram of each of the metals above were made into a one kilometre wire show that:

Silver	10.49 × 10^{-8} Ω m
Copper	1.68 × 10^{-8} Ω m
Aluminium	2.65 × 10^{-8} Ω m

(a) their cross sections would be 9.5, 11.2 and 37.7 mm2 respectively
(b) their resistances would be 1.67, 1.50, 0.703 Ω respectively. ($R = \rho\, l\, /\, A$)
How does this illustrate the advantage of using aluminium as a conductor for electricity transmission?

Source

This article is based on one of the many lessons that you can download from Science and Technology in Action: www.ista.ie. *More than 200 lessons are available on topics in biology, chemistry and physics. Each lesson is accompanied by student excercises and learning resources.*

Crossword

Randal Henly

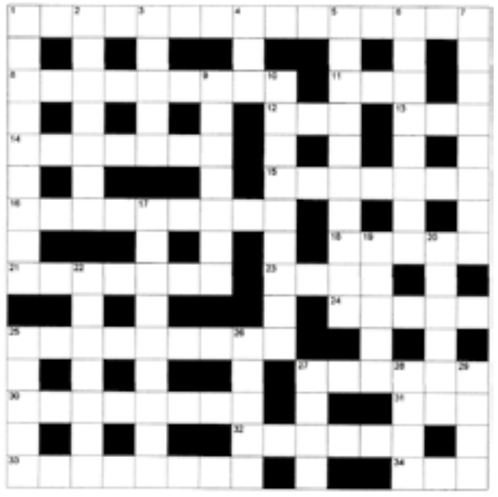
SCIENCE CROSSWORD 86

Clues Across

1. Receivers of microwaves (9,6)
8. 1×10^{-9} m (9)
11. It propels a boat making use of Newton's 3rd law(3)
12. The hard fruit of some plants (3)
13. Wet earthy material found in Bermuda (3)
14. The top part of a Bunsen burner (7)
15. The region centred on the islands of the Pacific Ocean (7)
16. Animals that eat food of both animal and vegetable origin (9)
18. School exams held usually in February (5)
21. Contractible bundles of fibrous tissue in animals (7)
23. Gemstone consisting of hydrated silica (4)
24. Rotatable rigid body for transferring movement (5)
25. Easily set on fire (9)
27. In the southern hemisphere, it's the period from December to February (6)
30. The action of setting something on fire (8)
31. Another right answer! (3)
32. A tropic or a disease (6)
33. A salt of the acid in grapes (8)
34. Our nearest star (3)

Clues Down

1. Noise made when an aircraft exceeds the speed of sound (5,4)
2. A stretching force (7)
3. It can be either the SI unit of luminous flux or the cavity within a sac or gland (5)
4. Product obtained from the distillation of coal (3)
5. A line on a map drawn through places at equal temperature (10)
6. Component of a complex vibration that is a multiple of the fundamental's frequency (8)
7. Early tellers of time during the day (8)
9. Through these nozzles, air is blown into the blast furnace; yes true ! (7)
10. Optical instrument introduced into the body to view internal parts (9)
17. Electrical measuring instrument (9)
19. Fuming sulphuric acid, containing extra SO_3 (5)



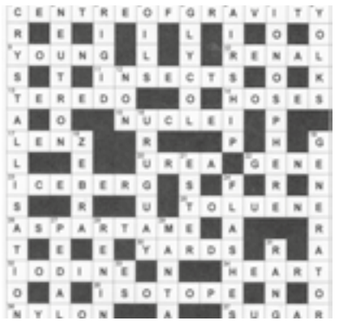
20. Found on a magnet or in the zoo (6)
22. Instrument that examines the body using radiation, MRI or ultrasound (7)
25. Hard grey rock, used for ancient weapons or nowadays in some kinds of lighter (5)
26. Kind of spear used by mounted warriors in Medieval warfare (5)
27. Opposite/adjacent (4)
28. The red planet (4)
29. Precipitation (4)

€20 Prize

First ISTA member drawn from correct emails entries received by Monday, June 1st will win €20. Send your answer to: snjnfogarty@gmail.com via your ISTA registered email address.

Winner - November 2019

Well done to, Helen Murray Rockwell College, whose name was first drawn from the correct entries received by the closing deadline. The correct solution to Novembers crossword No. 85 is given below.



Continued from page 1.

Aodhagán will be updating it over the summer.

I would personally like to thank our outgoing Hon. President, Mr Gerald Fleming for his contributions to the journal, his articles were always inspiring and enhanced the journal greatly. I must of course welcome our new Hon. President, Prof. Luke O'Neill to these pages and indeed his first reflection for the journal is an excellent piece capturing the importance of science education in this current crises. We also have an article on the Covid-19 virus from Prof. O'Neill in this issue. I look forward to working with him during his term as President.

One might be forgiven for thinking that our AGM held last February (report inside) is of little significance in the light of current events. However it is just because of what has happened that its significance is so important. We have seen a response to this crisis that has worked well so far largely because of our education system that has not only produced the doctors, nurses, virologists, experts etc. that are at the front line but also the public who have, to an outstanding degree, followed the advice given to them. This is a reflection of the success of our education system and in particular our science education that has led to a population that accepts and values the advice of scientific experts. So the education system as it was worked well and delivered a scientific literate population that has produced the people necessary to fight the crisis as well as the people willing to heed the advice given. We must be careful when tinkering with that system not to destroy its good points. Change and improvement is always necessary and there are definitely improvements in the new Junior Certificate specifications, where the incorporation of 'the nature of science' as an integral part running throughout the course goes a long way to help improve the understanding of science among our young. Hopefully the NCCA will take note, as they say they will, of the motion proposed and agreed at the end of the AGM and make sure that the next science syllabi work as well as previous ones clearly have.

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