

OLLSCOIL NA GAILLIMHE UNIVERSITY OF GALWAY

Outreach-Conscious Science Teaching for STEM Advancement



Dr. Veronica McCauley

Associate Professor of Science Education School of Education, University of Galway, Ireland

Keynote for New Perspectives in Science Education Conference, 2023

STEM Deficit

- Research shows that we are still facing a STEM-Skills Gap
 2 items to consider:
- The fastest growing occupations require STEM skills to remain a top competitor in a global marketplace
- Students are greatly impacted by their teachers. Even if students do not pursue careers in STEM, they benefit from the communication, collaboration, critical thinking, and problem-solving skills gained from STEM education.



(Smith and Twaddle, 2023)



- Over decade ago, an extensive survey was carried out across the island of Ireland and revealed that there were diverse stakeholders administering Science Outreach, but predominantly carried out by Universities to Schools.
- While Science Departments were negotiating access to classrooms, an obvious partner was being overlooked...



(Davison, Domegan, McCauley & McClune, 2008)



 Who is best placed to influence and inspire our future public to engage in science and bridge the STEM-Skills gap?

2



 Who is best placed to influence and inspire our future public to engage in science and bridge the STEM-Skills gap?

Teachers!

• Teachers are one of the lead influencers of student behaviour (Inda-Caro et al., 2019; Smith and Twaddle, 2023)





This raises the question...who is best placed to influence teachers?





This raises the question...who is best placed to influence teachers?

Teacher Educators!

So,

 when thinking of New Perspectives in Science Education, let's consider how Teacher Educators can inspire

Outreach-Conscious Teachers!



Ollscoil na Gaillimhe University of Galway



STEP1: Deliberate discussion about outreach-conscious teaching, and value of a teacher's influence.

STEP2: Educate on evidence-based science teaching methods that engage students in science

STEP3: Educate on inclusive teaching methods that broaden the reach of science Science Capital Teaching Approach

STEP4: Seek opportunities to engage teachers with industry and universities, so they have personal experiences of future careers.



STEP1: Deliberate discussion about outreach-conscious teaching, and value of a teacher's influence.

STEP2: Educate on evidence-based science teaching methods that engage students in science

STEP3: Educate on inclusive teaching methods that broaden the reach of science Science Capital Teaching Approach

STEP4: Seek opportunities to engage teachers with industry and universities, so they have personal experiences of future careers.



STEP1: Deliberate discussion about outreach-conscious teaching & valuing a teacher's influence.

- The influential role of a science teacher is herculean.
 Each student science teacher engages with a few hundred pupils during their training; and a few thousand pupils in their career
- A teachers' focus is often entwined in the immediate, supporting student well-being in the moment, supporting students through a curriculum. But, what if it were also to promote science consciously? As an outreach-conscious teacher?



The Teacher Effect



Ollscoil na Gaillimhe University of Galway

STEP1: Deliberate discussion about outreach-conscious teaching, and value of a teacher's influence.

STEP2: Educate on evidence-based science teaching methods that engage students in science

STEP3: Educate on inclusive teaching methods that broaden the reach of science Science Capital Teaching Approach

STEP4: Seek opportunities to engage teachers with industry and universities, so they have personal experiences of future careers.



STEP2: Educate on evidence-based science teaching methods that engage students in science





STEP2: Educate on evidence-based science teaching methods that engage students in science





STEP2: Hooks: an evidence-based science teaching methods that engages students in science

Hooks represent an instructional method used at the beginning of class to grab attention, foster interest, and create engagement

a.k.a., Anticipatory Sets....



Photo/Image

Short story

Video





Realia (objects as teaching aids, or a Demo)

(McCauley et al., 2015; McHugh & McCauley, 2016; McHugh & McCauley, 2020; McCauley & McHugh, 2021)



STEP2: Hooks: an evidence-based science teaching methods that engages students in science

 Hooks: Micro-pedagogical injections that over time move students towards a more enduring, sustained interest in science





Hidi and Renniger's (2006) Four phase model of Interest Development

Situational Interest (external triggers)



Personal Interest (individual sustained)

Teacher's Role:

engaging students in active learning: investigations/debates/projects/ solving puzzles nurturing interest, encouraging them to ask deeper/curious questions, challenge them further into their topic of interest



Hooks: Interest theory: Engage in Science

Hidi and Renniger's (2006) Four phase model of Interest Development

Situational Interest (external triggers) Personal Interest (individual sustained)

Concept: Teachers can ignite SI through engaging hooks, making science interesting and engaging...moving students towards a more persistent PI



Hooks: Interest theory: Engage in Science

Co-creating Hooks with Student Teachers

Complex problems require co-creation 'with actors' (McCauley et al., 2019)









Co-creating Hooks with Student Teachers

With colleagues in the University of Galway, we have been developing lesson hooks with teachers for teachers, for over a decade, with over €200k of funding. (Local, national and EU funding)







Some Hook Outputs 'with student teachers':

Designed 3 'Hook Books' iBooks: Physics, Chemistry and Biology, targeting 12-15 year olds

Developed a 'Healthy Ocean' Hook ibook, now a permanent exhibition in Galway Atlantaquarium (88k visitors annually)

Designed 6 Hook modules, targeting 9-12 year olds, translated to Irish 2016 **PhD on Physics Hooks**



Ollscoil na Gaillimhe University of Galway

Co-creating Hooks with Student Teachers

STEP3: Educate on inclusive teaching methods that broaden the reach of science





OLLSCOIL NA GAILLIMHE UNIVERSITY OF GALWAY

https://sciencehooks.scoilnet.ie/physics/sink-or-float/

STEP1: Deliberate discussion about outreach-conscious teaching, and value of a teacher's influence.

STEP2: Educate on evidence-based science teaching methods that engage students in science

STEP3: Educate on inclusive teaching methods that broaden the reach of science Science Capital Teaching Approach

STEP4: Seek opportunities to engage teachers with industry and universities, so they have personal experiences of future careers.



STEP3: Educate on inclusive teaching methods that broaden the reach of science



Everyone has different amounts of science capital and this affects whether or not they feel: YES, Science is for me!

16th March 2023

STEP1: Deliberate discussion about outreach-conscious teaching, and value of a teacher's influence.

STEP2: Educate on evidence-based science teaching methods that engage students in science

STEP3: Educate on inclusive teaching methods that broaden the reach of science Science Capital Teaching Approach

STEP4: Seek opportunities to engage teachers with industry and universities, so they have personal experiences of future careers.



STEP4: Seek opportunities for teachers to engage in industry and university careers

 Joined a partnership with the 7 universities in Ireland to offer a STEM Teacher Internship Programme. Students can apply for paid industry placement during the Summers of their teacher education programme.







STINT HOST LOCATIONS 2022



STEP4: Seek opportunities for teachers to engage in industry and university careers

 Newly qualified teachers can apply for a 'Teacher in Residence' programme with CÚRAM (medical devices institute, Uni of Galway), where they learn about the science, inquiry & engagement activities and create lesson plans with scientists and upskill in the work of scientists in Universities.





Ollscoil na Gaillimhe University of Galway Tuesday 11th October – Welcome and overview Tuesday 25th October – Medical devices and biomaterials Tuesday 8th November – Stem cells, tissue engineering and regenerative medicine Tuesday 22nd November – Healing the heart and cardiovascular system Tuesday 6th December – Repairing the brain and nervous system Tuesday 24th January – Mending the musculoskeletal system Tuesday 7th February – Lesson plan development in collaboration with researchers Tuesday 21st February – Enquiry-based learning approaches Tuesday 7th March – Science engagement activities

Tuesday 21st March – Presentations of lesson plans

STEP1: Deliberate discussion about outreach-conscious teaching, and value of a teacher's influence.

STEP2: Educate on evidence-based science teaching methods that engage students in science

STEP3: Educate on inclusive teaching methods that broaden the reach of science Science Capital Teaching Approach

STEP4: Seek opportunities to engage teachers with industry and universities, so they have personal experiences of future careers.



Ultimate Goal:

Creating Outreach-Conscious Science Teachers

....Teacher educators are uniquely positioned to impact STEM outreach by instilling an understanding in teachers that a part of their job is to do outreach work – to highlight the value of science and science skills in future life and to draw students, where appropriate into science careers



Ultimate Goal:

Creating Outreach-Conscious Science Teachers

...in short, I want us to consider a **New Perspective in Science Education**, where Teachers and Teacher Educators play a <u>Conscious</u> role in advancing STEM engagement





Thank you

Dr. Veronica McCauley, Keynote, New Perspectives in Science Education Conference 2023, Florence, Italy.

16th March 2023

University *of*Galway.ie



Questions?

Dr. Veronica McCauley, Keynote, New Perspectives in Science Education Conference 2023, Florence, Italy.

16th March 2023

University *of*Galway.ie



OLLSCOIL NA GAILLIMHE UNIVERSITY OF GALWAY

References

- Davison, K., Domegan, C., McCauley, V., & McClune, W. (2008). A review of science outreach strategies North and South: With some recommendations for improvement. Centre for Cross Border Studies. Chicago
- McCauley, V., & McHugh M. (2021). An Observational Narrative of Student Reaction to Video Hooks. *Education Sciences*, 11(6), 1-20. <u>https://www.mdpi.com/2227-7102/11/6/286</u>
- McCauley, V., Davison, K. and Byrne, C. (2015). Collaborative lesson hook design in science teacher education: Advancing professional practice. Irish Educational Studies, 34(4), 307-323. <u>http://dx.doi.org/10.1080/03323315.2015.1114457</u>
- McCauley, V., McHugh, P., Davison, K., & Domegan, C. (2019). Collective Intelligence for Advancing Ocean Literacy. *Environmental Education Research*, 25(2), 280-291. http://dx.doi.org/10.1080/13504622.2018.1553234
- McHugh, M., McCauley, V., Davison, K., Raine, R., & Grehan, A. (2020). Anchoring Ocean Literacy: Participatory iBook Design within Secondary Science Classrooms. *Technology, Pedagogy and Education*, 29(1), 89-107. <u>https://doi.org/10.1080/1475939X.2020.1715241</u>
- McHugh, M. and McCauley, V.. (2016). Getting Hooked on Physics! *The Physics Teacher*. Bristol: Institute of Physics Publishing. 54(9), 548 550
- McHugh, M. and McCauley, V. (2016). Designing physics video hooks for science students. Physics Education, 51(1), Bristol: Institute of Physics Publishing. <u>http://iopscience.iop.org/article/10.1088/0031-9120/51/1/015015/meta</u>
- Nalini M Nadkarni, Caitlin Q Weber, Shelley V Goldman, Dennis L Schatz, Sue Allen, Rebecca Menlove, Beyond the Deficit Model: The Ambassador Approach to Public Engagement, *BioScience*, Volume 69, Issue 4, April 2019, Pages 305–313, <u>https://doi.org/10.1093/biosci/biz018</u>
- Smith, T., & Twaddle, J. (2023). STEM Pedagogical Content Knowledge of Preservice Teachers. *International Journal of Multidisciplinary Perspectives in Higher Education*, 8(1), 168-182.
- Inda-Caro, M., Maulana, R., Fernández-García, CM. *et al.* Validating a model of effective teaching behaviour and student engagement: perspectives from Spanish students. *Learning Environ Res* 22, 229–251 (2019). https://doi.org/10.1007/s10984-018-9275-z



Please cite this presentation as:

McCauley, V. (2023). Outreach Conscious Science Teaching for STEM Advancement. Keynote Lecture. New Perspectives in Science Education Conference 2023. 16-17 March 2023.

Dr. Veronica McCauley, Keynote, New Perspectives in Science Education Conference 2023, Florence, Italy.

16th March 2023

University *of*Galway.ie



$Ollscoil {\tt na} Gaillimhe$

UNIVERSITY OF GALWAY