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EPI-STEM

**TEACHER-BASED CURRICULUM
DEVELOPMENT INCORPORATING NATURE
OF SCIENCE IN IRISH JUNIOR CYCLE
SCIENCE**

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Outline of Presentation

The logo for EPI-STEM is a yellow speech bubble with a green tail pointing downwards and to the right. Inside the bubble, the words "EPI-STEM" are written in a white, sans-serif font.

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- Introduction to the new Junior Cycle Science Specification
 - (1) Focus on the Earth and Space Strand
 - (2) Focus on Nature of Science (NoS)
- Design of the Current Study
- Theoretical Perspectives from which the study is grounded in- reasoning behind their focus
- Practical Examples of NoS
- Conclusions



Introduction to the new Junior Cycle Science Specification

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- Change to the Junior Cycle (Lower Secondary Level) Science Syllabus from September 2016 (NCCA 2015)
- Focus on key skills related to scientific practices and the process model of learning



New Content Strand

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Elements	Strand two: Earth and space
	<p>Learning outcomes</p> <p><i>Students should be able to</i></p>
Building blocks	<ol style="list-style-type: none"> 1. describe the relationships between various celestial objects including moons, asteroids, comets, planets, stars, solar systems, galaxies and space 2. explore a scientific model to illustrate the origin of the universe 3. interpret data to compare the Earth with other planets and moons in the solar system, with respect to properties including mass, gravity, size, and composition
Systems and interactions	<ol style="list-style-type: none"> 4. develop and use a model of the Earth-Sun-Moon system to describe predictable phenomena observable on Earth, including seasons, lunar phases, and eclipses of the Sun and the Moon 5. describe the cycling of matter, including that of carbon and water, associating it with biological and atmospheric phenomena
Energy	<ol style="list-style-type: none"> 6. research different energy sources; formulate and communicate an informed view of ways that current and future energy needs on Earth can be met
Sustainability	<ol style="list-style-type: none"> 7. illustrate how earth processes and human factors influence the Earth's climate, evaluate effects of climate change and initiatives that attempt to address those effects 8. examine some of the current hazards and benefits of space exploration and discuss the future role and implications of space exploration in society

Possible deficit in Teachers' Content Knowledge (Initial Interview Data)

Unifying Strand of the NoS

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Elements	Strand one: Nature of science
	<p>Learning outcomes</p> <p><i>Students should be able to</i></p>
Understanding about science	<ol style="list-style-type: none"> 1. appreciate how scientists work and how scientific ideas are modified over time
Investigating in science	<ol style="list-style-type: none"> 2. recognise questions that are appropriate for scientific investigation, pose testable hypotheses, and evaluate and compare strategies for investigating hypotheses 3. design, plan and conduct investigations; explain how reliability, accuracy, precision, fairness, safety, ethics, and the selection of suitable equipment have been considered 4. produce and select data (qualitatively/quantitatively), critically analyse data to identify patterns and relationships, identify anomalous observations, draw and justify conclusions 5. review and reflect on the skills and thinking used in carrying out investigations, and apply their learning and skills to solving problems in unfamiliar contexts
Communicating in science	<ol style="list-style-type: none"> 6. conduct research relevant to a scientific issue, evaluate different sources of information including secondary data, understanding that a source may lack detail or show bias 7. organise and communicate their research and investigative findings in a variety of ways fit for purpose and audience, using relevant scientific terminology and representations 8. evaluate media-based arguments concerning science and technology

Science in society	<ol style="list-style-type: none"> 9. research and present information on the contribution that scientists make to scientific discovery and invention, and its impact on society 10. appreciate the role of science in society; and its personal, social and global importance; and how society influences scientific research
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Design of the Current Study

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- Pilot Study with 9 science teachers from the Limerick Region.
- Focused on providing professional development of both teachers' content knowledge of Earth and Space and NoS.
- Resources, a workshop, online communication platform (professional learning community) and in-school support.



- Research Questions:
 1. What are the perceptions of teachers prior to and after a professional development experience towards NoS?
 2. How does the provision of professional development opportunities enhance teachers' practice with regard to NoS?
- Case Study
- Data collection for research questions: pre- and post-interviews and audio-recording of the workshop.

Reasoning behind using a Professional Learning Community (PLC)

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- A PLC constitutes a group of people sharing and critically interrogating their practice in an ongoing, reflective, collaborative, inclusive, learning-oriented and growth-promoting way (McRel 2003).
- Lewis *et al.* (2014) found that through active discourse within a PLC, teachers affected change in their classroom.



Reasoning behind using a Professional Learning Community (PLC)

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- Dohan *et al.* (2015) reviewed the empirical literature regarding PLCs and found that as a result of their involvement in PLCs, teachers shift towards more student-centred approaches, such as scientific inquiry.
- Engaging in a PLC can facilitate a teacher's changing self-efficacy (Mintzes *et al.* 2013).



Reasoning behind providing In-School Support

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- Kanter and Konstantenopolis (2010) stipulate that teachers are often left alone to apply what they have learned in the professional development course to their own practice: can effect the impact of the professional development experience.



Supporting Teachers' Conceptions of NoS

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- Research over the past 50 years indicates teachers do not have good understandings of NoS (Lederman 2014).
- Research indicates that inclusion of an explicit and reflective focus on NoS (Abd-El-Khalick 2001) and of an historical focus on NoS (Liu and Chen 2002) can support teachers' conceptions.
- An explicit focus on the scientific practices within specific domains develops the critical epistemic, cognitive and social practices that scientists and science learners use (Duschl and Grandy 2013).



NoS Framework used in the Current Study

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Family
Resemblance
Approach
(FRA)

Erduran and Dagher
(2014)



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- **Aims and values:** e.g. accuracy, objectivity, novelty
- **Methods and methodological rules:** e.g. evidence
- **Scientific practices:** e.g. classification, observation and experimentation
- **Knowledge:** e.g. theories, laws and models

- **Social values:** e.g. honesty, addressing human needs
- **Professional activities:** e.g. publishing, grant applications
- **Scientific ethos:** e.g. ethical consideration
- **Social certification and dissemination:** e.g. truthful reporting of data

Practical examples of NoS within new Science Specification



Science Core Idea	Earth and Space			
Topic	Building Blocks	Building Blocks	Systems and Interactions	Sustainability
Aims and Values	Use data on light spectra, motion of distant galaxies and the composition of matter in the universe to conclude whether the Big Bang Theory is a valid construct.	Use data on ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.	Use data to describe the cycling of carbon.	Use data to determine the current rate of global or regional climate change and its future impact to Earth systems.

Science Core Idea	Earth and Space			
Topic	Building Blocks	Building Blocks	Systems and Interactions	Sustainability
Practices	Justify how the data illustrates the accuracy of the Big Bang Theory.	Classify the planetary structures which potentially influenced Earth’s formation and early history.	Engage in experimentation to illustrate the carbon cycle.	Observe data on increasing average global temperatures to determine if there is an increasing temperature trend. Generate classifications on the pros and cons of different energy sources to promote sustainability.

Science Core Idea	Earth and Space			
Topic	Building Blocks	Building Blocks	Systems and Interactions	Sustainability
Methods	Compare the varying theories by engaging in online research to draw conclusions on the most probable theory based on scientific accuracy and rigor.	Analyse historical evidence to consider how geological structures were formed.	Analyse direct evidence to make a claim that one change to Earth’s surface can create feedbacks that cause changes to other Earth systems. Understanding that data can come from a variety of sources through various methods can lead to explanatory consilience	Discuss and compare the different sources of energy in terms of their efficiency and sustainability.

Science Core Idea	Earth and Space			
Topic	Building Blocks	Building Blocks	Systems and Interactions	Sustainability
Knowledge	Consider how the Big Bang Theory fits in with other theories relevant to the origins of the Earth.	Use a scientific model to illustrate the origin of the universe. This model could focus on illustrating how Earth’s internal and surface processes operate a different spatial and temporal scales to form continental and ocean-floor features.	Consider the cycling of matter, including that of carbon compounds and water with an emphasis placed on associating it with biological and atmospheric phenomena. Consider the hydrosphere, atmosphere, geosphere and biosphere in the cycling of Carbon.	Consider the use of models in demonstrating the rate of climate change at both a global and regional level.

Science Core Idea	Earth and Space			
Topic	Building Blocks	Building Blocks	Systems and Interactions	Sustainability
Social-institution	Discuss the freedom for individuals to hold personal views as to the credibility of the Big Bang Theory.	Discuss the importance of communication and publishing findings to inform citizens with the hope of creating an interest in the origins of our planet.	Discuss the political power struggles which can exist in terms of issues pertaining to current and future energy needs of the Earth.	Discuss the importance of showing respect for the environment.

Conclusions

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- Need to focus on reducing the gap between theory and practice of NoS using the FRA framework as a process for teachers to integrate NoS into their practice.
- Need to make professional development accessible to teachers and linked to the current syllabus.
- Need to consider the teachers' self-efficacy in the change process.



Thank you for Listening

