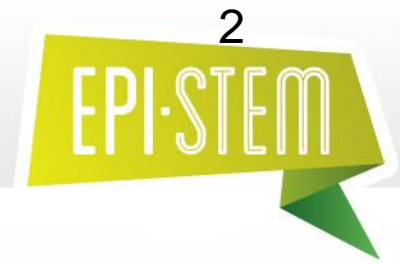


EPI-STEM

Integrating Mathematics into Science: Collaborative Curriculum Design SMEC 2016

*Gráinne Walshe, Jennifer Johnston and George
McClelland*

Integrated STEM



- Integrated STEM education: Preparing students for complexity of life in 21st Century (Rennie, Venville, & Wallace, 2012).
- Science & Mathematics integration can increase student conceptual understanding, interest and motivation, and transfer of knowledge (Czerniak and Johnson 2014, Hurley 2001, Lehrer and Schauble 2006) but under-researched (NRC 2014)
- There is little research on models that have sufficient detail to provide curricular guidance for teachers and schools for how best to integrate science and mathematics (NRC 2012)

Aim of Study

The logo for EPI-STEM is a green speech bubble with the text "EPI-STEM" in white, stylized capital letters.

Focus of Previous Study (PhD Research project: Stage 1):

To design, develop and evaluate a curricular model to assist teachers to develop integrated mathematics into science lessons at lower second-level in Ireland

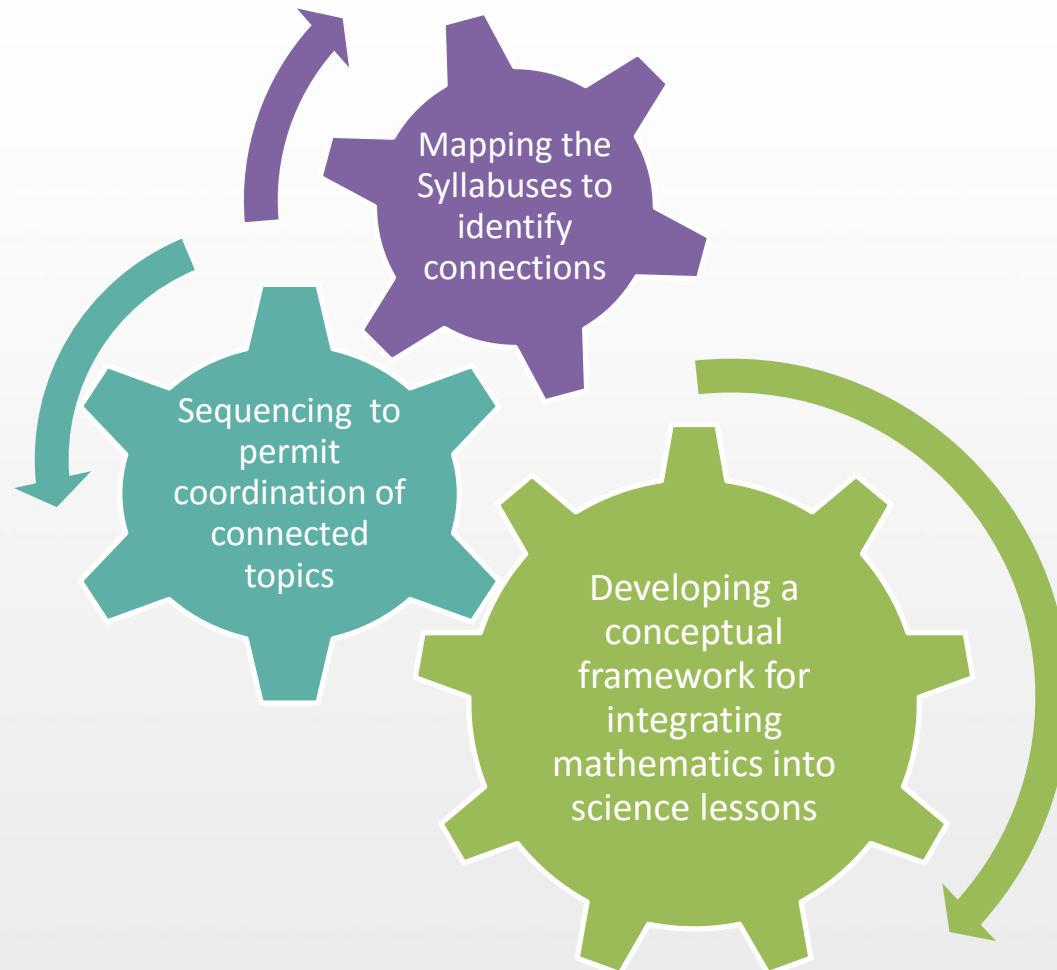
Aim of Follow-on Pilot Project (Stage 2):

To evaluate the implementation in the classroom of lesson units concerned to integrate mathematical practices into lower second-level science



Evolving a Curricular Model for Science and Mathematics Integration (Stage 1)

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Educational Design Research: Formative Evaluation of Curricular Prototypes

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Stage 1: Development of the Curricular Model in collaboration with practitioners

Design Guidelines for a Curricular Model

Map & Sequence 1

Expert Review
(n = 4)

Map & Sequence 2

Teacher & Principal Review
(n = 8)

Exemplary Lesson Units 1

Expert Review
(n = 4)

Exemplary Lesson Units 2

Teacher Review
(n = 17)

Stage 2: Field trial of the curricular model in the classroom

Plomp 2009; Nieveen and Folmer 2013



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Field trial of the Curricular Model (Stage 2)

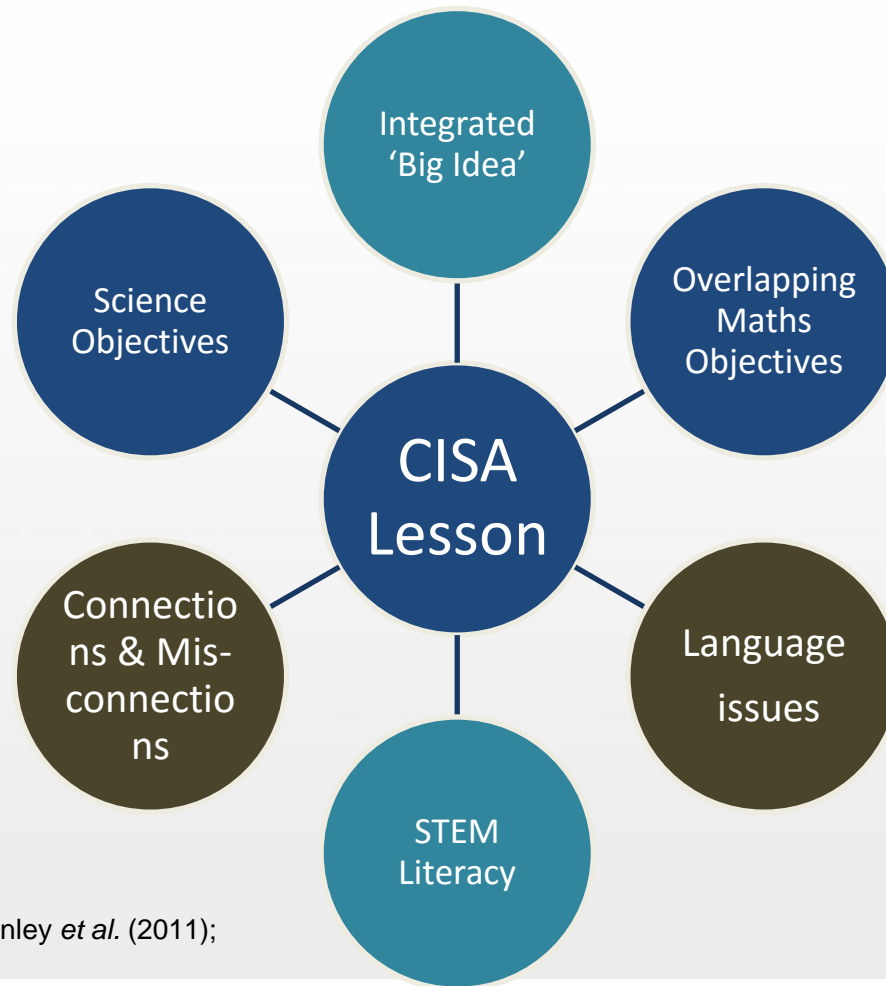
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- Teacher workshop Autumn 2016 (n = 3)
- Classroom implementation of an integrated lesson unit
- Measure impact on student learning and attitude to STEM (n = 75)
- Focus of presentation: How the teacher workshop design has been shaped by findings from Stage 1



The Conceptual Framework for Designing Integrated Lessons



Offer and Vasquez-Mireles (2009); Ainley *et al.* (2011); Yore *et al.* (2007)

Designing and Developing the CISA Lessons

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Exemplar CISA lesson Packs:

- To illustrate how a progression of mathematical practices can be integrated into Junior Science (Irzik and Nola 2011; Osborne 2014)
- Coordinated with stage of learning in both subjects
- To provide examples of integrated instructional materials, that could be adapted for a range of science topics
- To support student crossing of disciplinary boundaries



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Exemplary Lesson Unit Topics

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New First Years

- Lesson Unit 1: Introduction to Simple Statistical Inquiries in Junior Science Investigations (eg, food labels, pulse/breathing rates)

Mid First Years

- Lesson Unit 2: Investigating Relationships Between Two Variables in Science (solubility curves, temperature-time)

Second Years

- Lesson Unit 3: Investigating Linear Relationships between Variables in Junior Science (extension of a spring, distance-time)



Adaptability of the Lesson Units

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- First Lesson Unit: Statistics and Heart Rates/Nutrition

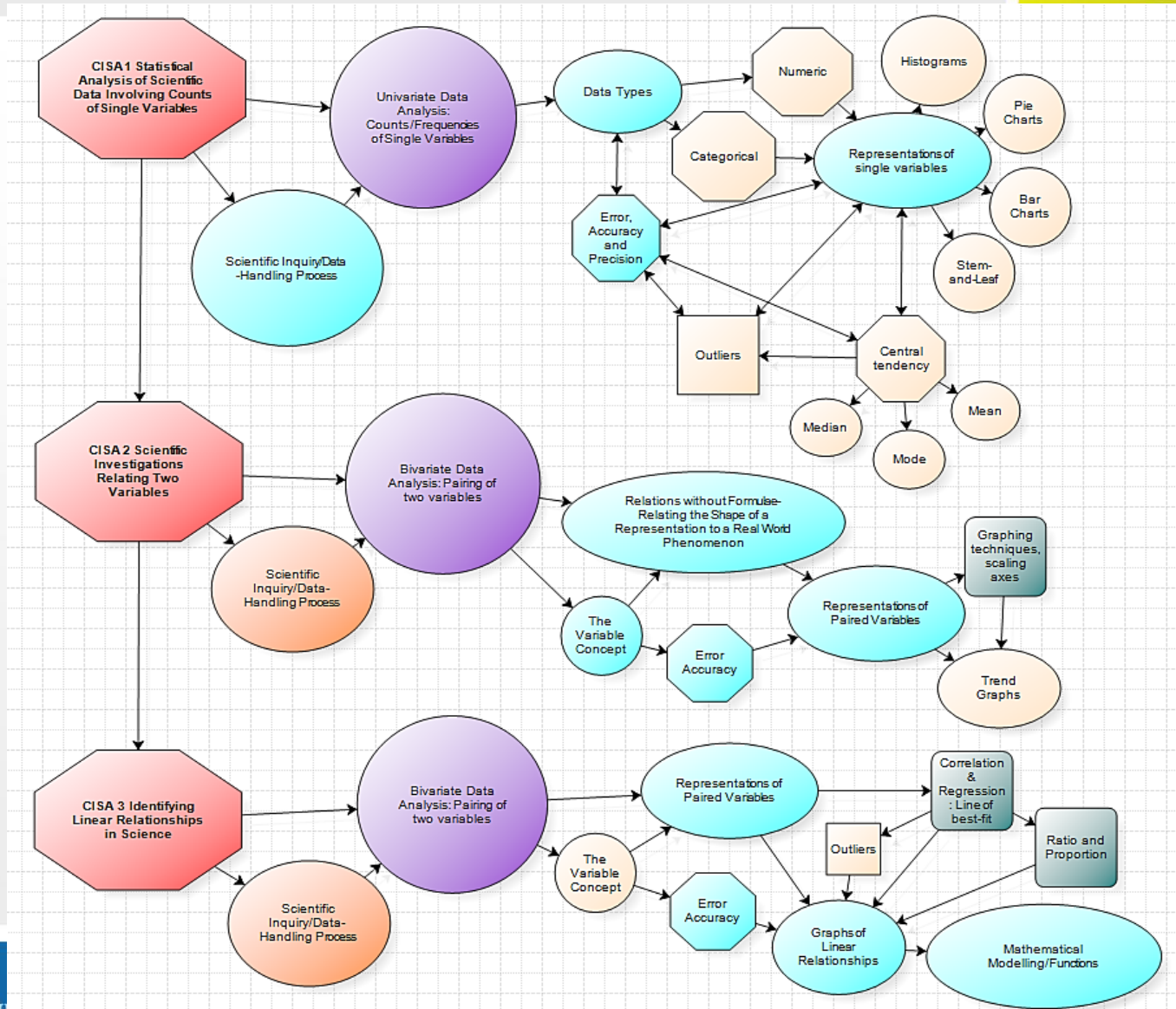
Could be used with investigations into:

- Counts of breathing rates
- Finding frequencies of different plants in a habitat (mandatory ecology investigation)
- Number of leaves on plants grown with/without water
- Heights of seedlings in the light/dark
- Masses of plants grown
- Length of leaves on a plant
- Number of leaves on a plant with/without compost
- Student heights/hair colour/eye colour in the class/school



Progression of Mathematical Practices

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Main Themes in the Feedback

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Support for Teachers in Integrating Maths into Science

Well presented/structured lessons

Support teachers in understanding **where the students are in mathematics** and how that can be linked to science

Very valuable for science teachers **who do not teach Mathematics**

Lessons **can be adapted** by teachers for other science topics

Evidence of student engagement and learning

Additional Support for **Teacher Knowledge** and Student Knowledge



Does the Model support teachers to cross the subject boundary?

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On board
– making
it my own

'I have never taught maths. The intro made it very clear what maths students do in primary and makes it clear how to differentiate depending on what they've done in secondary education.'
(Science teacher)

'As a JC Maths teacher, it was wonderful to see the cross-curricular approach and the marrying of the Project Maths topics, eg, Data analysis, probability, Data representation, etc'
(Science and Mathematics teacher)

This is
right up
my alley

Is this
science?

'Your different ways of doing it I thought was interesting, too. But does this mean that you're doing maths in the science class?' (Science and Mathematics teacher)

'I like the idea of the integration of the two subjects but I feel the science course is long enough...without adding the maths parts that are not relevant.... Maybe I just need to embrace it and decide to make it more relevant!' (Science teacher)

This is new –
I have to
think about it



Implications for the Teacher Workshop

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- Crossing subject boundaries can be disruptive a teacher's identity and self-efficacy, **even for subject 'insiders'**
- Teachers' need support to develop **aesthetic** understanding of out-of-subject teaching (Hobbs 2013)
- Curricular models need to take account of the **subject subculture, school structure and teacher subject identity** issues that impact on the curricular choices that teachers make
- **Participation in the process of formative evaluation** of curricular boundary objects can lead to reflection and reconceptualisation of subject identities



Workshop Structure

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Mapping

- Mapping to the new specification
- Mapping from the new specification onto the mathematics syllabus

Developing School-Level Curricular Plans

- Developing a mini-teaching and learning plan
- Developing collaborations with colleagues

Adapting the Exemplary Lesson Units

- Adapting the exemplary units – using the conceptual framework for different science topics
- Differentiation for students but also for individual teacher circumstances

Post-workshop evaluation



Thank you

