Integrating Mathematics into Science: Collaborative Curriculum Design

SMEC 2016

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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

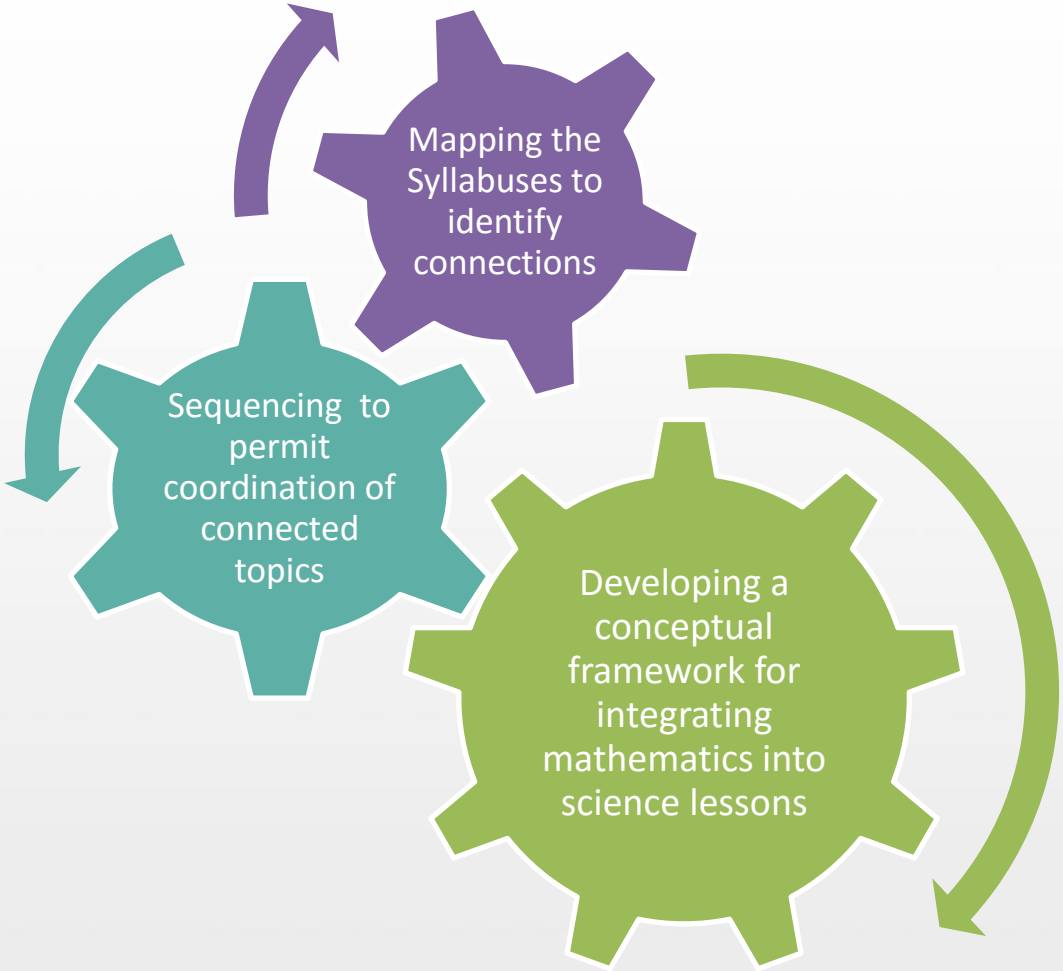
Focus of Previous Study (PhD Research project: Stage 1):

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):

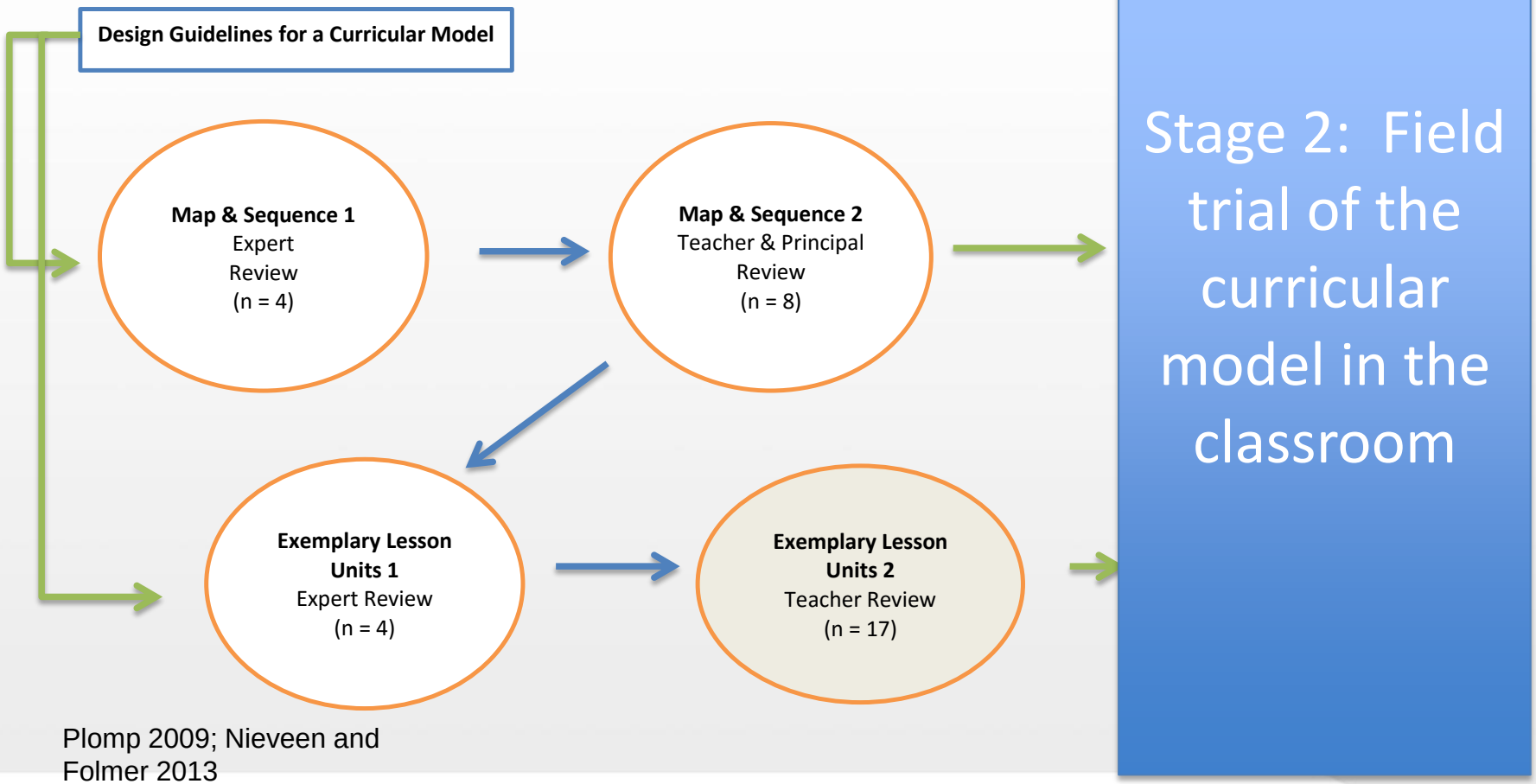
To evaluate the implementation in the classroom of lesson units concerned to integrate mathematical practices into lower second-level science

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



Educational Design Research: Formative Evaluation of Curricular Prototypes

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

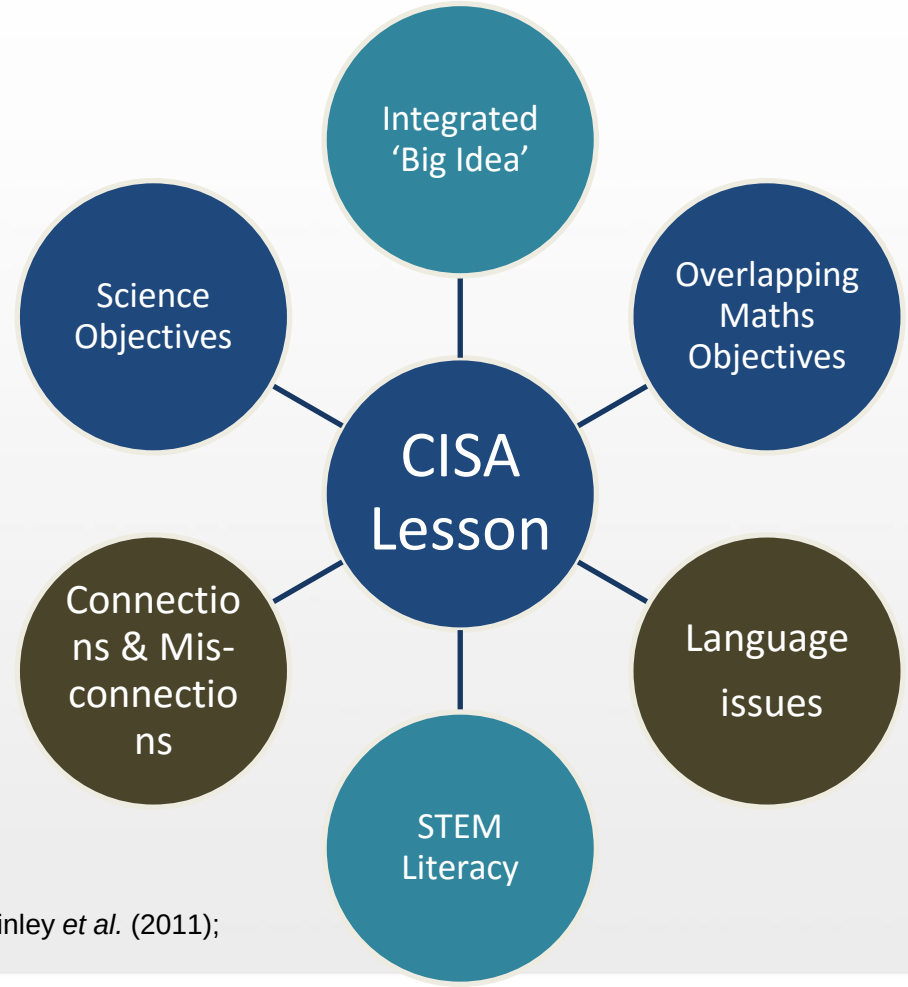


Plomp 2009; Nieveen and Folmer 2013

Field trial of the Curricular Model (Stage 2)

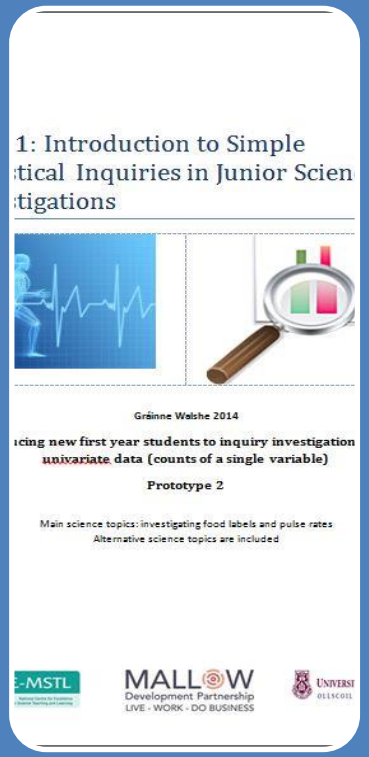
- Teacher workshop Autumn 2016 (n = 3)
- Classroom implementation of an integrated lesson unit
- Measure impact on student learning and attitude to STEM (n = 75)
- Focus of presentation: How the teacher workshop design has been shaped by findings from Stage 1

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



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

Exemplary Lesson Unit Topics

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)

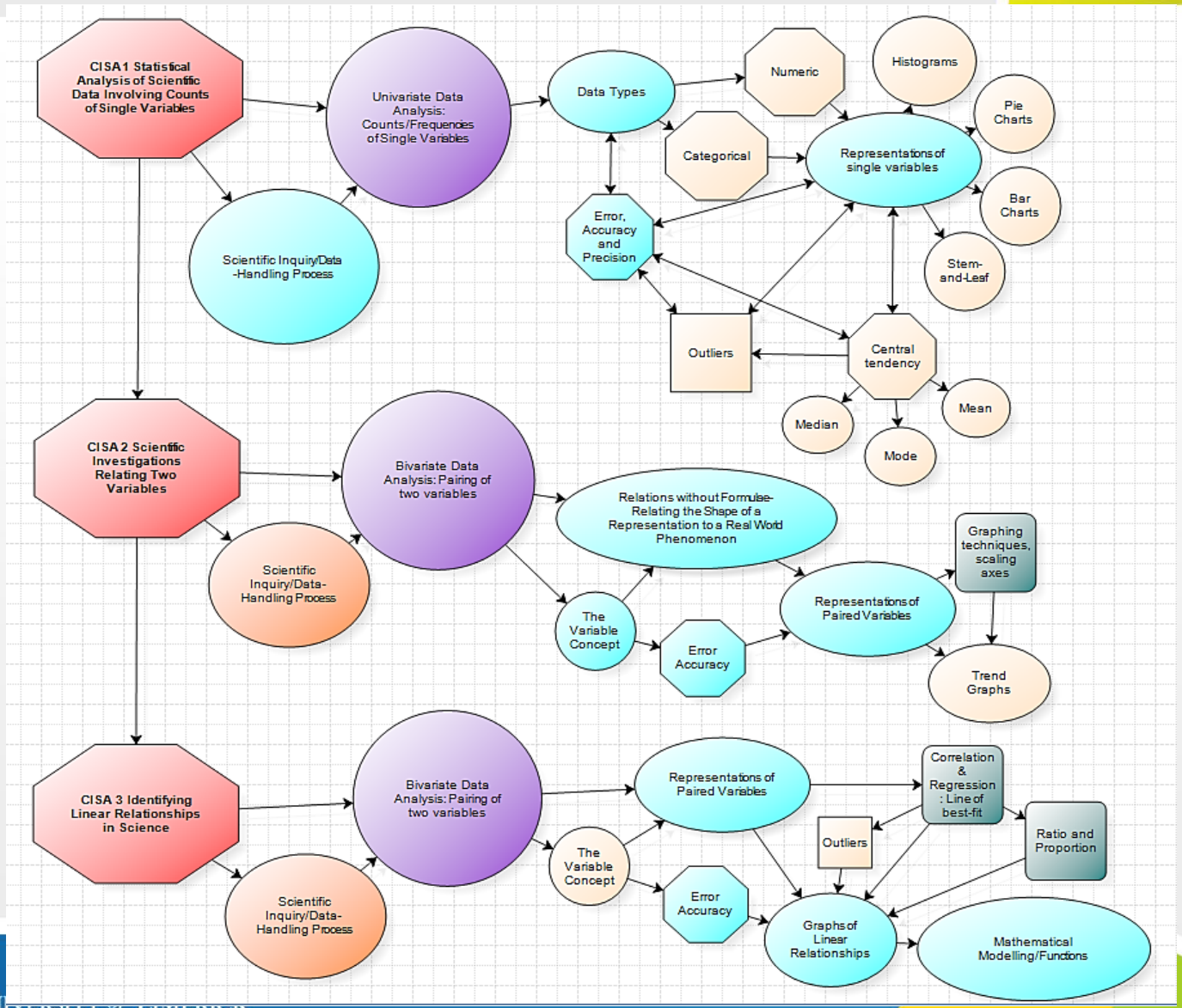
Adaptability of the Lesson Units

- 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



Main Themes in the Feedback

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?

On board – making it my own

This is right up my alley

Is this science?

This is new – I have to think about it

Implications for the Teacher Workshop

- 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

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

EPI·STEM

Thank you