Module 1: The DataScEd4CiEn Conceptual Framework

Introduction

Module 1 provides opportunities to learn about the DataScEd4CiEn project and the theoretical concepts that have informed its design. Using a case-based approach, the module provides insights into the components of the DataScEd4CiEn conceptual framework that supports teachers and students need when working with data derived from problem-driven STEAM contexts. By providing insights into the core components of the DataScEd4CiEn conceptual framework, the module will support learner's in engaging in problem-driven inquiry through the exploration of multivariate data on a range of topics related to citizenship education. Such inquiry can equip the younger generation with the knowledge and skills required to cope with the demands of modern society and become "tomorrow's progressive leaders, productive workers, and responsible citizens" (Ge et al., 2015, p. 384).

Learning objectives

It is expected that upon completion of this module participants will be able to:

- Demonstrate familiarity with the core components of the DataScEd4CiEn conceptual framework
- Explain the importance of a transdisciplinary approach to addressing scientific and everyday challenges.
- Appreciate how data science techniques can be used to explore complex societal problems and social justice issues that arise within STEAM contexts
- Apply their understandings to support the selection of problems that prepare learners to fulfil roles as active, responsible, thoughtful members of society.
- Identify key components of the DataScEd4CiEn conceptual framework as enacted in case studies of data science in practices in elementary classrooms

Expected/estimated time for completion: 5 hours

Outline of course structure and activities

Name of activity	Type of activity	Duration
1.0 Essential Viewing and Reading **Add Video here (in section 1.0)** A video case showing the exploration of environmental data by primary school children. Case Study #1: The STEAM-Ed project in Limerick, Ireland Watch the 10 min video that is a conversation with two of the researchers on the STEAM-Ed project in Limerick and read relevant parts of the associated paper here	Watch video case #1	1 hour
2.0 Preparation activity Before joining class place a reflection on the moodle forum	Moodle Forum	30 mins
3.0 Module 1: Exploring the DataSciEd4CiEn Conceptual Framework **Add Powerpoint here (in section 3.0)**	Synchronous Meeting (F2F or online)	3 hr

Description of the activities

1.0 Essential viewing

Educators struggle with a clear conceptualisation of data science and STEAM and how the disciplines might be connected in classroom settings. These activities provide insights into a data science project happening in an Irish primary classroom. In the project, primary school children explore environment data to answer questions of interest and work with an artist to use the data to improve conditions in their school.

1.1 Video case study

The STEAM-Ed project - capturing environment data using sensor technologies

In this video, we speak with two researchers on the STEAM-Ed project carried out with primary school children. The project was driven by a problem identified by the children who then engaged in iterative design to provide a solution. Children used sensor technologies to capture data and subsequently used visual arts practices to support them in the exploration and analysis of patterns from the data gathered. In the video, the researchers speak about their understandings

of STEAM education. Academic and artist Anne-Marie Morrin speaks about her research teams' transdisciplinary approach to supporting STEAM education in a primary school, through the use of data science. Academic and science educator, Dr. Maeve Liston shares insights into the disciplinary science work carried out in the schools to support the STEAM project.

Reading material:

Liston, M., Morrin, A.M., Furlong, T and Griffin, L. (2022). Integrating Data Science and the Internet of Things Into Science, Technology, Engineering, Arts, and Mathematics Education Through the Use of New and Emerging Technologies. *Frontiers in Education, 7*, Article 757866. doi: 10.3389/feduc.2022.757866

https://www.frontiersin.org/journals/education/articles/10.3389/feduc.2022.757866/full

2.0 Preparation activity

After you watch the video, please examine the graphs and images generated from the weather station (figures 5-7 on pages 8 and 9). Then, look at the how children used art to explore the weather data (figure 9 on page 12) and some of the children's comments based their interactions with data on figure 11 (page 13).

Then reflect!

Write a short 200-300 word reflection on the video and associated paper. You may wish to respond to part of the paper or issues the researchers spoke about.

Or, you may wish to use the following questions stimulate your thinking:

1. Reflect on how the integration of sensor technologies and visual arts practices in the STEAM project might impact young learners' understanding of data and problem-solving. How does this approach encourage students to think critically and creatively about real-world problems? Additionally, consider any challenges or supports you might need to implement a similar project in your own classroom
2. In what ways can you encourage students to make connections between the environmental data they collect and broader social justice issues, such as climate change, resource distribution, or community impact?

Resources

Reading material:

Liston, M., Morrin, A.M., Furlong, T and Griffin, L. (2022). Integrating Data Science and the Internet of Things Into Science, Technology, Engineering, Arts, and Mathematics Education Through the Use of New and Emerging Technologies. *Frontiers in Education, 7*, Article 757866. doi: 10.3389/feduc.2022.757866

https://www.frontiersin.org/journals/education/articles/10.3389/feduc.2022.757866/full

Associated video

3.0 . Module 1: Exploring the DataSciEd4CiEn Conceptual Framework

This module will introduce the components of the DataSciEd4CiEn Conceptual Framework and displays linkages between these components and the two video cases.

Name of Activity	Type of Activity	Duration (approx.)
A. Defining Data Science	Lecture, Video	20 mins
B. The DataSciEd4CiEn Conceptual Framework	Observation, Pair discussion, Group discussion & Sharing	20 mins
C. From STEM to STEAM	Lecture, Discussion	45 mins
D. Identifying 'worthy' data science problems	Lecture, Discussion	30 mins
E. Doing Data Science	Lecture, Discussion	20 mins
F. Considering civic engagement and social justice	Lecture	45 mins

A: What is Data Science?

An informative 5-min video for the presenter to watch before engaging in this section is available on youtube here: https://www.youtube.com/watch?v=uswU1s3M2VE

- What do data scientists do? Provide insights into the work that data scientists do and how it benefits society and our lives [https://youtu.be/KYvhoH5AzHA]
- What is the difference between data science and statistics?

**Make links to case study*: Make a link to the essential viewing/reading by discussing the type of data collected from the sensors in school. Use image to motivate discussion about the sensors collecting real time environmental data relating to the school (humidity, temperature, sound). What is different about the nature of the data generated from this problem?

B: The DataSciEd4CiEn Conceptual Framework

- Explore the image of the DataSciEd4CiEn Conceptual Framework. Initiate a discussion in pairs based on the prompts *What do you notice? What do you wonder?*

**Make links to case study*: Referring to the context of the video studies, map the reading on to the DataSciEd4CiEn Conceptual Framework. Make reference to the identified problem/question that motivated the STEAM learning context and data science practices that are referred to in the reading.

Make links to case study*: Have an informal discussion to analyze the strong STEAM emphasis in the study. Children received disciplinary instruction in **Science, collected data via the data sensor **T**echnologies, utilised the **A**rts through the music communication of the data and used visual arts practices to analyse the data and used Mathematics to support the visualizion of the data.

C: From STEM to STEAM education

Here are a series of slides to direct a discussion on STEM and STEAM education.

**Make links to case study*: Initiate a discussion about how STEAM was represented in the study. What was the disciplinary STEM that was explicitly taught (science) and what was the disciplinary arts focus (music, visual arts). Think back to the video, what disciplines were the researchers from?

D. 'Worthy' data science problems come from transdisciplinary STEAM contexts

- *Worthy problems require transdisciplinary STEAM approaches*. Introduce Integrated STE(A)M. Explore levels of STEM integration using the Vasquez et al. (2013) Framework: Disciplinary, Multidisciplinary, Interdisciplinary, Transdisciplinary. Focus on the continuum of levels of integration. Discuss transdisciplinary integration with reference to the solar system question.
- Worthy *data science* STEAM problems require learners to generate insights from data sources that differ from traditional textbooks (non traditional, noisy or messy data, or big/large data).

**Make links to case study*: Replay the video to hear the researchers speak about the problem under investigation. Discuss how they could not have solved the problem using STEM or the Arts alone – it needed a combined STEAM effort.

E: Doing Data Science

- Describe data science processes. Introduce inquiry in statistics education. Refer to the statistical investigation cycle—Problem, Plan, Data, Analysis, Conclusion (PPDAC) - and work of Wild & Pfannkuch (1999) to develop children's facility with statistical inquiry at an age-appropriate level. Introduce the International Data Science in Schools Project (IDSSP) framework for data science curriculum which provides a guide for a data science curriculum aimed at upper secondary level. It presents a similar framework, Cycle of

learning from data, that incorporates many of the features prevalent in PPDAC cycle and other statistical inquiry cycle. Present image from IDSSP.

- Describe data science practices and review the practices that are common in school curricula. Present practices in relation to their alignment with data science processes. Provide image from the IDSSP as one way to link the processes and practices.

**Make links to case study*: View the video and associated sound. Discuss how the STEAM-Ed project aligned with the processes of the data science framework. How did the problem elicitation and formulation happen? How did they get the data? How were data explored? Analyzed? How were results communicated?

F: Civic engagement and Social Justice

- Provide a brief summary of the Katie Makar reading about engaging young learners in learning about **citizenship** through data science. This case study of 9–10-year-olds illustrates how data science education can provide opportunities to develop primary children's learning and make authentic connections to their own citizenship. The paper draws on a series of six lessons where children generated and analysed non-standard data and debated social, well-being and privacy issues as they considered their activities in cyberspace.
- In the reading, Makar et al. (2023) used a critical citizenship education lens to consider the *politics* (e.g., knowledge of how broad systems can be unjust), *social* (e.g., awareness of how data are used in society), *self* (e.g., personal online digital footprint and identity) and *praxis* (personal agency and action) dimensions that the children expressed when talking about their interactions online. Summarise this on the slides.
- Pair discussion #1: teachers examine a transcript from the article: When initiating a discussion on cyberspace (Makar, Fry & English 2023; section 4.1, pages 972-974), the authors provide a transcript of some classroom dialogue and then identify elements of critical citizenship education that occurred in the conversation. Read this section again and see how the authors interpret what the children say through the political, social, self and praxis lenses. Come back and share.
- Whole class discussion: think about the students in your classroom and your local/national context. Identify a critical and relevant context from your own students' lives that may lead to discussion incorporating reference to the four dimensions of politics, social, self and praxis. Share a brief description of this context in the by referring to common examples are the environment, sustainability and energy use etc.

Makar, K., Fry, K & English, L. (2023). Primary students' learning about citizenship through data science. *ZDM – Mathematics Education, 55*, 967–979.