

STUDY GUIDE

Module 3: A toolkit to implement the DataScEd4CiEn approach in the classroom and aligning it to the curriculum

Introduction

Purpose

The purpose of this module is to familiarize teachers with the DataScEd4CiEn toolkit which was developed to empower teachers with the competences needed to bring social justice related data science activities into the STEAM curriculum. It focuses on good guiding questions, finding good data sets, data moves and on data exploration with digital tools.

Learning objectives

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

- **develop the ability to evaluate and improve statistical questions:** Teachers will be able to guide students in generating and refining appropriate statistical questions that promote deeper analysis and critical thinking.
- **identify and select appropriate data sets for classroom use:** Teachers will learn to locate and choose relevant, reliable data sets that align with curriculum goals and support meaningful, real-world data analysis.
- **apply data moves techniques to organize and analyze data:** Teachers will be equipped with strategies to manipulate, represent, and organize data effectively to uncover insights, making data analysis more accessible and engaging for students.
- **use data analysis tools like CODAP, the World Bank website or Gapminder:** Teachers will acquire the skills to import and analyze data using platforms such as CODAP, the World Bank website, and Gapminder, selecting the most appropriate tool to meet their teaching objectives and facilitate student learning.

Expected/estimated time for completion: ~ 8.5 hours

Outline of course structure and activities

Name of activity	Type of activity	Duration
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1.1. Essential Readings	Pre-requisite reading	1.5 hrs	
1.2. Preparatory Activity: Thinking of data science activities with CODAP	Preparatory activity (before joining class)	2 hrs	
2.1. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – introduction	Synchronous Meeting (F2F or online)	20 mins	3.5 hrs
2.2. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – statistical questions	Synchronous Meeting (F2F or online)	30 mins	
2.3. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – data sets	Synchronous Meeting (F2F or online)	35 mins	
2.4. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – applying data moves for data exploration	Synchronous Meeting (F2F or online)	30 mins	
2.5. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – importing data into digital tools	Synchronous Meeting (F2F or online)	40 mins	
2.6. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – designing a data-driven classroom activity	Synchronous Meeting (F2F or online)	45 mins	
2.7. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – reflection	Synchronous Meeting (F2F or online)	10 mins	
3.1. Collaborative Curriculum/Project Design	Group-based independent study	1.5 hrs	

Description of the activities

1.1. Essential Readings

Please, familiarize yourself with the following two texts that introduce you to central concepts of this DataScEd4CiEn module:

- Arnold, P., & Franklin, C. (2021). What makes a good statistical question? *Journal of Statistics and Data Science Education*, 29(1), 122-130.
- Erickson, T., & Chen, E. (2021). Introducing data science with data moves and CODAP. *Teaching Statistics*, 43, 124-132.

1.2. Preparatory Activity: Thinking of data science activities with CODAP

In order to later plan for data science activities that are to be worked on with digital tools, please make sure to walk through some key processes of a data science investigation and familiarize yourself with the digital tool CODAP:

Data science with data moves (30 minutes)

- *Summary:* Video Tutorial ("Data Moves and CODAP with Chad Dorsey and Bill Finzer from the Concord Consortium") – Teachers will watch an instructional video explaining key "data moves" (organizing, visualizing, and manipulating data). The video will walk them through specific examples of how to engage students with these moves to deepen understanding of data sets.
- *Task:* Watch the following video, thereby familiarizing yourself with how data moves can be realized in the digital tool CODAP: <https://www.youtube.com/watch?v=jVV5eylXQ9E> (2:32–30:02 mins)

Selecting a Theme and Topic (20 minutes)

- *Summary:* Teachers begin their research by selecting a theme or civic engagement topic relevant to their students. This could be related to social justice, environmental sustainability, or community issues that can be explored through data. The topic should be relevant to the students' context and provoke meaningful inquiry.
- *Task:* Identify a broad theme (e.g., climate change, poverty, gender equality) and narrow it down to a specific question that students can explore with data. Ensure the topic aligns with the (mathematics / STEAM) curriculum (of your country/federal state) and age level of the students.

Framing the Statistical investigative question (15 minutes)

- *Summary:* Teachers will generate a statistical question that guides the data exploration in the lesson. This statistical (research) question should drive inquiry, promote critical thinking, and help students explore the civic engagement issue using data exploration.
- *Task:* Write a specific, measurable statistical question related to the chosen theme. Make sure the question is clear, engaging, and suitable for students' skill levels.

Finding and Selecting appropriate Data (20 minutes)

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- *Summary:* Teachers search for an appropriate data set from online sources (e.g., World Bank, Gapminder, CODAP) or local data related to the selected theme. They will ensure the data is accessible for students and can be used to answer the statistical question.
- *Task:*
 - (1) Search for and review potential data sets.
 - (2) Evaluate the relevance, accuracy, and appropriateness of the data for the lesson.
 - (3) Download or prepare (data management, data cleaning) the data for student use in a format that is easy to manipulate (e.g., CSV or Excel).

Getting to know CODAP (30 minutes)

- *Summary:* Teachers use CODAP for their data science activities, getting a sense of what data science activities one could implement with the tool.
- Task:* Choose one of the three following activities to get to know the basic features of CODAP (further instruction for each activity in the text box):
 - *Getting started with CODAP:*
<https://codap.concord.org/app/static/dg/en/cert/#file=examples:Getting%20started%20with%20CODAP>
 - *Getting started with CODAP 2:*
<https://codap.concord.org/app/static/dg/en/cert/#file=examples:Getting%20started%20with%20CODAP%202>
 - *Earthquakes:*
https://codap.concord.org/releases/latest/static/dg/en/cert/index.html?url=https://concord-consortium.github.io/codap-data/SampleDocs/Science/E_Sciences/Earthquakes/EarthquakeData.codap#

For further instructions on how to use CODAP, you can check the following playlist of videos on YouTube: https://www.youtube.com/playlist?list=PLq_mgFaS8OGYF1cKF4lrBI_0RwB_SWQk1

2. Module 3: A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum (Synchronous meeting)

To provide teachers with hands-on experience and deeper understanding of the DataSciEd4CiEn toolkit, equipping them with the skills needed to integrate data science and civic engagement in their classrooms. By the end of the session, teachers will have developed a detailed, data-driven classroom activity and built confidence using data analysis tools and strategies.

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2.1. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – introduction

- Discussion: Begin with an introduction to the DataSciEd4CiEn toolkit. Provide an overview of the toolkit's purpose and the components, its role in integrating data science into STEAM education, and how it fosters critical thinking, problem-solving, and civic engagement.
- Learning Outcome Review: Review the specific learning outcomes for the session, emphasizing how each part of the activity connects to real classroom practice.

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2.2. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – statistical questions

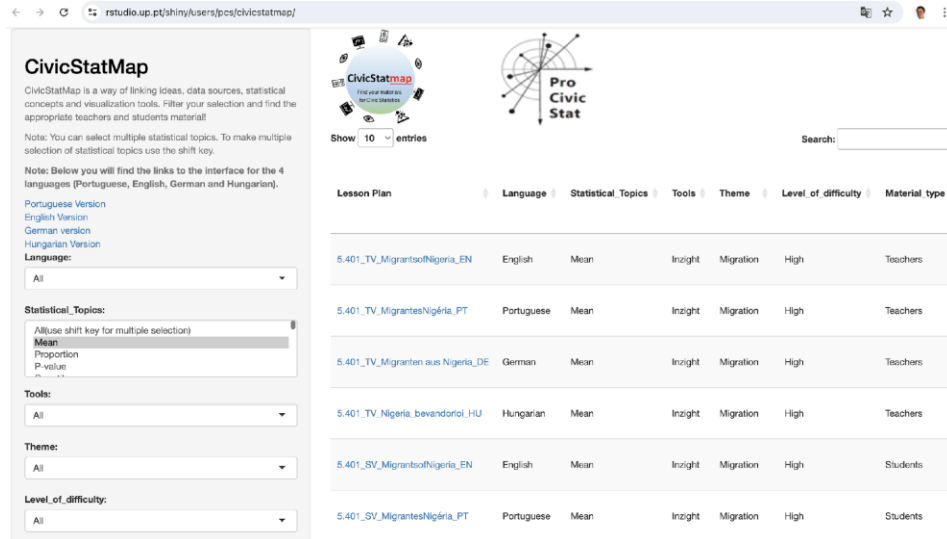
The following table from Frischemeier and Leavy (2020) can help as a first orientation.

Category	Guiding questions
Look at the question	- Is it meaningful? - Will the question sustain interest and curiosity of primary children? - Is the intent clear and unambiguous?
Think about the variables of interest	- Are the variables described clearly? - Are the variables available/possible to measure?
Look at the relationship between the question and the data it will generate	- Can the question be answered with a simple ‘yes/no’ response [avoid these type of questions]? - Will the question generate quantitative data (i.e. numbers)? - For our focus on comparing two groups: Will the question motivate a focus on two groups? - Does the question promote group comparison of data?
Look at (or imagine) the data	- Can you answer the question with the given or imagined data? - Is there, or will there be, sufficient data collected to answer the question? - Is there, or will there be, sufficient variability in data collected (is there the potential for a wide range of possible data values)?

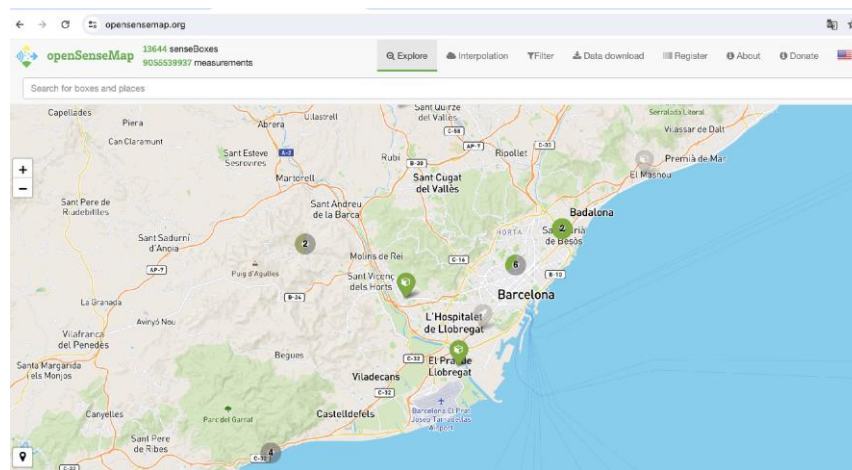
- Discuss the importance of statistical questions in guided data exploration activities. Focus on what makes a good statistical question and how it influences student inquiry and exploration.
- Teachers, in groups of three or four, will be given a worksheet with a set of pre-written statistical questions. They will discuss and evaluate these questions based on provided criteria, improving or rewriting them as needed to enhance their relevance and clarity.
- Groups will share one improved question, explaining how their revisions will drive more meaningful student analysis. Facilitators will offer additional insights and suggestions.

2.3. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – data sets

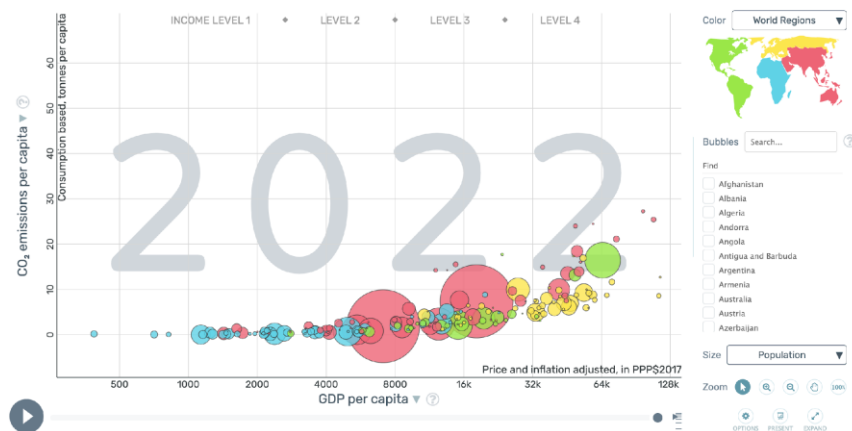
- Explain how to locate reliable data sets for classroom use. Discuss key sources such as the ProCivicStat (CivicStatMap), the World Bank website and/or Gapminder, as well as how to match data sets to classroom goals and student abilities.



Data from CivicStat Map

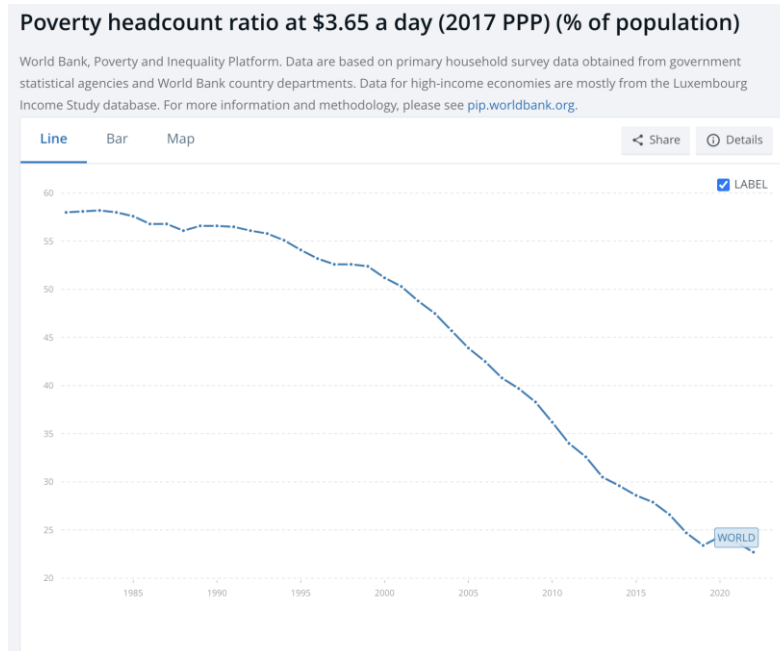


Data from Open Sense Map



Data from Gapminder

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Data from the World Bank Database

- Teachers will explore online resources (such as PCS, World Bank, Gapminder, or other recommended databases) to find a data set relevant to a topic they teach. They will consider the age group they teach and the interdisciplinary connections they can make with the data.
- Teachers will share the data sets they found, briefly explaining why they selected them and how these could support the learning goals for their classroom activities. Facilitators will offer feedback on the appropriateness and potential applications of the data sets.

2.4. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – applying data moves for data exploration

The data moves from Erickson et al. (2019) are supposed to serve as guidelines for the data exploration within the data set.

Data move	Interpretation
Filtering	Creating a subset of the data and focusing on this subset of the data
Grouping	Dividing the data into subsets (related to filtering)

Summarize	Aggregating your data, e.g., computing an average value (like the median) – often a pre-step before comparing groups
Calculating	Creating new attributes on the basis of already existing data, e.g. new computed columns in a data table
Merging/Joining	Connecting two datasets together
Making Hierarchy	Reorganizing the dataset by creating a hierarchical data structure.

- Walk through different data moves together, referring back to the pre-requisite reading task as well as the instructional video of the preparation activity.
- Hands-on Data Moves: Teachers will apply the "data moves" strategies to their selected data set using tools like CODAP, exploring different ways to manipulate and visualize the data. They will focus on uncovering key insights that could be used in classroom discussions or activities.
- Teachers will share their experience applying the data moves, noting any interesting trends or patterns they discovered. Facilitators will offer additional ways these strategies could be used in the classroom.

2.5. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – importing data into digital tools

- Introduction to digital tools for data exploration: A short overview of CODAP, the PCS, World Bank, and Gapminder website, focusing on their unique features and advantages. Discuss how these platforms can support data-driven learning in the classroom.
- Hands-on Exploration: Teachers will import their selected data sets into CODAP, or explore the tools offered by the World Bank or Gapminder website. They will practice creating visualizations (graphs, charts, maps) and manipulating data to support classroom inquiries. Teachers are encouraged to experiment with the different tools to see which best fits their teaching needs.
- Discussion: Teachers will share any challenges they encountered and brainstorm solutions. Facilitators will provide guidance on overcoming common issues and offer prompts for using the tools more effectively in a classroom setting.

2.6. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – designing a data-driven classroom activity

- Using the knowledge and skills gained so far, teachers will individually design a classroom activity that incorporates data science and civic engagement using the toolkit. The activity should involve the following:
 - An adequate statistical question for students to explore.
 - The selection of a relevant data set.
 - The use of data moves and data exploration tools (CODAP, World Bank, or Gapminder).
 - Opportunities for students to interpret the data and connect it to real-world social justice or civic issues.

- **Peer Review and Feedback:** Teachers will pair up and exchange their draft lesson plans. They will provide constructive feedback on each other's activities, focusing on clarity, relevance, and potential challenges. Facilitators will offer additional feedback and suggestions for improvement.

2.7. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – reflection

- Teachers will reflect on the skills and competencies they developed during the session, their comfort level using the toolkit, and how they plan to implement data-driven activities in their classroom. Questions include:
 - Which tool do you feel most comfortable using, and why?
 - What challenges do you anticipate in integrating data science into your curriculum?
 - How do you plan to foster critical thinking and civic engagement in your students through data science?

3.1. Collaborative Curriculum/Project Design

Teachers participate in individual groups where they co-create a multi-week curriculum unit that integrates DataSciEd4CiEn principles. The unit would involve students progressively working through data-driven civic engagement projects, culminating in a final product (e.g., a presentation, community action plan, or data visualization).

For that, please collaborate in groups with different subject backgrounds. Try to identify topics and themes that enable rich data-driven classroom activities for a particular grade. Identify relevant topics and competences in the curriculum that allow for a transdisciplinary approach. When you found a topic, look for potential data sets and try to decide which tool(s) to use in class.

Table of activity resources

Title	Description
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1.1. Essential Readings Arnold, P., & Franklin, C. (2021). What makes a good statistical question? <i>Journal of Statistics and Data Science Education</i>, 29(1), 122-130. Erickson, T., & Chen, E. (2021). Introducing data science with data moves and CODAP. <i>Teaching Statistics</i>, 43, 124-132.	Text: https://www.tandfonline.com/doi/pdf/10.1080/26939169.2021.1877582 Text: https://onlinelibrary.wiley.com/share/4ZSJ6ZIM5IRJGQMFYKKH?target=10.1111/test.12240
1.2. Preparatory Activity: Thinking of data science activities with CODAP Video tutorial Exemplary data science activities in CODAP	https://www.youtube.com/watch?v=jVV5eylXQ9E (2:32–30:02 mins) - Getting started with CODAP: https://codap.concord.org/app/static/dg/en/cert/#file=examples:Getting%20started%20with%20CODAP - Getting started with CODAP 2: https://codap.concord.org/app/static/dg/en/cert/#file=examples:Getting%20started%20with%20CODAP%202 - Earthquakes: https://codap.concord.org/releases/latest/static/dg/en/cert/index.html?url=https://concord-consortium.github.io/codap-data/SampleDocs/Science/E_Sciences/Earthquakes/EarthquakeData.codap#
2.2. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – statistical questions Activity	Worksheet, provided on the Online Learning Platform
2.3. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – data sets Online resources for different data sets	CivicStatsMap Open Sense Map World Bank Gapminder – Bubbles

<i>2.4. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – applying data moves for data exploration</i> Data Sets	Climate Change Gender Pay Gap
<i>2.5. A toolkit to implement the DataSciEd4CiEn approach in the Classroom and Aligning it to the Curriculum – importing data into digital tools</i> Digital tools	CODAP inzight Tableau World Bank Bubbles by Gapminder

Additional resources for further study

Playlist of tutorials on how to use CODAP:
https://www.youtube.com/playlist?list=PLq_mgFaS8OGYF1cKF4IrBI_0RwB_SWQk1