

STUDY GUIDE

Module 5: Applying the DataScEd4CiEn approach in the Classroom and Aligning it to the Curriculum

Introduction

This document presents the study guide corresponding to the application of the DataScEd4CiEn approach in the Classroom for students ages 9 to 15 and aims to align it the National Curriculum fostering teaching innovation and teacher professional development in the field of STEAM Data Science Education.

Purpose

The purpose of Module n° is for participants to activate the DataScEd4CiEn approach to Data Science STEAM education for Civic Engagement and Social Justice. Teachers will evaluate the applicability and success of the DataScEd4CiEn approach (a) by analyzing the examples of DataScEd4CiEn examples developed by the consortium, and (b) by creating accompanying educational scenarios and using them in their STEAM classrooms. To develop their scenarios, teachers will work in groups to either customize and expand upon educational scenarios and accompanying instructional materials provided by the consortium or develop their own from scratch. Teachers will be supported by the local project team in each country, but also through the transnational community of educators.

Learning objectives

It is expected that through this module participants will:

- Collaborate with other educators to design/co-design a STEAM scenario based on the principles underlying the DataScEd4CiEn approach
- Implement the scenario with the support of the local DataScEd4CiEn team
- Identify critical incidents from the enactment of the STEAM scenario related to students' work and their own classroom teaching.
- Share ideas and experiences within a dynamic transnational community of educators.

Expected/estimated time for completion: 12 hours

Outline of course structure and activities

Name of activity	Type of activity	Duration
1.1. Essential reading	Pre-requisite reading	1 hr
1.2. Preparation activity	Online template collaborative activity. Forum	1h
1.3. Applying the DataScEd4CiEn approach in the classroom and aligning it to the curriculum PART A: Design of STEAM Educational Scenarios PART B: Design-based research in education PART C: Preparation of the Guided Field practice. (re)-designing the scenario	Synchronous Meeting	2.5 hrs
1.4. (Re)-designing the DataScEd4CiEn scenario	Online or f2f collaborative activity	3 hr
1.5. Conducting the DataScEd4CiEn scenario. Scenario template completion and field notes	Independent practice Forum participation	3.5 hrs
1.6. Teacher self-report	Independent practice	2 hr

Description of the activities

1.1. Essential Readings

An essential reading for understanding what it means to identify critical incidents from the enactment of the STEAM scenario related to students' work and their own classroom teaching is: **Students' actual purposes when engaging with a computerized simulation in the context of citizen science** (Dvir, M. and Ben-Zvi, D. (2023). British Journal of Educational Technology, 53(5), 1202-1220. DOI: 10.1111/bjet.1323

This research paper discusses the importance of developing data science competencies in today's information age and the new data-related demands. They provide a case study of one pair of middle school students' engagement in an extended learning sequence inspired by authentic data practices adapted to also be authentic for young learners. They conclude on the four different purposes the students expressed and identify aspects of design that contributed to the gradual re-shaping process of their actual purposes, which differ from the intended purposes designed by the teachers.

We suggest that before the synchronous meeting reading the section results of the paper (<https://doi.org/10.1111/bjet.13238>) (from pages 8 to 14) and analyse which critical incidents have identified the teachers/researchers during the implementation of the scenario and how they question students to engage students in thinking and reasoning on the simulated data.

If you are also a researcher, you are encouraged to read the whole paper and identify the theoretical and methodological aspects described on how the researchers conclude on the four different purposes the students expressed and how these differ from the intended purposes designed by the teachers to reflect on:

- Which is the STEAM data science task?
- How is the proposed task in the scenario related to STEAM and Data Science?
- What connections do you make between the key ideas of the paper and the planning and enacting of the STEAM Data Science scenario?

References

Dvir, M. and Ben-Zvi, D. (2023). Students' actual purposes when engaging with a computerized simulation in the context of citizen science. *British Journal of Educational Technology*, 53(5), 1202-1220. <https://doi.org/10.1111/bjet.13238>

1.2. Preparation activity

In this module we provide two examples of STEAM Data science scenarios for civic engagement and social justice. Those scenarios have been created considering the theoretical framework presented in module 1, the methodological principles of STEAM education presented in module 2 and the data science practices presented in module 3, which provide an approach to the answer of the questions:

- which the social justice problems/issues of the XXI century presented in the scenario,
- how this/these problems are treated in your National Curriculum,
- which curricular content knowledge underlies in this social issue,
- how can it be treated considering a STEAM approach,
- which can be the contributions of different STEM subjects,
- what data practices can we design to advance in the solution of this problem,
- how can technology help us with data analysis practice,
- which kind of statistical dispositions promotes the engagement in the scenario,
- how do we interpret the data from the different subjects,
- how does the conclusion help to solve the social justice problem/issue from a STEAM approach,
- how are students civically engaged for ideating and creating a solution/product/outcome to solve the social problem,
- how the evaluation of the civic engagement of students, the development of global competencies and dispositions is assessed.

Think on which of the previous questions challenge your interest and analyse how these have been addressed in, at least, one of the scenarios proposed. You are asked to participate in the forum with your reasoning about the questions that you have analysed.

The example 1, “*Economy*”, has been designed for students between the ages of 9 to 12. The example 2, “*Design thinking: Droughts! no?*”, has been designed for students ages 13 to 16. For each scenario, you will find two documents: the scenario lesson plan, informing how to implement it and the main principles of design and the students’ materials or work plan, which include all the tasks to be performed.

You can find the documents in the table of the activity resources

Post in the forum your reasoning about the questions that you have selected to analyze the scenario. Inform about the scenario that you have chosen and which are the reasons for choosing it.

References

UNESCO (2017). *Education for Sustainable Development Goals: Learning Objectives*. UNESCO, <https://doi.org/10.54675/CGBA9153>

1.3. Applying the DataScEd4CiEn approach in the classroom and aligning it to the curriculum

This synchronous meeting is divided into three different parts. Part A is an introduction to the design of STEAM Data Science scenarios for civic engagement, Part B describes the principles to the design-based research in education, and in Part C you will participate in activities aimed at helping you to start designing, in collaboration with other participating teachers, the educational scenario that you will eventually implement in your classroom.

PART A) Design of STEAM Educational Scenarios

We will first introduce the “*design of educational scenarios*”, in general, and you will get familiar with the design phases and structure of an educational scenario and with how to design your own DataScEd4CiEn educational scenarios based on the principles of this approach. Finally, the “*DataScEd4CiEn scenarios template*” will be presented and analysed in one example.

References

Biehler, R., y Fleischer, Y. (2021). Introducing students to machine learning with decision trees using CODAP and Jupyter Notebooks. *Teaching Statistics*, 43(S1), S133–S142. <https://doi.org/10.1111/test.12279>

Cukic, B., Hague, D. y Maher, M. L., (2020). An Innovative Interdisciplinary Undergraduate Data Science Program: Pathways and Experience. En *2020 IEEE Frontiers in Education Conference (FIE)*, Uppsala, Sweden, pp. 1-5, <https://doi.org/10.1109/FIE44824.2020.9273976>

- English, L. (. (2017). Manufacturing licorice: Modeling data in third grade. En J. Newton, y E. Galindo (Eds.), *Proceedings of the 39th Annual Conference of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA)*. Hossier Association of Mathematics Teacher Educators.
- Fowler, S., & Leonard, S. N. (2021). Using design based research to shift perspectives: a model for sustainable professional development for the innovative use of digital tools. *Professional Development in Education*, 50(1), 192–204.
<https://doi.org/10.1080/19415257.2021.1955732>
- Gould, R. (2017). Data Literacy is statistical literacy. *Statistics Education Research Journal*, 16(1), 22-25.
- Hardin, J., Hoerl, R., Horton, N. J., Nolan, D., Baumer, B., Hall-Holt, O., ... Ward, M. D. (2015). Data Science in Statistics Curricula: Preparing Students to “Think with Data.” *The American Statistician*, 69(4), 343–353.
<https://doi.org/10.1080/00031305.2015.1077729>
- Lee, H. S., Mojica, G. M., Thrasher, E. P., & Baumgartner, P. (2022). Investigating data like a data scientist: Key practices and processes. *Statistics Education Research Journal*, 21(2), <https://doi.org/10.52041/serj.v21i2.41>
- Rubin, A. (2019). Learning to Reason with Data: How Did We Get Here and What Do We Know? *Journal of the Learning Sciences*, 29(1), 154–164.
<https://doi.org/10.1080/10508406.2019.1705665>
- Wiegand, S. and Borromeo Ferri, R. (2023). Promoting pre-service teachers’ professionalism in steam education and education for sustainable development through mathematical modelling activities. *ZDM-Mathematics Education*, 55(7), 1269-1282.
<https://doi.org/10.1007/s11858-023-01500-8>

PART B) Design based research in education

Design based research is an important methodology for conducting studies in an authentic educational context. This research requires collaboration between researchers and teachers to co-design instruction and assessment, analyse findings to inform subsequent interactions, and make thoughtful revisions.

Watch the video, “15 minutes about Design-Based Implementation Research (DBIR)” and reason how the design-based research methodology can help teachers to innovate for their professional development

References

- Calvera-Isabal, M., Santos, P., & Hernández-Leo, D. (2023). Towards Citizen Science-Inspired Learning Activities: The Co-design of an Exploration Tool for Teachers Following a Human-Centred Design Approach. *International Journal of Human-Computer Interaction*, 40(14), 3805–3826.
<https://doi.org/10.1080/10447318.2023.2201554>
- Steiner, T. (2021). Towards a more comprehensive model of teacher noticing. *ZDM Mathematics Education* 53, 85–94. <https://doi.org/10.1007/s11858-020-01202-5>

PART C) Preparation of Guided field practice

In this part C, you will participate in an activity that will help you to (re-)design the STEAM Data Science scenario for civic engagement and social justice. In this activity you are asked to work with your group to start to (re-)design your scenario that you will implement in your classroom

The scenario will be based on the DataScEd4CiEn approach. Here there are some questions that may help you to (re-)design the scenario:

- Which are social justice issues that can be solved/improved through the participation of students?
- How can these problems be authentically transformed into educational social justice problems for your students?

- What do we know of this problem from the different subjects taught in your school?
- What we still do not know and students can research on?
- What research questions on data can we pose?
- Where can we find data?
- How will the sample size affect the results?
- How should we organize, structure and transform the data?
- What kind of data analysis can we perform?
- How can visualizations help us to understand the data and its variability?
- What patterns emerge from the data analysis?
- How modellization can help us to make inferences or predictions from data?
- How can we interpret the data?
- Which conclusions can we obtain from the data?
- How do we interpret this data from the different subjects?
- How does the conclusion help to solve our educational social justice problem?
- What should we do to solve this problem?
- Which outcome helps us to solve this problem?
- How should we design it?
- Which is the process of its designing?
- How has our problem contributed to the solution of the social justice problem?
- How can we assess the students' learning and dispositions?
- What kind of STEAM and Data Science pedagogical approaches are you planning to use to attract the interest and dispositions of students?
- How are you planning to integrate the use of CODAP platform for data analysis?
- What other technological tools will students use during the classroom implementation?
- What difficulties to do you anticipate that students will experience in carrying out the activities?
- What criteria will be used to monitor and assess the learning and teaching process?

To develop your scenario, you will either customize and expand upon the examples of the educational scenarios and accompanying instructional materials provided, or develop it on your own from scratch.

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1.4. (Re)-designing the DataScEd4CiEn scenario

The synchronous session and the forum participation has given you the main ideas to design your scenario and educational materials. This activity enables you to dedicate additional time with your group in order to finish the initial version of your DataScEd4CiEn scenario.

1.5. Conduct the DataScEd4CiEn scenario and complete the scenario template and field notes

It is time to move into the implementation of the scenario that you have (re-)designed about DataScEd4CiEn. You are asked to keep a record of your daily activities and examples of the students' productions. In activity 5.2, we provided a forum where you can share with others any problems that might emerge during your teaching experimentation and ask advice from other teachers or the DataScEd4CiEn team.

You are asked to:

- Complete the *DataScEd4CiEn STEM Scenario Template* described in PART A of the synchronic session and included in the table of activity resources.
- Participate in the discussion forum on issues encountered during the implementation. The aim of this forum is to share any issues you might encounter during the teacher intervention, and to get feedback from the rest of the course participants as how to deal with these issues.
- Provide video-taped teaching episodes and/or examples of your students' work with your field notes about what you have noticed.

1.6. Teacher self-report

Once the didactical proposal is implemented in the classroom, it is necessary for the teacher to reflect back on its design and the actual teacher implementation. Retrospective reflection implies a pause, in order to look back and to think about what has happened and why.

You are asked to write a teacher self-report about the (re)-design and implementation of the DataScEd4CiEn scenario. In order to help you to prepare the self-report, we propose some questions to think on and answer. You do not need to answer all the questions, select the ones that inform about your interest when implementing the scenario.

- How effective were the social problems posed and the tasks included in the scenario to civically engage students and enlarge the Data Science students' learning and dispositions to learn?
- Has there been a match between the tasks (re-)designed and students' diverse needs and interests?
- What strategies did you use to motivate and enlarge students' dispositions on Data Science during the classroom intervention?

- What caused the biggest difficulties for students during the implementation of the scenario?
- To what extent do you think that the DataScEd4CiEn approach introduced during the intervention was useful in tackling students' understanding the difference between statistics and data science education?
- What kind of interactions are taking place among students, and between students and you that were relevant to Data Science Education?
- Have you observed any student purpose, action or disposition different from those that you have designed? How have you tackled them?
- What problems of classroom or technology management do you experience? How did you cope with them?
- What are the challenges and opportunities that you face in using the DataScEd4CiEn approach?
- What will you improve for the sustainability of the DataScEd4CiEn scenario and for posterior implementations?

Table of activity resources

Title	Description
Dvir, M. and Ben-Zvi, D. (2023). Students' actual purposes when engaging with a computerized simulation in the context of citizen science British Journal of Educational Technology, 53(5), 1202-1220. DOI: 10.1111/bjet.1323	This research paper discusses the importance of developing data science competencies in today's information age and the new data-related demands. They provide a case study of one pair of middle school students' engagement in an extended learning sequence inspired by authentic data practices adapted to also be authentic for young learners https://doi.org/10.1111/bjet.13238
Example 1. " <i>Economy</i> " (ages 9 to 12). Understanding the theoretical framework	This document provides information about how the scenario, named Economy, was designed accordingly with the DataScEd4CiEn theoretical framework https://www.canva.com/design/DAGJ3LeR_nY/eUJ-LVQyvYuYI4Ly-F8Xw/edit?utm_content=DAGJ3LeR_nY&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton

Example 1. “ <i>Economy</i> ” (ages 9 to 12). Teaching material	The document presents the lesson plan of how the Economy scenario can be implemented with students ages 9 to 12. https://docs.google.com/document/d/1lzRFHtKwloJmRXZAJuKy1VH103jRvmJ_y3OMfkFpp4A/edit?usp=sharing
Example 1. “ <i>Economy</i> ” (ages 9 to 12). Students’ work plan	The document has been created as a material to help students to use the digital tool of the Mundial Bank to understand the distribution of poverty in the world. It includes two tasks: • Poverty since I was born • The Global Food Poverty Map • Closing the session https://docs.google.com/document/d/1-o-3DblbrhzY8rXdM0dOG5cGE-bSYuq2sIbhAZKRzZQ/edit?usp=sharing
Example 2: “ <i>Design thinking: Droughts! No?</i> ” (ages 13 to 16). Scenario lesson plan	This lesson plan describes the theoretical principles, the lesson plan, timing, resources and materials, and the evaluation of the designed scenario. https://docs.google.com/document/d/1eRWwQsqjvgvoIQL4cV2opQddR0RyznpOi9jJtUB6O60/edit?usp=sharing
Example 2: “ <i>Design thinking: Droughts! No?</i> ” (ages 13 to 16). Students’ work plan	This document is a Genially Webpage in which students have all the tasks, resources and indications of the “ <i>Design thinking: Droughts! No?</i> ” scenario. https://view.genially.com/667d3c7600cf7a0014536739/learning-experience-didactic-unit-mab4sadesign-thinking
Design of educational scenarios	The document presents how the scenarios have been designed according to the theoretical frameworks presented in module 1 and 2, and data practices presented in module 3. https://www.canva.com/design/DAGJ3LeR_nY/eUJ-LVQyvYuYI4Ly-F8Xw/edit?utm_content=DAGJ3LeR_nY&utm_campaign=designshare&utm_

	medium=link2&utm_source=sharebutton
DataScEd4CiEn scenarios template	This is the template to be completed before, during and after the implementation of the (re)-designed scenario and which informs about the STEAM data science objectives, problems and methodologies, the lesson plan, timing and resources and the assessment plan. https://docs.google.com/document/d/1UIHmJRcx10BNiqn1i8jvV521mZUOzJEloD5obfzSUYk/edit?usp=sharing
<i>“15 minutes about Design-Based Implementation Research (DBIR)”</i>	The video <i>“15 minutes about Design-Based Implementation Research (DBIR)”</i> describes the role of the teachers in the design-based research methodology mainly in the phase of the implementation of the innovation and the reflection for their professional development. https://www.psy.lmu.de/isls-naples/video-resources/guided-tour/15-minutes-penuel/index.html

Additional resources for further study

Examples of Data Science STEAM scenarios for civic engagement

- Turtles: Impact of climate change on Flatback turtle populations
<https://www.digitaltechnologieshub.edu.au/teach-and-assess/classroom-resources/lesson-ideas/turtles-impact-of-climate-change-on-flatback-turtle-populations/>
- Connection 2020 The learning sequence
<https://connections.edtech.haifa.ac.il/Research/Connections-2020>
- Here Today, Gone Tomorrow: Saving Migratory Animals
https://www.sciencebuddies.org/science-fair-projects/project-ideas/EnvSci_p057/environmental-science/saving-migratory-animals
- Dalfys. DAta Literacy competences for young students towards STEAM education.
<https://www.dalfysproject.eu/>

<https://docs.google.com/document/d/17T7zTwQZMBXCpvDY8WQt58B-YJMeeNRnulSd88fdY-k/edit#>