

R4.1. DataScEd4CiEn STEAM Scenario Template

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Introduction

Title

Mission Trash: We Investigate and Improve

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Summary of the scenario

This lesson focuses primarily on the amount of waste generated at the students' own school. It addresses the societal problem of growing environmental impact caused by excessive waste. In all areas of human life, including at school, a significant amount of waste is produced every day, which consumes resources and harms the environment. Furthermore, many people—including children—do not know exactly how to avoid or reduce waste. Therefore, throughout the series, data on waste generation will be collected at the class level to make the problem visible. Following the analysis of the data, students will independently develop solutions to reduce waste generation at their own school. Through this unit, children are expected to develop an awareness of how much waste is generated in their daily school life and how they can avoid it. At the end of the unit, students should be able to apply the insights gained to other areas of their lives and thus act sustainably in terms of waste generation and reduction.

Age of the students

This lesson is designed for third- and fourth-grade elementary school students. The students have prior knowledge of methods for collecting and presenting data. They are familiar with bar charts, column charts, and tables as ways to present data. In addition, they know how to sort trash properly and understand why this is important for the environment.

‘Data Science Content in STEAM for Civic Engagement and Social Justice from the Early Years’

Subjects and topics

The subject at the forefront of this lesson series is mathematics. Key content includes collecting, organizing, and documenting data; presenting data; comparing quantities; and interpreting data. Students use mathematical data as a basis for investigating a real-world problem from their everyday school life and, building on this, making informed decisions.

In addition, the subject of general studies is incorporated into various contexts. Topics covered include waste, waste generation, resource consumption, environmental awareness, and sustainability, as well as waste sorting, disposal, and responsibility in everyday school life. This also addresses the Science and Technology aspects of the STEAM approach, for example, by examining different materials and their impact on the environment. The engineering component is addressed in the lesson series through the development of concrete solutions for reducing waste at the school. The arts aspect is primarily incorporated through the design of posters, data visualizations, and the creative presentation of developed solutions. The problem to be addressed has a clear connection to civic engagement. This is evident above all in the students’ active involvement with a real-world problem in their community, in their assumption of responsibility, and in their commitment to sustainable action.

The aspect of social justice is reflected above all in the equitable use of shared resources. In addition, the project fosters an awareness that environmental problems affect everyone and that sustainable action is necessary to shape a shared future responsibly.

Real-life questions

How much waste is generated at our school?

What solutions can we develop to sustainably reduce our waste?

Objectives for the scenario

Students explain the impact of human waste production on the habitats of animals and plants.

The students determine weights using an appropriate measuring device by weighing the trash.

Students collect data on waste generation from their immediate surroundings.

The students compare the weights of the different types of waste.

The students present their data in appropriate charts and/or tables.

Students extract data from their charts and tables and interpret it to answer the central question.

Students develop possible courses of action to protect habitats by creating a strategy to reduce waste in their own classroom.

Skills and competencies

The competency objective of the social studies curriculum—“Students explain the impact of human activity on the habitats of animals and plants”—is to be achieved by the end of the unit, with students discussing what happens to their trash during the activity phase of the first lesson. In addition, the teacher shows the children photos of a plastic bottle in the environment, thereby building further knowledge about the impact of human waste production on the environment. Another competency in general studies is “Students develop possible courses of action for the use and protection of spaces.” This is fostered through the activity in the fifth lesson, as the children are expected to independently develop solutions to the problem of high waste production. Here, they are to demonstrate, for example, how waste can be avoided and thus present a possible course of action for protecting the habitats of humans, animals, and plants. In mathematics, the competencies to be achieved can be assigned, among other things, to the competency area of data and frequencies.

“Students collect data from their immediate surroundings and examine different consumer needs” is a skill that is intended to be developed through the activity of collecting data on the weight of trash. Here, students measure the weight of the various types of trash generated in the classroom every day. This is followed by the competency “Students determine quantities (including lengths, time intervals, volumes, and weights (mass)) using appropriate measuring instruments,” as students use a kitchen scale to measure the weight during data collection. Since the weights of the different types of trash are compared with one another during the reflection in the fourth lesson, the competency “Students compare and organize quantities (including data sets, lengths, and weights (mass))” is also promoted. During the activity phase of the lesson, the students present their data in an appropriate format as part of the data analysis process. They “present data and frequencies in diagrams and tables [...]” To answer the central question, they extract information about the amounts of waste from these representations. This promotes the competency “Students extract data from calendars, diagrams, and tables and interpret it to answer questions involving mathematics and consumer-related issues.”

Teaching approaches and learning strategies/theories

This lesson series addresses a concrete and real-world problem that corresponds to the various disciplines of the STEAM approach. In particular, the subjects are Mathematics, social studies with its various sub-disciplines, and art are all represented. This approach, among other things, involves problem-based learning. The real-world problem is introduced in the first lesson as a starting point through photos of overflowing trash cans in the schoolyard and litter scattered around. The implications of this problem are also addressed as students consider what happens to their own trash. This expands their knowledge of the topic of waste and

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encourages them to develop a solution to the existing problem. Inquiry-based learning is also

incorporated, as students develop research questions of personal interest during the first lesson. Subsequently, data collection is planned in the second lesson, carried out in the third lesson, and finally evaluated in the fourth lesson. An important principle of STEAM education is transdisciplinarity, which is also present in this lesson series. This is because the central problem can be situated within the subjects of art, mathematics, and social studies. It should be noted here that social studies already links various perspectives. By examining waste generation, the scientific perspective—in the form of environmental pollution caused by waste—the technical perspective through the potential design of solutions, the geographical perspective through the discussion of global consequences, and the social science perspective through the recognition of the consequences of one's own waste-related behavior are all covered. Furthermore, cross-curricular competencies for STEAM education are also fostered. Since group work takes place in every lesson, communication skills, collaborative work, and teamwork are initially promoted. For example, when developing solutions or alternative courses of action, the children must coordinate and agree on which ideas are suitable. But even in the very first lesson, the children must exchange ideas about the consequences of their own waste and cooperatively agree on how to present those ideas. Furthermore, especially in the fifth lesson, the children's inventiveness, ingenuity, and imagination are fostered. They are given an open-ended task that allows for many different solutions and must be creative themselves to develop alternative courses of action or solution strategies. The topic of waste production also requires critical thinking from the students; particularly during the introductory and working phases of the first lesson, the children should become aware of the problem, and by formulating their own questions, they may already begin to critically question their own actions. This is reinforced in the fourth lesson, where data on their own waste is analyzed and compared, resulting in a final tally of the class's waste production. Critical thinking is then further developed as the children are tasked with devising solutions to the problem. The activity of presenting initial ideas for their own solutions therefore also fosters problem-solving skills.

Educational Scenario planification

Lesson plan

	Lesson Description	Description of the activity	Material	Social form	Time
Lesson 1	Introduction	Social formation: Circle Activities and tasks: The teacher displays real-life pictures on the board that illustrate the problem: Full trash cans at school or trash in the schoolyard as a silent prompt. The students express their initial associations with the pictures. The teacher prompts: "What do you notice? What is the problem?" The teacher refers to the series transparency and structures the lesson within it. The teacher explains the assignment, writes the two guiding questions on the board, and explains them: What happens to our trash? What questions can we explore regarding our trash? She emphasizes that drawings should only be made with a pencil. She also explains that the Research questions related to the waste	Image: Trash (Appendix 1) chart Row transparency (Appendix 2)	Circle time	10 min
	Work Phase I	The teacher has already placed five	five cards per group "What	Group Work	20 min

		Happens	to	
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Lesson 2		blank cards on each table. The students exchange in small groups and discuss what happens to their own trash. The students write down or sketch their ideas on the cards provided. Next, afterward, they the students formulate research questions for the lesson series, agree within each group on a question and write these down on a card.	Our Trash?" (Appendix 3) One card per group: "What questions can we use to explore our trash?" (Appendix 4)		
	Wrap-up and reflection	The students hang their completed cards addressing the first guiding question on the board and explain their ideas. The teacher builds on the students' ideas by hanging the pictures of the plastic bottle on the board and using them to explain what can happen to this plastic bottle. The students hang their research questions on the board and read them aloud. Based on these questions, the teacher explains that in the next class, they will work together to consider how the class rubbish can be investigated.	Image: Plastic bottle in the schoolyard (Appendix 5) Image: Plastic bottle in the river (Appendix 6) Image: Old, dirty plastic bottle (Appendix 7)	Circle time	15 min
	Introduction	The teacher reminds the students of the previous lesson. After that she refers them to the sequence chart and	Group Row transparency (Appendix 2)	Circle time	

		places	the	lesson		
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		within it. She places the students' questions in the center of the circle. She explains that she has brought two statements from a conversation between a garbage collector and a researcher. The teacher posts two statements on the board: "Garbage collector Matteo says: I think Class 4b produces mostly residual waste." "Researcher Müllix says: I think Class 4b produces more packaging waste than residual waste." The teacher asks how the students can figure out which statement is correct and how they can examine their trash. The students share their ideas. The teacher jots down the ideas in bullet points on the board. The teacher explains station-based learning, which already at was prepared at the group tables.			
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	Work phase	The students go from table to table and work through the stations. <u>Station 1:</u> Weighing and Measuring Key question: What materials can help us investigate how much trash our class produce?	Worksheet for each student (Appendix 9) Card with task instructions for each station (Appendix 10) Station 1: - Cardboard box	Group work: Station-based learning	25 min
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	The Students try the Material using the cardboard boxes from, and then answer the main question in the table on the answer sheet. <u>Station 2: Sorting</u> Key question: Why could sorting trash for our study be important? The students sort the four items or pictures the correct type of trash and answer the following the main question in the table on the worksheet. <u>Station 3: Counting</u> Key question: Is the category with the most pieces of trash also the Category with the most Trash? The students share the paper waste into the categories large, medium, and small. Then they count the trash in each category. Then the students answer the main question in the table on the worksheet.	- Scale - Tape measure - measuring cup Station 2: - Picture cards (paper waste, Plastic waste, organic waste, Residual waste) (Appendix 11) - plastic packaging tablets - Cardboard box - Picture: banana peel (Appendix 12) - Picture: soiled kitchen paper (Appendix 13) Station 3: - ten small paper scraps - three A4 sheets - a large cardboard box		
Consolidation and Reflection which station	The teacher asks the students which station is best suited or week to examine how much garbage the class produces. The students describe the weight method as best suited and describe limitations of other methods.			10 min

		The LP supplements the statements with the advantages and disadvantages of the various survey methods, e.g. Issues Various sizes of large pieces of trash during counting; sorting as an important basis for the survey, with the however cannot be used to collect concrete data; minimal time required for weighing. The teacher asks the students which elements a research form should include for recording the amount of trash. The students list the various elements of the research form, e.g., date, weight, comments /special notes, etc. The teacher names the group members and assigns the topics for the survey (plastic waste, organic waste, paper waste, general waste).			
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Lesson 3	Introduction	The teacher refers to the lesson sequence and explains how this lesson fits into it. The teacher places the “Research Box” in the circle as a silent prompt. The students share their initial ideas in a quick brainstorming session. The teacher explains	series transparency Research Box (with gloves, a scale, cloths, worksheet for collecting data) (Appendix 14)	Circle time	15 min

		that starting today, they will collect real data and practice proper data collection together. The teacher poses guiding questions such as “Why is it important that all groups weigh the same?” and “What could happen if we don’t work accurately?” to the class. Students recognize the importance of accuracy and comparability when working with data. The teacher demonstrates the “correct” way to weigh once, commenting on important steps and recording the results. The students closely observe the teacher’s procedure and reflect on whether they understand everything. Students repeat the steps in the plenary session that are followed when weighing the trash, and the teacher briefly notes them on the board.			
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	Work phase	The teacher explains the assignment. The students gather in their measurement groups and gather all the necessary materials. Within their groups, they practice weighing the trash correctly and recording the data accurately data.	Research kit for each group Worksheet for data collection (Appendix 14)	Group work	20 min
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		During the group work phase, the teacher observes the children and is available to provide help and answer questions.			
	Reflection	The teacher leads the reflection with prompt questions such as “What went well?”, “What was difficult?”, and “What do we need to keep in mind when we?” The students share	Poster “Rules for Weighing Trash” (Appendix 15)	Circle discussion	10 min

Lesson 4	Introduction and reflection on data collection	Teacher brings a bar chart and a table and hangs them on the board. She asks the students what this might have to do with collecting data on trash. The students share their thoughts on presenting data. The teacher refers to the overall structure of the unit and situates the lesson within it. The teacher reviews the data collected over the past week. The teacher alternates the facilitation role among the different groups. The students briefly present their findings and report on their experiences based on the guiding questions: “What went well?” “What was difficult?” “Were there any measurement issues or surprises?” The teacher explains the assignment and	Series transparency (Appendix 2) empty table (Appendix 16) empty Bar chart (Appendix 17) Statements by researcher Müllix and garbage collector Matteo (Appendix 7)	Circle time	15 min
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		notes that students will now find the weight of all types of trash on the worksheet. They should choose a way to present that allows them to easily compare the data and decide whether researcher Müllix or garbage collector Matteo is right.			
	Work phase	The students meet in their groups to present the data in a structured way. First, they recall what is important for creating a table and a Bar chart to create. Then select the bar chart, the table or another form of presentation and display the weight of the trash. Then drag they draw initial conclusions. The teacher supports the students in creating the charts and tables. She reminds them of important rules, e.g., that the boxes must have the same significance for all types of waste.	Worksheet for each student (Appendix 18) Tip card (Appendix 19)	Group work	20 min

	Reflection	The teacher asks: What can be done in the table can be seen than in Bar chart? What can you see more clearly in the bar chart than in the table? The teacher asks the students:	Statements by researcher Müllix and Matteo the Garbage Collector (Appendix 7)	Circle time	10 min
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		What do you notice when you compare all the types of waste in the chart? Which types of waste are in a proportion to one another (e.g., similar amounts, significantly more or less)? What do the data as a whole tell us about how we handle trash in class? The LP refers to the two statements and asks which one is correct.	Worksheets with diagrams by the students		
Lesson 5	Introduction	The teacher refers to the sequence chart and places the lesson within it. The teacher has brought a diagram of a group from the previous lesson. The teacher asks the students what problem they identified in the previous lesson. The teacher explains that garbage collector Matteo says: “It’s best if we just throw all the trash into the compost bin, then no other trash will be created.” The students comment on the statement. The teacher explains that the students are to work in groups to solutions.	Row transparency (Appendix 2) Bar chart Statement by garbage collector Matteo (Appendix 20)	Circle time	10 min

	Work phase	The students form groups of up to five people and work together to develop solutions to reduce waste at the school. The ideas are developed based on the collected data. They visualize their ideas on A3 posters.	A3 posters Presentations of the data from Lesson 4	Group work	
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	Reflection	The teacher facilitates the presentation of ideas in a plenary session. The students present their developed ideas to the class using their posters. The teacher asks probing questions such as “Why does this solution make sense?” “What data led you to this solution?” and “Can it be implemented at school?” The students provide feedback and jointly assess the feasibility. After the final group’s presentation, the teacher leads the concluding reflection: “What have we learned from the data? How did it help us find solutions?” The students reflect on the process of finding solutions based on the data. At the end, the teacher and students agree that the ideas that are feasible will be tested in the future at the class or school level. The students receive a certificate for Completion of the series of lessons.	posters with solution ideas Certificate “Data Pro” (Appendix 21)	Circle discussion	20 min
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Timing

The first lesson falls under the category of social studies, as it primarily focuses on basic scientific concepts and situating the problem within the real world. Prior knowledge about

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waste management and the consequences of high waste production is activated and

expanded. Since the children can choose their own way of representing their ideas about the waste process, art is also involved, albeit to a lesser extent. Therefore, the first lesson should take place during social studies class.

The second lesson can be conducted during a math or social studies class. Through weighing, measuring, and counting, the math component is covered, just as the nature and environment component of social studies is addressed through sorting waste.

The third lesson focuses on data collection, which covers the mathematical aspect. However, the data comes from the students' everyday lives and is collected through observation of the environment—specifically, the amount of waste. Therefore, social studies is the primary focus here.

The fourth lesson takes a more concrete look at the data, focusing on methods of presentation and how information can be derived from the data. Therefore, the mathematical aspect of data is in the foreground. Consequently, a math lesson should be used for this analysis.

The fifth period is set aside for art class, as the focus is on creatively designing solutions. The presentation will be done on a poster, so students will also work creatively with photos, drawings, or other elements.

In total, five individual lessons are planned. It is important to note that there must be at least one week between the third and fourth lessons so that the children have time to collect their data daily.

Teaching and Learning Materials

In the first lesson, the teacher uses photos taken at the school beforehand to introduce the topic. These photos should be tailored to the specific class and drawn from the students' real-life experiences to illustrate that the problem of increased waste production is a genuine issue for the school or class. The appendix includes an example of such a photo, showing an overflowing trash can. For the next phase of the activity, each group receives five cards with the question: "What happens to our trash?" The cards also have space for the students' ideas. The teacher explains the task orally: "Write or draw on the card what you think happens to your—or our—trash. Make sure that for drawings, you only use the "You should use a pencil." In addition, each group receives a card with the question: What questions can we explore using our trash? Here, too, the teacher gives verbal instructions: "Once you've written down or sketched your ideas, think of a question within your group that interests you and that you'd like to explore using the trash. Write this question on the card." During the consolidation and reflection phase, three images of a plastic bottle are used. In one, it lies in a schoolyard; in another, it is floating in a body of water; and in the third, an old and already soiled plastic bottle is shown. Using this bottle as an example, the teacher explains what can happen to trash, thereby expanding on the ideas the children have developed.

At the start of the second lesson, two statements are posted on the board:

Researcher Müllix says: I think that Class 4b produces more packaging waste than general waste.

Matteo, the garbage collector, says: "I think Class 4b mainly produces general waste."

The teacher asks: "I've brought you two statements from a conversation between Professor Müllix and garbage collector Matteo. How can we figure out which one of them is right?" This

motivates the students to plan their investigation. In the next phase of the activity, each student

receives a worksheet. The assignment on the worksheet reads: Complete stations 1–3 and follow the instructions at each station. At the end of each station, come up with an answer to the question. The worksheet includes a table where students can record their answers to the question, as well as additional information about each station (e.g., weight, number of trash items, etc.). At the first station, the children will find a kitchen scale, a measuring tape, a measuring cup, and a cardboard box, along with a card instructing them to measure and weigh the box. At Station 2, picture cards featuring images of general waste, plastic waste, paper waste, and organic waste are provided. There, students should match the image of a banana peel, the image of a soiled paper towel, an empty plastic pill bottle, and a cardboard box to the corresponding categories. A card with the task of sorting the items into these categories is also required for this station. The third station requires ten small paper scraps, three sheets of A4 paper, a large cardboard box, and a card with the task of sorting these items by size and then counting how many items belong to each category.

At the start of the third lesson, this is also placed back in the sequence display. Afterward, the teacher demonstrates the correct way to weigh the items in front of the class. For this, she needs a research kit containing gloves, a scale, and the worksheet for recording data, as well as cloths in case anything needs to be cleaned. This research kit ensures that the children have all the necessary materials right at hand and can be brought out whenever the trash needs to be weighed. The worksheet for documenting the data is designed in table form and provides space to enter the date, type of waste, weight, and any special notes. The layout of the worksheet is intended to provide clarity and enable students to document the data accurately and in a comparable manner, while also simplifying the documentation process. Additionally, during this lesson, the poster with the “Weighing Guidelines” are created. After the students have practiced weighing in groups, the class discusses what to look out for during the weighing process. The teacher writes down the most important points on the poster and hangs it up in the classroom. The poster is intended to help the children with weighing in the days that follow and ensure that they always follow the same, precise procedure so that the data remains comparable.

At the beginning of the fourth lesson, the teacher posts a blank table and a blank bar chart on the board as a starting point. These blank templates are intended to help the children realize that the lesson will focus on presenting their data. The lesson is then positioned within the sequence of lessons. The teacher presents two different statements: “Researcher Müllix says: I think that Class 4b produces more packaging waste than general waste.” And “Garbage Collector Matteo says: I think Class 4b produces mostly general waste.” These statements will be revisited at the end, and after the data has been presented and analyzed, a decision will be made as to which statement is correct. The worksheet “We Compare Our Data on Waste 1” is provided for presenting the data. This worksheet contains blank boxes where the children should first note down how to create a bar chart and a table. This task serves to review previously acquired knowledge about different types of data presentation so that, when presenting their data in Task 2, they know exactly what to look for. The children should choose one of the two presentation formats and present their data in the designated field. This is followed by the worksheet “We Compare Our Data on Trash 2” with Task 3. This task involves interpreting the data they previously presented. The children should note down what they can deduce from the data presentation, or what conclusions can be drawn about the trash in their classroom based on the presentation. To assist with the presentation, there are two tip cards,

one for the bar chart and one for the table. Students can refer to these if they are unsure about either of the presentation methods.

The fifth lesson also begins by reviewing the data. The teacher then shows a chart from the previous lesson to refresh the children's memories, so that the class can collectively identify the central issue revealed by the data. The teacher also shares another quote from Matteo the garbage collector:

"The best thing to do is just throw all the trash in the compost bin—that way, no other trash is created." The students should recognize the garbage collector's supposed solution as impractical. This discussion and the garbage collector's ineffective suggestion should motivate the children to develop their own solutions. To document and develop their solutions, the illustrations from Lesson 4 and blank DIN A3 posters are needed. Following this work phase, the students should present the ideas they have developed to the whole class during the reflection. The poster serves here to visualize the ideas. At the end of the lesson, all children receive a "Data Expert Certificate" for their participation in concluding the lesson series.

Assessment

The assessment of the stated learning objectives and expected competencies could take the form of a written assessment that combines various question formats with the various topics.

In this assessment, students can first explain the impact of human waste production on the environment in short tasks. This could then be followed by tasks involving data collection and processing. The students first explain

step by step how they proceeded during the weighing process. In the next task, , they then describe, based on the measurement guidelines, what needs to be taken into account. In the final task regarding the data, they should then explain in a few sentences what results emerged regarding waste generation after the data was analyzed.

Finally, an open-ended task could follow in which the children can develop and justify possible actions for waste prevention at school. Optionally, they could also explain and justify the idea developed in the fifth lesson in more detail. This assesses the extent to which the students can apply their insights from the data analysis to a specific problem and derive meaningful solution strategies from them.

Annex