Teachers Teaching with Technology™

T³ EUROPE

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Garbage in the Classroom

How to build your own garbage solution.

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How to build your own garbage solution

1. Learning objectives

a. Learning objective and curriculum

In the garbage project students learn about the waste problem in the wider world but especially in their own country. They get a little insight into the amount of waste that is produced and which kinds of solutions are used in their own country to diminish the garbage. The physics curriculum in the Netherlands allows the possibility to choose 2 out of 4 topics. These topics are not tested by the central exam and the learning outcomes are loosely defined. These topics provide an opportunity to the teacher to bring their own interest into the classroom. One of these subjects is technical automation.

In this garbage project students are invited to build their own garbage solution. The garbage problem is used as a basis for smaller projects:

- Garbage collection
- Separation of metals from garbage
- Separation of plastic from garbage
- Cleaning glass bottles
- Reducing the volume of non-recyclables

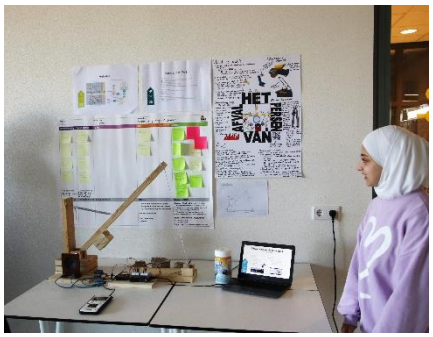


Figure 1: Final presentation. Scrum board, poster and solution. Photo C. Baars

The students had to investigate their subproject and to design and build a technical solution for their project. During the project they have to present 3 times their work:

- A poster presentation about the dimension of their subject in real world (how much garbage etc.?)
- A PowerPoint presentation including: 2 drawings of solutions, a flow chart of their computer program and 2 movies about the testing of partial solutions
- A final presentation of their garbage solution including a totally automated system for their garbage problem.

The students worked in groups of 4 using the scrum method. Every group had a scrum master and a scrum board to administrate their work.

In this project the following learning objectives were covered:

- Technical automation
- Technical design and the design cycle
- Presentation skills
    - Poster
    - PowerPoint
    - Video
- Programming
- Group work and group responsibility

Figure 2: Students discussing the scrum board. Photo M. Goulmy

This project covered many learning objectives and therefore could last 3.5 weeks of 4 lessons a week.

b. Science background

In this project students built their own solution. They had to use the hub and make a little program in python. The most programs were very simple. A motor had to turn a few seconds and then a different motor had to turn. Or they used a program that was written to let a speaker make a sound to collect metals from the garbage. The most programs were at maximum 10 lines. They were very surprised that they could use the same programs again and again (which was a nice learning outcome).

The following physical subjects were used:

- Electromagnets with coil and core
- The Law of Moments
- Displacement, velocity and time

The students knew a little bit of programming in Python. Before the garbage project they followed an online course in programming art during the lockdown period.

c. Connection with Sustainability Development Goals

In this project students become aware that there is a garbage (waste) problem. But much more importantly they find out that they are able to do something about the problem with simple equipment from school and that “grown-up problems” can be solved by them and in future will have to be solved by them. This is part of goal 4: Quality Education. The groups were blindly composed on the basis of skills not friends. The scrum master chooses his/her partners from a list of skills each student provided at forehand (no names were shown). This gave all students, boys and girls, equal importance in the project (goal 5: Gender Equality). Working on a real authentic problem which gave insight to students that there is a waste problem and that we had to work on it is part of goal 12. Goal 12 is about Sustainable Production and Consumption patterns and is intimately linked to the production of waste.

2. The garbage project

Before the students started this project, they followed 12 lessons about programming art during the lockdown period. They were familiar with Python on the computer although it was not very thorough. The project flow will be described in 4 phases. To let the students work more efficiently in groups the scrum method is used. For more information about scrum at school, the following website (in Dutch) is helpful: https://scrumatschool.nl/

or in English https://www.scrum.org/

The following garbage subprojects were defined:

- Garbage collection
- Separation of metals from garbage
- Separation of plastic from garbage
- Cleaning glass bottles
- Reducing the volume of non-recyclables.

You need as many subprojects as groups in the class. The groups consisted of 4 people.

Skill chart

I am:

	Friend 1	Friend 2	Friend 3	Own
Creative				
Ambitious				
Independent				
Reliable				
Responsible				
Positive minded				
A go-getter				
Good in building structures				
Good in problem solving				
Good in programming				
Good in tinkering				
Good in planning				
Good in technic				
Good in couraging people				
Good in activating people				
Good in taking the lead				
Good in helping people				

a. Phase 1: Composing the groups

The working method is the Scrum method and the groups are composed on the base of the skills of each student. Therefore, each student had to choose 5 skills from a list that he/she possesses. The student handed the complete list to 3 friends and asked them to fill the form also for him/her (without seeing the skills chosen by the person or other friends). The student compared his/her list of skills with the list of skills that their friends said that they possessed. Then the student decided what their strongest skills were and what he/she would offer for the project. Every student filled a Google Forms document with 3 of their best skills.

5 Scrum masters choose in turn a group member from the offered skill list (without seeing the name of the student). The Scrum masters need to know that all skills are needed to fulfill the project.

Phase 1 takes 1 or 2 lessons.

b. Phase 2: Working on sprint 1 (this is Scrum terminology), background information about subproject

Students need to look for background information about their subproject. The following questions must be addressed (at least):

- What is the amount of garbage you are talking about?
- How much money is spent every year for this problem?
- What solutions are used at this moment to solve the problem?
- What physical topics are involved?
- What does it look like?
- What are the design requirements for your solution?

Students have to deliver sprint 1 as a poster with a presentation. Sprint 1 is graded with the aid of a rubric.

Table 1: Rubric of sprint 1

Skill	4	3	2	1	score
Use of time	Effectively and productively time use	Most of the time effectively an positively time use	Some time is used effectively and productively	No efficient time use	
Pictures/graphs	Clear and relevant pictures	Most are relevant and clear	Some are relevant and clear	Not relevant or clear	
Required elements	All elements are present and well organized	Most elements are present and/or well organized	Some elements are present or well organized	Missing most elements	
Clarity and appeal	Very nice design and layout	Nice design and layout. Improvement could be made	A lot improvements can be made in the design and layout	No poster or no clarity or bad appeal	
Language	No mistakes in grammar, punctuation and clearly own work	Minor grammar or spelling mistakes	Many errors	Not own work	
Problem definition	Clear problem definition, good formulation	Clear problem but not clearly formulated	Have a notion about the problem but not clear	Vague idea about the problem	
Requirements	Good list of testable requirements	Good list but not good formulated and testable	A few requirements	Vague or unclear requirements	

Phase 2 takes 1 week of 4 lessons of 40 minutes and if wanted by students some spare time.

c. Phase 3: Working on sprint 2, testing of partial solutions

In this sprint students try different partial solutions of their project. They investigate if things work as they expected them to work. The students may also update their requirements of the project if parts are not working. In fact, the students make small design cycles of sub problems. During this process students need to make movies of their testing and schematic drawings of their solutions.

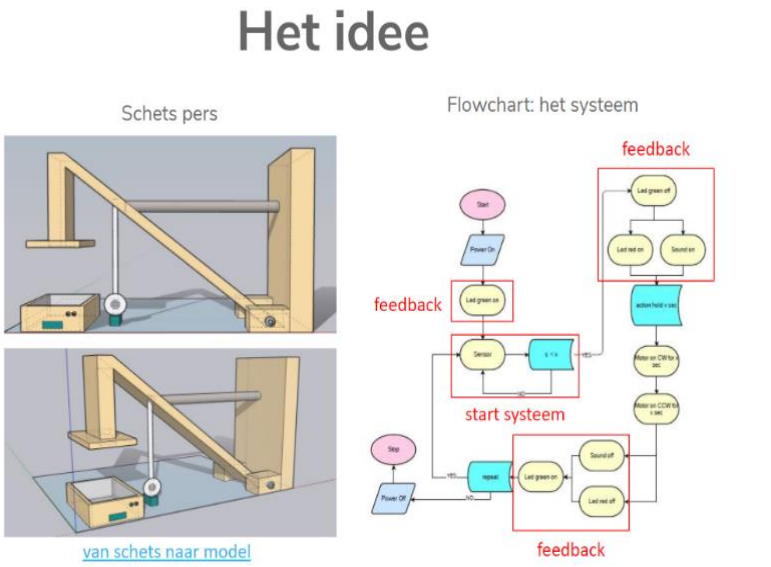


Figure 3: Schematic design drawing and flow chart, created by E. Boots

The delivery of this sprint is a PowerPoint presentation including at least:

- 2 partial solutions of their problem
- A schematic drawing of the solution
- A testing report
- 2 movies of the actual testing.

This PowerPoint presentation is graded with a rubric

Part	4	3	2	1	Score
Requirements	Good list of testable requirements	Good list but not good formulated and testable	A few requirements	Vague or unclear requirements	
Partial solutions	Every problem has at least 2 different solutions	2 solutions for every problem	1 solution per problem or more solutions for only 1 problem	No or no relevant solutions	
Testing	Good testing, good evaluation and rapport	Good testing without proper evaluation or rapport	Bad testing, superficial testing	No testing	
Relevance	Good solution for relevant problems	Good solution but not clear for what or why	Vague solution for a vague problem	No relevant solutions	
Design of solution	Clear drawings with details and sizes and flow chart of program	Drawings and flowchart with limited details	Sketches of solutions without details	No sketch or flow chart at all	

Phase 3 takes one week of 4 lessons and some spare time

d. Phase 4: working on sprint 3 at final delivery of project

In this last sprint students have to work on their final product. A solution for their problem that works totally without the assistance of a human being. This phase takes about 4 to 6 lessons. On the delivery day it is nice for the students to have access to their project the whole day to be able to do the last (always lengthy) adjustments.

The final product is also graded with a rubric.

Part	4	3	2	1
Panning	Clear design drawings including sizes and connections	Design drawings with little detail	Sketches without details and thinking	No design drawings
Quality	Totally independent working solution	Solution needs small human assistance	Solution needs much help	Solution is not working
Appearance	Nice, appealing, stable and robust	Reasonable stable and robust and nice to see	Product very unstable and fragile	Fragile, messy, falling apart
Programming skills	Program works and is clever programmed	Program needs some help	Program works a little	Program is not working at all
Fulfilment of requirements	All requirements are fulfilled.	Most requirements are fulfilled	Some requirements are fulfilled	No fulfilment.

The total grading of the project is based on the grades of the 3 sprint deliveries. The total score was 28 + 20 + 20 = 68 points.

3. Used equipment

For this project the following equipment is used:

- TI-Nspire™ with Python
- Hub with cables
- Servo-motors, MOSFETs, light sensors, LEDs, speakers and breadboards
- K'NEX®
- Lego® Technics™
- Straws, glue, lollipop sticks, thread, plastic, wood, screws

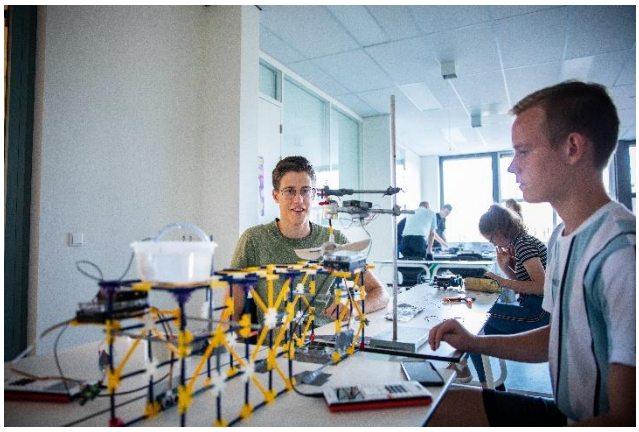


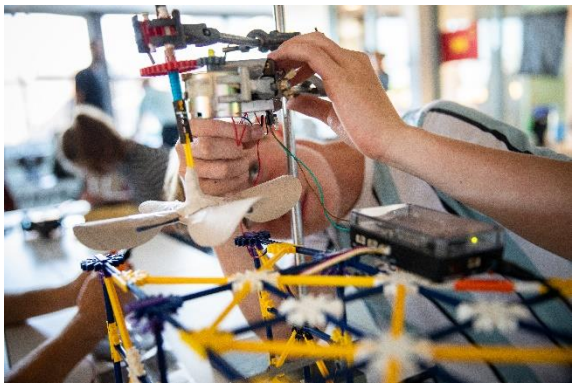
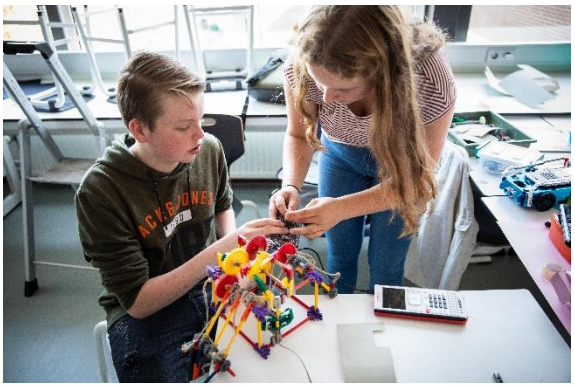
Figure 4 K'nex used to build a glass wash street. Photo M. Goulmy

On the following page is a gallery of pictures made during the project

4. Gallery

All photos are made b by M. Goulmy.





A video impression about the project is found at … https://www.t3europe.eu/en/t3-europe/edublogs/waste-solutions

5. For more information

More information is available at Cathy.Baars@martinuscollege.nl.