

Teaching method

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1 Comments for teachers

Every day, young people make judgments about aspects of life they're familiar with – at school, within their family, and among their friends. Shouldn't they also be able to understand and make judgments related to the environment?

The goal of the **Experimento Game** together with this teaching method is to increase the students' awareness of the complexity of environment-related judgments, point out to them the necessary conditions for making a fair judgment, and create an understanding for others' judgments. They should become aware of their own interests and be able to analyze them.

The digital game opens up new possibilities because the players are put in a dual role: First, they enter into the game world and the events taking place within it; second, they actively intervene in the events, therefore embracing them as their own.

1.1 Target group

- Students ages 11 to 13 in all types of schools

1.2 Technical requirements

Recommended system requirements

Operating system	Windows, Mac, Linux
Main memory	4 GB RAM
Processor	Modern dual-core processor over 2.7 GHz
Graphics card	Dedicated
Programs or browsers	Mozilla Firefox or Google Chrome
Additional hardware	Keyboard
	Mouse
	Monitor (min. resolution 1024 x 768 pixels)
	(optional) speaker/headphones

To reach as many users as possible, we decided to create the game as a browser version. This offers the advantage that all common desktop operating systems (Windows, Mac, Linux) are supported (mobile operating systems such as iOS and Android are **NOT** supported). The users only need an up-to-date desktop browser to run the game. Since the game uses new Web standards like HTML5 and WebGL, the desktop browser must also support them. To be able to play the game online and offline, users should have Mozilla Firefox (Version 53.0.3 or later) or Google Chrome (Version 59.0 or later) installed, both of which are available for all desktop operating systems free of charge. Use of the new Web standards means that **NO** additional plug-ins (for example, Adobe Flash Player) are required.

The browser game runs well on a system that meets the recommended requirements. The loading progress of the game is indicated by the loading symbol. Once the display reaches 99 percent, it may still take a moment until the game is ready to play. If individual systems still do not display the Experimento Game fluidly, it may be for the following reasons:

- The system is being used to capacity by other programs (for example, antivirus software).
- The main memory may be insufficient due to open programs running in the background (for example, Word).

- Other browser tabs open in the background are using the system's computing power (for example, YouTube, Spotify).
- The operating system is slow.

1.3 Game content

The **Experimento Game** is a point-and-click adventure. It unfolds as a linear plot made up of two successive moral dilemma stories and integrates puzzles, search tasks, and combinatorial tasks. The game starts with a tutorial phase that illustrates the controls in the game in an entertaining way (making a fire, setting up a tent, collecting items in a backpack, etc.). In the digital game, the players go through the moral dilemmas in a different form. They don't just watch how a figure experiences the story; they actively participate and control the figure.

The story in the *Experimento Game* depends on the players' decisions in the dilemma situations and their success in the puzzle and skills exercises. The players all go through a defined storyline.

The players may choose one of three characters at the beginning of the game: Sappho, Dante, or Mokobe.

In addition, the players can select a language:

German, English, or Spanish.

The game can be played with or without sound. Because the sounds are solely background noises, they are not necessary to successfully play the game.

1.3.1 Dilemma story 1: We produce drinking water – methods of purifying water

Der Spielcharakter ist in der Natur unterwegs. Er hat die Nacht im Zelt verbracht und ein kleines Lagerfeuer hat ihn gewärmt. Am nächsten Morgen wandert er durch die Landschaft von *Experimento Game*. Er überquert dabei einen Flusslauf und lauscht dem sanften Plätschern des Wassers. Die Sonne brennt, doch unermüdlich läuft der Spieler weiter. Er begegnet einem Fremden, dieser ist schwach und durstig. Der Fremde spricht den Spieler an und bittet diesen um einen Schluck Wasser.

Der Spieler hat in der Nacht die Wasserreserven fast aufgebraucht. In seinem Rucksack ist noch ein kleiner Schluck Wasser übrig. Der Spieler hat weit und breit keine Möglichkeit Wasser nachzukaufen. Das Wasser aus dem Flusslauf kann er auch nicht abfüllen, denn der Flusslauf ist stark verschmutzt.

Wie entscheidet sich der Spieler?

Behält er das Wasser für sich, oder gibt er seinen letzten Schluck dem Fremden?

Decision options in the game	
(A) I will keep the water for myself because I still have a long way to go!	(B) I will give my last sip of water to the stranger.
Values addressed in the game	
Responsibility, solidarity, sustainability (scarcity of resources), openness	

1.3.2 Dilemma story 2: Waste incineration/waste separation

The game character returns to the city and sees his/her grandmother on the street. This is a happy moment because he/she really likes Grandmother. Suddenly, he/she notices that Grandmother is burning her trash outdoors in an old drum and asks her what she is doing. She answers that she would rather burn her trash than separate it. That's faster and easier for her because she finds

waste separation too strenuous. After all, she is old and that was the way she always did it in the past.

Right next to her is a tree with a bird’s nest full of young chicks that are fighting for their lives in the midst of the dark billowing smoke from the burning trash.

The game character respects Grandmother and always greatly values her opinion. In addition, she is very stern and quickly becomes angry whenever anyone meddles in her affairs.

What will he/she do now?

Will he/she let Grandmother continue to burn her trash or actively intervene?

Decision options in the game	
(A) I will take my grandmother’s trash away from her and separate it later. (active)	(B) I will simply let my grandmother continue burning her trash, and then I won’t have to worry about making her angry. (passive)
Values addressed in the game	
Environmental awareness (treating the environment carefully), responsibility, initiative Underlying ideas: <ul style="list-style-type: none"> ▪ Fostering environmental awareness: do I as a player even recognize a critical situation? ▪ Demonstrating consequences of actions ▪ Do I as a player actively intervene in what’s going on in the game and thus take action to preserve the environment or do I as a player remain passive? 	

Each dilemma story also includes a mini game that offers the player the opportunity to collect points.

In a puzzle and skills exercise in connection with dilemma story 1, the player makes a water filter that is used in the course of the game to make the dirty stream water drinkable.

In a skills exercise in connection with dilemma story 2, the player separates waste.

At the end of the game, the players receive a summary report on their decisions and the points they scored in the game.

1.4 Serious game – why a computer game for teaching?

A steadily growing number of digital games whose primary purpose is to transfer knowledge rather than to entertain are called serious games. Serious games have the advantage that they offer possibilities for interaction, which cultivate an awareness in the players for how their decisions impact their world. Serious games can be highly motivating if the context in which they are used is kept in mind. That’s the case with the Experimento Game.

In addition to critical thinking, the Experimento Game fosters the ability to ask the right questions and the ability to change one’s perspective. The game encourages students to critically reflect on their existing knowledge, independently develop new, relevant questions, and search for answers. The Experimento Game thus boosts the students’ self-confidence and, in an entertaining way, provides them with methods to independently find answers to new questions and solve real problems in the transfer process.

Playing involves forms of learning. It thus helps in the acquisition of competences, knowledge, and experiences and simultaneously in experimentation and discovery. Learning occurs best when it describes an active process, when it is goal-oriented, contextualized, and interesting. Serious games including the *Experimento Game* have this potential.

What value does game-based learning add compared to a real learning situation?

- It spurs motivation through immediate feedback (points).
- It creates opportunities to talk and makes room for discussion and reflection.
- The opportunity to select the game character allows the player to experience being the initiator of his actions.

The game can be used in a wide range of applications. It can be used to prepare for new learning material, to reinforce existing knowledge during class, or to summarize and review as a follow-up to the lesson. A worksheet is available for each scenario (see appendix).

1.5 Focus of the *Experimento Game*: Value formation in a science and technology context

The game focuses on value formation through dealing with dilemma situations in the context of science and technology. The examination of dilemma situations not only helps students learn what principles there are and which of them are most important for the respective individual, but even more so, it encourages them to analyze values and standards and review and reflect on their consequences in everyday life. In view of a lasting transfer of values, it is important that children learn to weigh the arguments for and against something, think critically, and strive to change their perspective. In this respect, working with dilemma stories combined with selected hands-on experiments from *Experimento | 10+* (environment) offers teachers the opportunity to promote the students' capacity for reflection and, most of all, to foster their knowledge of responsibility.

What is the *Experimento Game* designed to accomplish?

- Generate intrinsic motivation in students to examine the topic of waste and water contamination.
- Pique students' interest in the topics of environmental awareness and sustainability and sensitize them to environmental issues.
- Create space and opportunities to speak for reflection: A reflection phase guided by the teacher following the serious game is crucial to value formation.
- Enable students to make decisions in a protected space without having to fear "real" consequences.
- Give students the opportunity to reflect on their behavior in the game and become aware of the reasons for their decisions.

What is the *Experimento Game* not designed to accomplish?

- Convey background and factual knowledge. This can be done by conducting experiments B3 and B4 from Experimento | 10+ and as preparation by conducting experiment B2 Water purification from Experimento | 8+.
- Replace experimentation in class.
- Simulate the conducting of experiments.
- Allow students to design the game how they want.

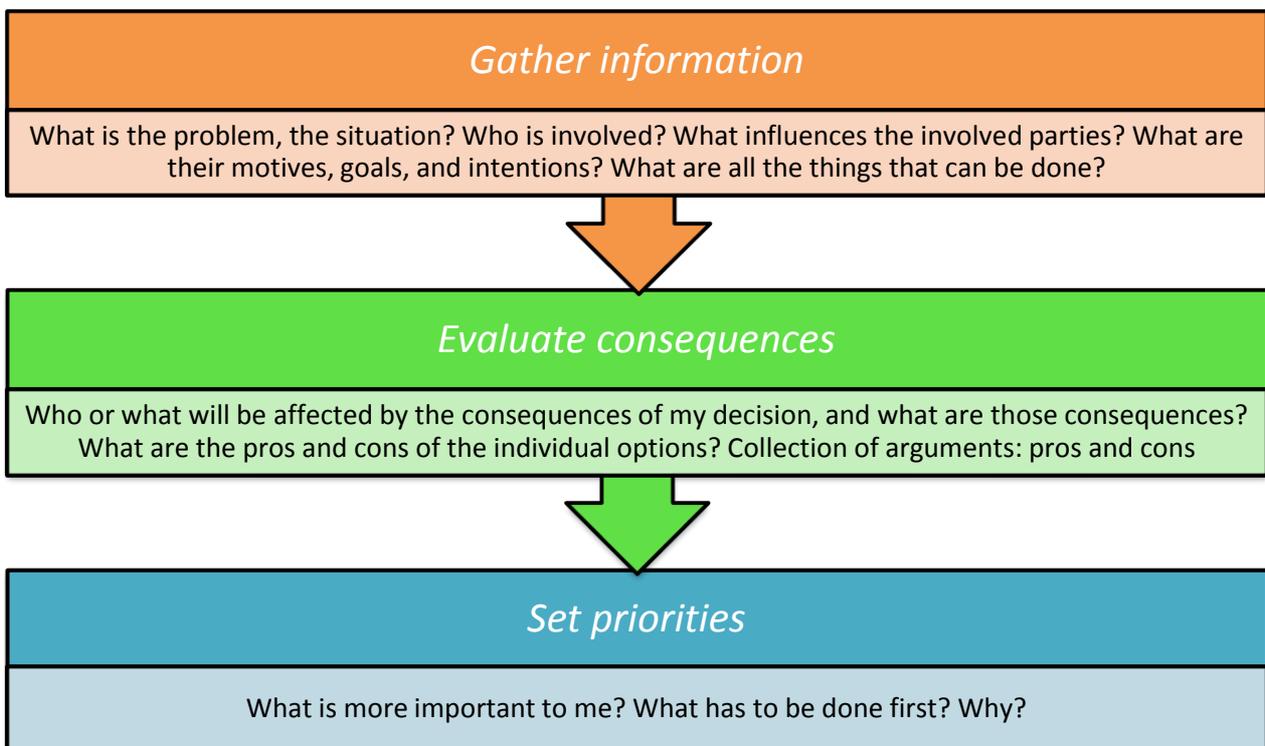
Students' prior knowledge

In principle, prior knowledge is not necessary to play the game. Depending on the scenario that the *Experimento Game* is used for (preparation, reinforcement, summary, or review), it makes sense to have discussed the following topics in class:

- Water as a solvent
- Water as a “vital substance” for humans, animals, and plants
- Protection of natural bodies of water (→ water as a habitat)
- Possibilities for waste separation

Explanations for teachers on handling the dilemma stories

To make a judgment, a person must do the following:



2 Relevance to the curriculum

The aim of environmental education is to train the students to take responsibility for helping shape the natural environment and to build environmental awareness. The fostering of sensitivity to and respect for nature leads to a comprehensive environmental orientation among the students. In addition to ecological knowledge (basic and technical knowledge), the fostering of environmentally responsible behavior in particular is necessary for this.

The destruction of the environment and our natural surroundings is a major issue of our era.

Therefore, schools should especially strive to integrate ecological content in lessons.

Legitimate reasons for environmental education in schools can be derived from the following German legal sources and apply to waste separation and waste prevention as well as to water pollution:

- Bavarian Law on Education and Teaching [Bayerisches Erziehungs- und Unterrichtsgesetz (BayEUG)]

The BayEUG (art. 2 par. 1) explicitly assigns schools the task of “instilling a sense of responsibility for the environment” among the students.

- North Rhine-Westphalia state strategy: “Education for sustainable development (ESD) – Learning the future in NRW (2016 – 2020)”
The state educational strategy aims to “anchor ESD in all areas of the education system in NRW” and also includes the topic of environmental education.

2.1 Z Main issue: Environmental pollution and destruction

Topic 1: Water contamination – water purification

- For many people, having access to fresh, clean drinking water on a daily basis is not a given. The drinking water shortage is one of the largest social problems of the 21st century. Around the world, almost one billion people do not have access to clean drinking water. How is it possible that a planet, two-thirds of which is covered with water, cannot supply its inhabitants with a sufficient amount of drinking water? Among other things, the answer can be traced to the Earth’s growing population, regional water shortages caused by climatic conditions, and the deforestation of water-retaining forests. In many areas, though, the main reason is the contamination of natural water reserves (rivers, lakes, and ground water) by households, industry, and agriculture. Students need to become aware of the fact that often not even groundwater can be used as drinking water without first being treated. (Text from the teacher instructions for Experimento | 10+ “B4 We produce drinking water – methods of purifying water”)

Topic 2: Environmental pollution due to waste – waste disposal and waste separation (recycling)

- The constantly growing flood of waste and garbage from households and industry is increasing global pollution and in fact endangers the foundations of human life. One example is plastic waste in the oceans, which is beginning to endanger fish populations in many locations. For this reason, waste prevention and waste recycling are important goals when it comes to protecting the environment. The exploding prices of raw materials and resources that are becoming increasingly scarce require that industry, private companies, public offic-

es, and private households carefully and consciously conserve the valuable resources of our planet. “Recycling all waste materials” is one of the solutions.
(Text from the teacher instructions for Experimento | 10+ “B3 How does waste separation work? – Separating materials by density and magnetism”).

2.2 Einordnung in den Unterrichtszusammenhang

The game is closely related thematically to several experiments from Experimento | 8+ and Experimento | 10+ and can be used in the course of conducting these experiments. The instructions for teachers and students can be found on the medial portal:

- “B2 Water purification” (Experimento | 8+)
(Link: <https://medienportal.siemens-stiftung.org/portal/main.php?todo=showObjData&objid=106150>)
- “B3 How does waste separation work? – Separating materials by density and magnetism” (Experimento | 10+)
(Link: <https://medienportal.siemens-stiftung.org/portal/main.php?todo=showObjData&objid=105031>)
- “B4 We produce drinking water – methods of purifying water” (Experimento | 10+)
(Link: <https://medienportal.siemens-stiftung.org/portal/main.php?todo=showObjData&objid=105033>)

3 Acquiring competence

3.1 Technical competence

The students will ...

- understand the process of filtering water through a simple filter system.
- be able to reflect on the causes of water contamination.
- realize that not all pollutants and substances that are harmful to health can be identified with the naked eye.
- understand the filtering properties of the individual filter components (paper filter, activated carbon, coarse and fine sand, moss).
- analyze their own practical experiences and opinions of waste separation.
- reflect on the separation of waste types according to categories as they have become common in private households (glass, paper, plastics, biological and residual waste).
- learn how to use resources responsibly.

3.2 Methodical competence

The students will learn (especially in connection with the hands-on experiments) ...

- to work in a group.
- to approach problem solving.
- to give feedback.
- to discuss and reason.

3.3 Computer- and information-related competences

The students will learn ...

- to process and generate information by playing the game.
- to use a new digital medium (computer game) in a reflective manner.

4 Appendix

Worksheet 1: Preparing for a new topic

Worksheet 2: Reinforcing existing knowledge during the lesson

Worksheet 3: Summarizing and reviewing in the follow-up to the lesson

Worksheet 1

What influences our judgments?

We make numerous judgments every day: Chocolate ice cream tastes better to me than vanilla ice cream. Finishing my homework now is more important than going to the movies. We don't make these judgments independent of influences. What influences them?

To what degree are we influenced by which people in the following situations?
 Make entries as follows:

Strongly influences me: ++
 Influences me: +
 Hardly influences me: o
 Doesn't influence me at all: --

Add more factors and situations as needed!

Factors 									
Situations 	Friends	Parents	Rules/ laws	Media	Adverti- sing	Role models and stars	Religion	Own experi- ence	
Hobbies									
Clothing style									
TV									
Waste separa- tion									
Conserving drinking water									

Worksheet 2

Introduction to the topics of water contamination and waste separation

The topics of **water contamination and water purification** can be handled in class in various ways; they are key topics that every child should know about.

The following are important questions that need to be clarified:

- What is water used for? (nature/people)
- Where does water come from? (water cycle)
- How is water purified? (mechanical, biological, chemical purification)
- What bodies of water are there? (stream, river, lake, ocean)

The topic of water is particularly important as a basis for future science subjects like chemistry and biology, for which a basic understanding of water is a prerequisite.

The topics of **waste prevention and waste separation** are just as important as the topic of water contamination:

The main issues can be discussed in class:

- What methods of waste separation are there?
- Why is separating waste important?

Dilemma discussion as a method in STEM teaching

Introduction to dilemma situations – What is a dilemma situation?

Moral dilemmas are characterized by the fact that it's not immediately and clearly obvious which decision is morally correct and thus required. The classic dilemma situation – the genuine ethical dilemma – is 'two-pronged,' that is, for a chosen action there exist at least two different possible decisions for which nearly equivalent arguments can be made for and against the action. Only in rare cases are clear solutions possible. Rather than making a final decision, the purpose and benefit lie in the discussion of various alternative actions.

Lead a dilemma discussion based on the two moral dilemmas in the game!

Several different methodical procedures are possible. A few will be presented here:

- I. Group discussion
- II. Discussion in pairs
- III. Take a stand – define a position

Group discussion

Brief description

The presentation and discussion of alternative actions with respect to the specific morally difficult situation teaches students how to deal with their own moral beliefs and allows them to experience an – often prevailing – equivalence of moral decisions.

Instructions

First, read the dilemma situation aloud. Any questions about meaning can be clarified at this time. Then divide the students into small groups. We recommend giving a copy of the dilemma to each group. The groups should then discuss which of the possible actions is the best one for them and collect the arguments in favor of it. At the end, the results are presented to the entire class.

The results can be presented in a wide variety of ways and the presentations simultaneously determine the subsequent discussion method.

Various possibilities include the following:

- Oral presentation of the selected possible solution
- Dramatic presentation of the selected possible solution
- Poster (drawing, collage, mind map, etc.) showing the situation, the possible solution, or both

Analysis

The discussion that follows the presentations of the possible solutions by the individual groups is simultaneously part of the analysis. As already mentioned, several procedures are possible here, which of course must be related to the selected form of presentation.

Various possibilities include the following:

- An open discussion is facilitated by the teacher.
- The designed posters are hung up in the room and discussed in succession. Each group can explain its poster and answer questions, or the other students can first describe what they see and guess which possible action is being presented.
- The prepared skits are performed and discussed individually.

After a discussion, it may also be possible to think up and give a joint presentation that includes various aspects and possible solutions. For each form of presentation, the analysis should always include the respective group's reasoning.

- Why did we specifically choose this possibility?
- What alternatives did we also consider?
- Why did we not select the alternatives?
- In our opinion, what are the arguments against the other possible solutions?

Discussion in pairs

Brief description

see above description.

Instructions

First, read the dilemma situation aloud. Any questions about meaning can be clarified at this time. Then all possible alternative actions are collected. One of the actions is selected. The students now line up in pairs facing each other. One student of each pair represents the position in favor of this possible action; the other represents the opposite position.

The teacher gives the start signal for the discussion of the individual pairs. After two to five minutes, the teacher gives another signal, and the students switch pro and con positions within the discussion pair. The student who was previously for the alternative action is now against it; the student who was initially against it is now for it. They should discuss their positions again for two to five minutes.

Analysis

In the analysis that follows, all arguments should be collected. They are immediately sorted into pro and con arguments, for example, on a flip chart. The responses (or direct counterarguments) in each case can thus be sorted immediately (such as in a table). Afterwards, the students should exchange their experiences about the discussions in pairs with the entire class.

- Did I think that my partner's reasoning was conclusive?
- Was I able to respond to my partner's argumentation?
- How did he/she respond to my arguments?
- Which position is easier for me to represent?
- Which position is more in line with my own opinion?

Position beziehen – Standpunkt festlegen

Brief description

see above description.

Instructions

First, read the dilemma situation aloud. Any questions about meaning can be clarified at this time. Then all possible alternative actions are collected. Now a line (approximately 10 meters long) is drawn, laid, or taped on the floor. The midpoint of this line is also marked. One end of the line reflects the position in favor of the alternative action, the other end the position against it. The midpoint represents a neutral position. Now the collected alternative actions are read aloud and the students must stand at the location on the position line that represents their own position. The students can stand at any point along the entire line in order to take an ambiguous position on the presented alternative action.

Analysis

The individual students are questioned about their positioning.

- Why did you stand exactly here?
- What does your position mean?
- Did you deliberate for a while before you decided?

Depending on the size and discipline of the group, the teacher may only want to question the students about their position. However, the discussion will be more varied if several situations and alternative actions are processed in this way and different students are questioned about their position each time.

Additional assignment

Look for examples of other dilemma situations that people can get into.

Create a table according to the following template:

Situation/dilemma; What is the conflict?	Ethical rules involved	Values involved	Suggested solution for the conflict

Worksheet 3

Waste disposal and waste separation

The sequence at a glance

The students first fill out the waste separation quiz.

- Give them 15 minutes for the quiz.

In the second step, as a class, discuss a letter to the editor on the topic of waste.

- Show the letter to the students and ask them to take a position on it. Is it possible to let such a letter stand without comment? Divide the students into small groups and have them collect and write arguments on cards. Collect all of the arguments for a counterstatement and structure the arguments in a class discussion.

Letter to the editor on the topic of waste disposal and waste separation

Prevent waste – yes, but how?

Nearly everything you can buy is packaged! How am I supposed to reduce my amount of waste? Why should I reduce waste anyway? After all, waste can be burned or deposited in a landfill. There's enough room for landfills. And why should I separate my waste? Collecting waste in separate bins is an imposition for everybody. You need three or four different trash cans in the kitchen and have to spend more time separating waste than cooking. I often stand there trying to decide what I'm supposed to toss in which can. Schools would have to introduce the subject of waste separation so that at some point everybody will understand the sorting. Therefore, I'm in favor of bringing back one large bin that we can throw everything in.

Tanya Tidy, Rubbishville

Waste separation quiz

In which bin does each type of waste belong? Please mark with an X.	Paper bin	Glass bin	Organic waste bin	Residual waste bin	Special bag
Vegetable scraps					
Jam jars					
Aluminum foil					
Light bulbs					
Yogurt container					
Ash					
Wilted flowers					
Cardboard boxes					
Diapers					
Newspapers					
Coffee filters					
Milk cartons					
Plastic sheets					
Food cans					
Cigarette butts					

What can be made from recyclable materials?

Name an example for each category.

Organic waste	
Plastic waste	
Scrap paper	

5 Please give us feedback

Dear teacher,

With the short *Experimento Game* computer game, we hope to provide you with a modern format as an additional method of value formation in science and technology education. We would love to hear from you whether we've succeeded. We're particularly interested in the following questions:

- How did you use the *Experimento Game*? Before, during, or after the lesson?
- Have you discussed with your students the decisions they made?
- How did you organize the reflection phase?
- Did you conduct experiments from Experimento | 8+ or 10+ on the topics of waste and water purification beforehand or afterwards?
- How well did you and your students get on with the game?
- Do you have criticisms?

It would be nice if you would take a little time to answer these questions. In this way you will be helping us refine the project. We eagerly look forward to your constructive feedback! Simply write an e-mail to: medienportal@siemens-stiftung.org

Many thanks for your assistance!