TRAINING AND TEACHING • PROGRAMME FOR INNOVATIVE •

PIT

2#Climate Killer Internet

2.1 Didactic Commentary

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Climate, war, coronavirus – three major crises that are heavily affecting the lives of the younger generation. In fact, most young people in Europe see them as the most pressing challenges of our present and future (Eurobarometer 2022; for Luxembourg: YSL, Youth Report). Global warming issues such as climate justice and behaviours that preserve natural resources (e.g. veganism, avoiding air travel) are much-discussed topics among young people on social media. Like in many other areas, it is a constant struggle to distinguish between facts and opinions, especially in this age of fake news. The newspaper Le Monde diplomatique recently published the article `No such place as the cloud', about how internet use impacts the climate and the environment. The high energy consumption of data centres for streaming Netflix series, for example, the costly and massive cooling systems running 24/7 for the data infrastructure, or the resource-devouring extraction of rare earths for the production of smartphones are already well known at the scientific level. However, research on Instagram, Facebook and Twitter shows that these effects of digitalisation are less often discussed or considered by young people. A discussion in classrooms about the ecological footprint of individuals can therefore make pupils reflect on their own resource consumption. On the other hand, a critical awareness of social and ecological causes and consequences of human intervention in ecosystems can be cultivated by teaching them productive and receptive argumentation skills using real-world examples. At the same time, the processes for forming own opinions and individual value systems can also be made transparent. Argumentation skills are an essential learning outcome for all subjects and a prerequisite for social participation, 'with the help of which one's own economic, political, ecological or social interests can be actively asserted in a considered manner' (Budke & Uhlenwinkel, 2011, p. 114).

One very useful tool for intuitively collecting and weighing up arguments, but also for discussing, negotiating and revising them in individual and group settings, is the argumentation seesaw (https://argumentationswippe.de). It allows the user to spontaneously add arguments for and against, prioritise them and finally form a judgement and their own opinion on the issue being evaluated. When the tool is used for the first time (or when argumentation skills and inference processes are discussed with a class for the first time), the focus initially is not on elaborate argumentation methods and rhetorical techniques. Instead, it is often a matter of making it clear to the pupils how a collection of facts and the formation of arguments based on these facts differ from their own opinion, and then assessing the soundness of the arguments together with the pupils. This can be done within the subject of Life and Society (VIESO) or in interdisciplinary teaching settings, such as when covering naturalistic, is-ought fallacies or the Toulmin argument model (for pupil-centred approaches, cf. Pfeifer, 2022, p. 7–27 and Hilgart, 2017, p. 7–11), but also in one's own subject-specific domains (cf. Tumbrink, 2018, as an example for geography lessons).

This module is expressly not about emphasising only the negative implications of internet use. After all, digitalisation and the internet don't just offer many benefits – they have become indispensable tools in this digital age. Of course, watching the information video or using the digital argumentation seesaw will also generate carbon emissions, but this should not just be seen from a negative perspective, as these actions also serve a beneficial purpose. The work in this module is mainly intended to highlight the dilemma that our society is currently facing, as well as making us question our own value hierarchies and justification strategies and come up with ideas for solutions. You can learn more about this topic in the interview with Dr. Benoit Mattlet, in which we discuss the constant rise in electricity consumption, as well as digital solutions for monitoring it more effectively.

References:
Budke, Alexandra & Uhlenwinkel, Anke. (2011). Argumentieren im Geographieunterricht – Theoretische Grundlagen und unterrichtspraktische Umsetzungen. In: Meyer, Christiane et al. (Eds.), Geographische Bildung (S. 114–129). Braunschweig: Westermann.
Europäisches Parlament & Europäische Kommission. (2022). Future of Europe 2021.
Hilgart, Johannes (Ed.). (2017): Standpunkte der Ethik: Lehr- und Arbeitsbuch für die gymnasiale Oberstufe. Paderborn.
Ministère de l'Éducation nationale, de l'Enfance et de la Jeunesse & Université du Luxembourg (Ed.). (2021). Rapport national sur la situation de la jeunesse au Luxembourg 2020. Le bien-être et la santé des jeunes au Luxembourg.
Pfeifer, Volker. (2022). *Ethisch argumentieren. Eine Anleitung anhand von aktuellen Fallanalysen. Paderborn.*
Tumbrink, Jonas. (2018). Argumentationswippe. Reflexion von Wertmaßstäben durch das Gewichten von Argumenten. *Praxis Geographie*, 7/8, 36-39.

2.2 Lesson planning

01 | Theme of the lesson within the overall structure of the key topics

Module	Axes	Focus	Interdisciplinary ideas and link with other subjects
#Involution	Topic 1 My digital world and me!	• Games and algorithms • Algorithm of the shortest path	• Mathematics • Geography
#Climate Killer Internet	Topic 2 Understanding the internet: the World Wide Web and me	• Internet and climate • Judgement skills	• VIESO (Life and Society) • Geography • German • French
#Data Viz Superpowers	Topic 3 Do you speak Informatique?	• Different types of data visualisation • Manipulation of graphics	• Artistic education • Mathematics
#Discover Life on Mars with a Rover	Topic 5 Robots, partners for better or worse?	• Programmation en Scratch • Educational Robotics	• VIESO
#Pupils vs Machine	Topic 6 Is there a machine as intelligent as I am?	• Basic functioning of AI	• Mathematics • VIESO

Since the modules do not follow on from one another, the *#Climate Killer Internet* module can be taught without having covered any of the other modules.

02 | Conditions of unit

1. Target audience: 7e–5e (first to third year of secondary education)
2. Room: A projector can be used for the presentation, which can optionally be controlled using an iPad or a computer in the classroom.
3. Facilities: Each pupil needs a smartphone or tablet and a pair of headphones, so that they can watch the information video on the internet.
4. Time: Two lessons – ideally one double lesson.

03 | Contextualisation of knowledge

A recently published study shows that the carbon footprint of the internet is at least as big as that of all air traffic worldwide (Freitag et al., 2021) or even bigger. The researchers estimate that the internet and computers account for between 2.1% and 3.9% of global greenhouse gas emissions. Depending on the source, the proportion of carbon emissions caused by air traffic varies between 2.5% and 3.01% of global CO2 emissions (Statista, 2022, IEA, 2020, Ritchie, 2021).

Everything on the internet consumes energy, be it googling something, sending emails or streaming. For a single search query on Google, the average computer consumes exactly the same amount of electricity that is needed to light a room with a 40-watt energy-saving bulb for half an hour. However, how much a device actually consumes depends on the hardware and on the behaviour of the user.

Streaming videos or music also uses energy. One hour of streaming or a one-hour video conference call will produce 3,200 grammes of carbon emissions (Statista, 2022). Among other things, this is due to the huge cooling systems that have to run around the clock to make sure the data infrastructure doesn't overheat. For comparison purposes: Driving 10 kilometres causes 1,500 grammes of carbon emissions. The climate compatibility of cloud services such as video streaming therefore depends largely on which energy sources the providers (e.g. Netflix) use to power their data centres. In the case of YouTube, 56% of the electricity consumed is 'clean energy' (Cook, 2017). It also makes a difference which technology is used to transmit the data from the provider to the users. For example, the German Environment Agency (2020) found that transmission via fibre optic cables is the most environmentally friendly method.

Digitalisation and using the internet have become an integral part of the lives of pupils and are also necessary for them to participate in social life. However, within the context of climate change, they are not completely harmless. This topic is therefore especially suitable for making the pupils question their own value hierarchies.

04 | Didactic transposition

a. Learning outcomes and target skills

The pupils can explore and elaborate on the internet's impact on the climate and develop a critical awareness of it by considering their own value hierarchies and justification strategies.

Sub-objective: The pupils understand the concept of the argumentation seesaw and are able to apply it.

Learning outcomes from the Media Compass[1]

- Comptences 1 – Information and data: 1.1 Filtering and researching data, information and digital content, 1.2 Analysing and assessing data, information and digital content
- Competences 2 – Communication and collaboration: 2.1 Work with others, 2.2 Sharing and publishing data, information and digital content
- Competences 5 – Digital world: 5.2 Interacting with the digital world in a socially responsible way

[1]https://www.edumedia.lu/medienkompass/medienkompass/

b. Didactic justification

The contextualisation of knowledge already shows the omnipresence of carbon emissions generated by using the internet. The objective within the subject Digital Sciences – i.e. for individuals to become aware of what their own online activities and behaviour have on themselves and others (De World Wide Web, säi Netzwierk an ech) – is being pursued with this learning arrangement.

c. Didactic reduction

The pupils' ability to make factual judgements and value judgements is developed by visualising (on a virtual seesaw; www.argumentationswippe.de) the judgement process for the impact of internet use on the climate.

Based on the analysis and interpretation of sources and representations, pupils as well as scientists can form different judgements and opinions by attributing different importance to positions and, in particular, arguments. With the argumentation seesaw tool (www.argumentationswippe.de), arguments can be collected, categorised and weighed up. The seesaw makes it clear to the pupils that it is not just the number of arguments 'for' or 'against' using the internet that counts but, above all, how relevant these arguments are. This is shown by visualising the arguments on the seesaw. The digital seesaw helps pupils to reflect on judgements by evaluating their own and other people's positions and by questioning and revising the rationale. In doing so, the pupils use their personal priorities regarding their values to put forward and weight arguments. It is not about finding one specific solution in a judgement phase. Rather, it is always about 'reasoned potential solutions' (Kayser & Hagemann 2010, p. 38). This means it is not so much the results that matter in the end but, rather, the individual thought process, the reasoning and the weighting as an argumentation basis.

05 | Over the course of the lesson

In preparation for the subsequent double lesson, the pupils figure out themselves at home how the argumentation seesaw works. This flipped approach leaves more time in the classroom setting to work on the topic 'Climate Killer Internet' and apply the seesaw method. Pupils receive a corresponding worksheet (M1) and try out the concept at home.

As an introduction to the classroom phase, the teacher projects the two pictures (M2) as inspiration for ideas. In a group brainstorming exercise, the pupils discuss the pictures (approx. 10–15 minutes). Their comments are either recorded on a digital pinboard (Miro, Padlet, TaskCards), or they can be written down on index cards and pinned to a board. In this phase, the teacher directs the lesson with stimulus and guiding questions, in order to ensure that the pupils understand and can explain the concept of the ecological footprint and they can define 'ecological footprint' in their own words. They also identify which of their own behaviours might increase and/or reduce their personal ecological footprint.

In a transition phase (5 minutes), the teacher discusses the explanations and definitions of the pupils and explains how the concept can be used to 'measure' lifestyles: Every human being leaves behind their own ecological footprint (also called 'environmental footprint' or 'carbon footprint'). This makes our personal lifestyle (how we live) measurable and comparable. Our planet's resources are finite. The question should therefore be: 'How much do I consume myself?' Food, clothing, mobility and energy consumption are all taken into account in the ecological footprint. It is possible to calculate how much CO2 an individual generates through behaviours such as eating meat or travelling. The smaller the footprint, the less damage their behaviour causes to the planet. In this phase, the pupils can put their own thoughts and ideas into context within the scientific discourse on sustainability.

The following work phases are based on the think-pair-share concept. The first work phase (15–20 minutes) is therefore the think phase, during which the teacher sets the pupils a task to complete individually. The pupils watch the video on their tablets with headphones (M3). They are also given a worksheet (M4) with guiding questions for analysing the video. As an alternative, weaker pupils can be given a text in plain language (M5) and a corresponding worksheet (M6) instead. The pupils must identify and document the arguments 'against' that are put forward in the video. Using the worksheet, they also develop and document arguments 'for' independently.

In the subsequent transition phase (10–15 minutes), the teacher can clarify any questions about the video in the group. The argumentation seesaw introduced in phase 0 is then presented as a tool for the subsequent work, and the pupils are split into groups of two to four, depending on the size of the class. This concludes the first of the two lessons.

The second lesson begins with the pair phase, in which the teacher sets the pupils the following task: 'Using the argumentation seesaw, come up with a reasoned opinion on the suggestion that the internet should be shut down for climate reasons.' The pupils present their arguments for and against (which they wrote down on their worksheet during the think

phase) to the other group members, and they position these arguments on the argumentation seesaw. In so doing, they discuss their individual weighting of the arguments with the group and can change their mind if they wish. The teacher can listen in to the discussions in the groups and, if necessary, provide stimulus and guide the pupils, so that they move beyond merely collecting facts on the argumentation seesaw to a real collection of arguments.

In the subsequent share phase (15–20 minutes), each group shares its 'for' and 'against' arguments from the pair phase with the class as a whole using the flash feedback method (max. 2 minutes per group). The respective argumentation seesaw is projected for this purpose and the pupils summarise and explain their overall result.

At the end of the lesson (5–10 minutes), the teacher summarises the group results and establishes a link to the concept of 'ecological footprint' described at the beginning.

The pupils reflect on their attitudes within the context of the overall class result.

06 | Differentiation possibilities

The information video can be stopped at any point by the pupils or re-watched in parts. Pupils with poorer listening comprehension skills can be given the information in plain language instead (text M5). The worksheet M6 is used here.

07 | Further quality criteria to be met as part of the lesson series

a. **The Luxembourgish context:** Global warming and environmental damage are global problems that also affect pupils in Luxembourg. With the introduction of the new subject Digital Sciences in particular, the pupils are to be made aware of the effects of digitalisation.
b. **Differentiation:** The information can be provided in different media formats which take into account the different levels of ability of the pupils, both in terms of the complexity of the task and the amount of assistance provided.
c. **Media Compass:** See the learning outcomes of the media literacy framework in the didactic analysis of this document.
d. **The 4Cs model:** Communication, collaboration, creativity, critical thinking. The 4Cs model is taken into account in various ways through the different social forms and teaching activities.
e. **Relation to current research:** Global warming and environmental damage are very important topics in various fields of research. Reducing the ecological footprint with the help of new and innovative methods is a primary goal for many scientists.
f. **Relation to research in Luxembourg:** In the interview with engineer Dr. Benoit Mattlet, he explains how Luxembourg is using its electricity grid to support the energy transition and become more energy-efficient.

References:

Cook, Gary. (2017). Clicking Clean: Who is winning the race to build a green internet? Greenpeace Inc. http://www.clickclean.org/downloads/ClickClean2016%20HiRes.pdf
Freitag, Charlotte, Berners-Lee, Mike, Widdicks, Kelly, Knowles, Bran, Blair, Gordon S. & Friday, Adrian. (2021). The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations. *Patterns (New York, N.Y.)*, 2(9), 100340. https://doi.org/10.1016/j.patter.2021.100340
IEA (2021): Aviation, IEA, Paris https://www.iea.org/reports/aviation
Hilgart, Johannes (Hg.). (2017). *Standpunkte der Ethik: Lehr- und Arbeitsbuch für die gymnasiale Oberstufe. Paderborn.*
Pfeifer, Volker. (2022). Ethisch argumentieren. Eine Anleitung anhand von aktuellen Fallanalysen. Paderborn.
Ritchie, Hannah. (2021). Climate change and flying: what share of global CO_2 emissions come from aviation? *Our World in Data.* https://ourworldindata.org/co2-emissions-from-aviation
Statista. (2022). So viel Energie verbraucht das Internet. https://de.statista.com/infografik/26873/co2-vergleich-dsl-und-glasfasernetz/
Tumbrink, Jonas. (2018). Argumentationswippe. Reflexion von Wertmaßstäben durch das Gewichten von Argumenten. *Praxis Geographie* 7/8, 36-39.
Umweltbundesamt. (2020). Video-Streaming: Art der Datenübertragung entscheidend für Klimabilanz. https://www.umweltbundesamt.de/presse/pressemitteilungen/video-streaming-art-der-datenuebertragung

08 | Detailed planning of the lesson

Theme of the lesson: Effects of the internet on the climate

Learning objectives and skills to be developed during the lesson:
Main objective: The pupils identify the effects of digitalisation and internet use on the climate and reflect on their own usage behaviours by considering value hierarchies and justification strategies.
Sub-objective: The pupils understand the concept of the argumentation seesaw and apply it in an adequate manner.

Evaluation (if planned): Self-directed, see 2.5 Evaluation ideas

Time	Phases	Main content	Social form/methods	Resources and media	Learning process
0min	HW	**Learn how an argumentation seesaw works**	• Individual work	• https://argumentationwippe.de • Worksheet M1 on how the argumentation seesaw works	The pupils... ... **understand** the concept of the argumentation seesaw and how it works, and they have tried it out using examples.
Lesson 1 of 2					
10-15min	Introduction	**Picture stimulus 'ecological footprint'**	• Class group • Classroom lecture • Brainstorming & discussion	• Whiteboard/PPT: 'Ecological footprint' M2 • Mural/Padlet/TaskCards/Mir	The pupils... ... **understand** the concept of the ecological footprint. ... can **describe** and explain the concept of the ecological footprint in their own words. ... **define** 'ecological footprint' in their own words. ... **identify** which of their own behaviours might increase and/or decrease their personal ecological footprint.
5min	Transition	**Teacher's summary following the pupils' definitions and explanations: 'Making lifestyles measurable'**	• Classroom lecture	• Add the summary to the Mural/Padlet/Miro based on the pupils' answers	The pupils... ... **put their** own thoughts and ideas into context within the scientific discourse on sustainability.
15-20min	Work phase I (THINK)	**Set the task and Work phase I**	• Individual work (The video can be viewed individually by the pupils with a smartphone/tablet and a pair of headphones) • Worksheet for video analysis/text work	• Video stimulus M3: https://t1p.de/PITT – Climate Killer Internet • Worksheet M4 • Alternative for differentiation M5: Text in plain language • Worksheet M6	The pupils... ... **identify** and **document** arguments ('against') on the basis of guiding questions. ... **develop** and **document** arguments ('for') independently.
10-15min.	Transition	• **Answer any questions about the video** • **Introduce the argumentation seesaw and split the pupils into work groups**	• Class group • Classroom lecture • Work groups (depending on class size, in pairs or max. 4 pupils per group)	• Tablet/desktop PC/notebook (1 per pair or group) • https://argumentations-wippe.de • Individual worksheets from Work phase I	The pupils... ... are **proficient** at using the virtual argumentation seesaw.

Lesson 2 of 2					
20-25min	Work phase II (PAIR)	**Set the task and Work phase II**	• Pairs/work groups	• https://argumentations-wippe.de • Individual worksheets from Work phase I (M4/M6) • Task: Form an opinion on the suggestion that 'The internet should be shut down.' • Use the argumentation seesaw to form an opinion on this suggestion.	The pupils... ... **know** and **understand** the assigned task. ... **present** arguments 'for' and 'against' from the THINK phase. ... **position** these arguments on the argumentation seesaw. ... **discuss** their individual weighting of the arguments and **change** their own views during the discussion as the case may be.
15-20min	Presentation II (SHARE)	**Present the group results**	• Class group • Flash feedback (max. 2 minutes per group)	• Whiteboard/projector/ SharePoint	The pupils... ... **present** arguments 'for' and 'against' from the PAIR phase. ... **summarise** and **explain** their overall result for/against.
5-10min	Summary/ wrap-up	**Summarise the group results (for/against of the class) using the argumentation seesaw and link to the concept of 'ecological footprint' described at the beginning**	• Class group • Classroom lecture	• Whiteboard/projector/ SharePoint	The pupils... ... **reflect** on their attitudes within the context of the overall class result.

2.3 Materials

M1 | The argumentation seesaw tool on one page

1

First steps

Open the argumentation seesaw website (www.argumentationswippe.de) on your iPad or scan the QR code.

2

Name

You will now see your new argumentation seesaw.

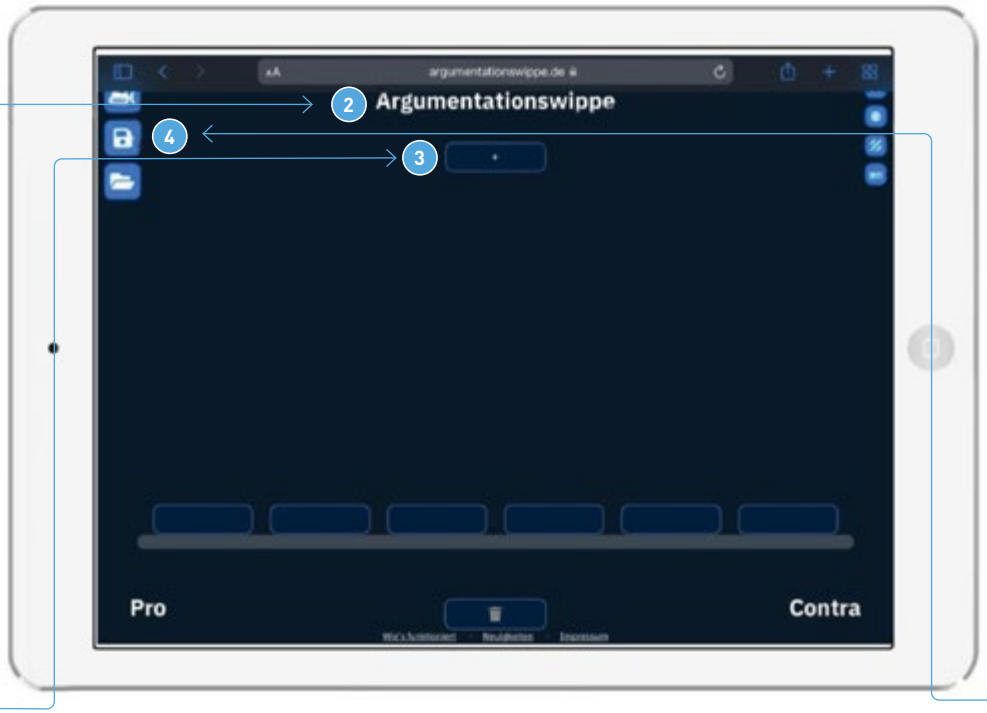
Tap on the heading. 'Argumentationswippe' in the middle of the screen (2) to edit it. You will now see the cursor as a flashing line and you can delete the heading.

Give your argumentation seesaw a new name.

3

Add argument

Tap '+' 3, and write down an argument 'against' eating meat (e.g. animals have to die). Now drag the argument to the 'against' side of the seesaw. You will see that the seesaw tilts towards against.



4

Add argument

Tap '+' again 3 and write down an argument in favour of eating meat (e.g. meat provides important proteins for the human body).
Now drag the argument to the 'for' side of the seesaw. You will see that the position of the seesaw changes.

5

Weighting

Depending on how much weight an argument has for you, move it further in or out on the seesaw. Convincing arguments will be further outwards,
less convincing ones a little further inwards.
Try this with other arguments.

6

Save

Have you placed all of your arguments on the seesaw? Then save your seesaw 4

Tip for categorisation:

If you tap the arrow in the argument box, you can change the colour of your argument. This way, all arguments in a specific category can be given the same colour, e.g.:

yellow = ethical
blue = eco-friendly
red = health-related

The argumentation seesaw tool on one page

M2 | Online resources

Source : https://www.greenmobility.com/fi/en/earth-overshoot-day/

M3 | Video

This video is bad for climate change

M4 | Worksheet Climate Killer Internet

Why is the internet bad for the climate?

Note:
Watch the video below

This video is bad for climate change

Write the answers on a separate sheet of paper if you need more space.

1. What represents the largest part of the emissions generated by the life of a phone?

2. Which activities on the phone produce the largest part of emissions?

3. Why is electricity consumed when a user streams a video ?

4. Explain the title of the video.

5. Now that you have watched the video, provide some arguments **against** using the internet.

Anti-internet
1.
2.
3.
4.
...
...

6. Your own arguments
Now think of some arguments **for** using the internet.

Pro-Internet
1.
2.
3.
4.
...
...

M5 | Text in plain language

Your phone consumes energy while it is turned on. You consume a particularly large amount of electricity when using mobile data, such as for chatting, sharing photos or commenting on them on social networks, or for watching videos on YouTube.

This electricity is generated mostly from coal or natural gas. CO2 is produced during the process. CO2 stands for carbon dioxide. It is harmful to the climate. The power that the mobile phone needs is not the biggest problem. Much more electricity is consumed in huge data centres, which are needed for the internet. A data centre contains hundreds of special computers, also called servers. These servers operate around the clock, because all of the data on the internet runs through servers based all over the world. No matter what you do on the internet, the data always passes through several data centres. When you visit a webpage, when you send a picture to a friend, or when you stream a cat video.

A data centre consumes as much electricity as a small town. This is partly because all of the servers have to be cooled 24/7. If they are not cooled, they overheat and break down. Cold air from huge air-conditioning units is therefore pumped into the server room continuously.

In fact, every year we consume more and more electricity for the internet, which means we also produce more CO2. This is mainly down to the fact that we are uploading and downloading ever larger volumes of data over the internet. All of this data has to be stored on servers. Video files account for most of it by some distance.

Because the files are so big, they require a lot of space on the servers and therefore use more energy when being sent and received. Watching a video for just half an hour causes as much CO2 as driving a car for ten minutes. On YouTube alone, 80,000 hours of new videos are uploaded every single day. We want to watch our videos in the best quality, in HD or even in Ultra HD. However, a video in UHD quality is more than twice the size of a normal HD video. This requires more storage space and computing power and, in turn, more energy.

It can therefore be seen that all users consume energy with their smartphones and tablets when streaming or gaming, for example. So the more you use the internet on your mobile phone, the more electricity will be consumed overall.

But the internet and the massive data volumes are only one part of the problem. The other is our equipment. This is because a lot of CO2 is also released when devices such as smartphones and laptops are manufactured. Valuable raw materials are needed to make these devices. And large areas of primary forest have to be cleared to obtain the raw materials. This is a problem, since these woodlands are home to many endangered animals and are also extremely important for our climate.

This text has been adapted from the script of the German video 'Klimakiller Smartphone'? (https://www.youtube.com/watch?v=1FjCZP_BmrA) by the WDR broadcasting institution.
It is a highly abbreviated and linguistically simplified version of the script.

M6 | Worksheet Climate Killer Internet – plain language

Why is the internet bad for the climate?

Note:
Read the text M5: Climate Killer Internet
Write the answers on a separate sheet of paper if you need more space.

1. Name some activities that consume electricity when you use your smartphone.

2. What is electricity made from?

3. Why do data centres consume so much electricity?

4. Why does a video in Ultra HD quality consume so much electricity?

5. Why is the extraction of the raw materials used to make smartphones harmful to the environment?

6. Now that you have finished reading the text, provide some arguments **against** using the internet.

Anti-Internet
1.
2.
3.
4.
...
...

7. Your own arguments

Now think of some arguments **for** using the internet.

Pro-Internet
1.
2.
3.
4.
...
...

M7 | Tips

When using the internet, there are a few things you can do to protect the climate:

1. **The video resolution when streaming:** When you stream videos on your mobile, the resolution (i.e. the picture quality) makes a big difference. Do you always need to watch in Ultra HD? Or could you maybe watch the video in a lower resolution?
2. **Use WiFi instead of mobile data:** Connect to the WiFi network if possible. This uses much less data – and therefore less energy – than the mobile network.
3. **Delete photos:** Sort out your old photos from time to time. Your mobile will often save the photos in a cloud on the internet. Every deleted photo saves storage space and therefore energy as well.
4. **Use an external storage device:** Data that you don't need very often, but you don't want to delete either, can be stored on external storage devices instead of backing them up online. This also saves energy.

2.4 Interdisciplinary ideas

You can also choose to collaborate with colleagues from other areas and disciplines on the topic of *Climate Killer Internet.*

VIESO (Life and Society)

In the subject VIESO (Life and Society), topics such as naturalistic, is-ought fallacies or the Toulmin argument model can be worked on (for pupil-centred approaches, c.f. Pfeifer, 2022, p. 7–27 and Hilgart 2017, p. 7–11) in addition to the argumentation seesaw.

English, German and French lessons

In language lessons, you can use extracts (the whole text is too long and heavy) from the article 'No such place as the cloud' by Guillaume Pitron, published in Le Monde diplomatique (English: https://mondediplo.com/2021/11/09digital-waste, German: https://monde-diplomatique.de/artikel/!5793006, French: https://www.monde-diplomatique.fr/2021/10/PITRON/63595).

For example, in a module to comprehend informative/factual texts, in which the learning objective 'pupils can present descriptive structural patterns of factual texts and use them in text interpretation' is pursued. Alternatively, this text can be used in a module to develop debating skills, with which the learning objective 'pupils can acquire and apply knowledge to construct arguments' is pursued.

Geography lessons

In geography lessons, human intervention in nature and the environment can be addressed. With the help of the argumentation seesaw, this can be evaluated by the pupils.

References :
Hilgart, Johannes (Hg.). (2017). *Standpunkte der Ethik: Lehr- und Arbeitsbuch für die gymnasiale Oberstufe.* Paderborn.
Pfeifer, Volker. (2022). *Ethisch argumentieren. Eine Anleitung anhand von aktuellen Fallanalysen.* Paderborn.
Tumbrink, Jonas. (2018). Argumentationswippe. Reflexion von Wertmaßstäben durch das Gewichten von Argumenten. Praxis Geographie 7/8, 36-39.

2.5 Evaluation ideas

Reflection and elaboration

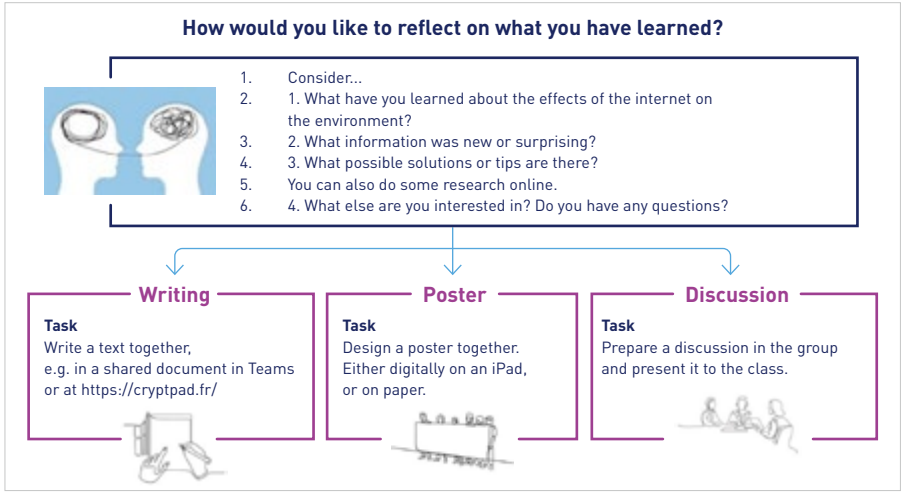
As an idea for another lesson or as homework, the pupils can reflect on their learning and the knowledge they have gained during the work phases of the module #Climate Killer Internet.

They can use guiding questions to help them, and can decide themselves on a strategy for elaborating upon what they have learned so far (e.g. text work, poster work or discussion based on the table below). If the pupils need some inspiration for the last question, the teacher can use the tips in the resources (M7) as a guide.

This largely self-organised and interest-led learning can be challenging for the pupils, as it requires skills that often need to be practiced first. The most important thing is that the pupils reflect on their own learning and work within the context of their overall approach. For this purpose, we suggest a discussion between the individual groups and the teacher in which the pupils reflect on their learning process in a methodologically differentiated way. With this form of self-evaluation, the pupils should:

a) articulate their own interest in the teaching content
b) justify their preferences and skills with regard to the chosen form of work
c) state their individual skills and knowledge
d) assess the quality of their own performance
e) reflect on the timing of the work

During the discussion, the teacher should offer help and suggest strategies for improvement.



Source: inspired by the LPS-method: https://unterrichten.digital/2020/11/12/blended-learning-methoden/#LPS-Methode_Learn_-_Practice_-_Share

2.6 More on this topic

01 | The digital world and energy consumption

The article *Quand le numérique détruit la planète* (Pitron, 2021a) provides an impressive account of how the digital world consumes massive amounts of energy. This is not because the information technology has not been developed efficiently enough. In fact, quite the opposite: The first computers – such as the ENIAC, which was presented to the public in 1946 – used as much electricity as an entire town. Although today's smartphones are much more powerful than the first computers and use very little energy, more energy is being consumed overall than before. This is due to the ever-increasing number of electronic devices such as computers, tablets and smartphones.

It is estimated that information technology nowadays causes 2% to 3% of all carbon emissions, more than the total emissions from commercial aviation (Abiteboul & Dowek, 2017; cf. Pitron, 2021, for a more detailed description of this topic). However, with regard to the effects of digitalisation on the environment, it is not just carbon emissions that play a decisive role. A recently published study by R. Obringer et al. (2021) not only takes into account the carbon footprint, but also the water and land footprints that are created when data is stored or transmitted through the fixed internet. The researchers found that particularly large amounts of CO2 are produced when streaming videos, and a lot of water is also consumed. In addition, large areas of forests are cleared to extract important raw materials for producing the technology that is needed for streaming. Video streaming therefore has a large carbon footprint, as well as large land and water footprints.

The impact of the fifth generation of mobile communication on the environment should not be underestimated either: '5G', as it is known, will take over from the current 4G standard. It offers faster data transmission and only needs one thousandth of the energy per transmitted bit compared to its predecessor. The downside is that the introduction of 5G will most likely give rise to what is known in economics as the Jevons Paradox or rebound effect. This occurs when technical progress enables a raw material to be used more efficiently, which then leads to it being used more. In our context, this means: Due to the faster data transmission speeds offered by 5G, it is very likely that the total data volume will increase significantly (Abiteboul & Berry, 2021).

02 | The positive aspects of the digital revolution on the environment

Sustainable development is another area that is continuously benefiting from the advancements brought by the 'digital revolution'. For example, scientific models that predict and analyse global warming trends are based on algorithms. Without algorithms and computer science, it would be virtually impossible to create such models and predict future developments. Even the sheer volume of data that enables us to produce reliable scientific climate studies can only be processed and analysed with the help of digital technologies. Equally reliant on digitalisation are smart electricity networks that continuously align the production of electricity with consumption and thereby contribute towards a more environmentally friendly energy supply. Whereas in the past, huge power plants were built that produced electricity for a very large area, local solutions in which electricity is produced and distributed locally have become more feasible in recent times. However, this is only possible with the help of algorithms that manage the distribution (Abiteboul & Dowek, 2017). To quote the engineer Dr. Benoit Mattlet (see interview): 'In the past, we consumed what was produced. Today, we produce what we consume.'

03 | Possible solutions for the future

The impact of individual decisions and behavioural changes – such as only using search engines in considered and justified cases or only sending urgently needed attachments by email – is very minor, as things like emails only make up a very small proportion of the total data traffic (Abiteboul & Dowek, 2017). Videos, on the other hand, account for a large percentage. An important goal would therefore be to optimise the transmission of video-related data. However, the sheer distance that has to be covered between the streaming providers' servers and the end users is a big problem. A local solution would therefore be desirable here, too: If these videos were available on servers close to us (e.g. on the server of a neighbour who has just watched the same video), we would be able to save electricity. This process is known as peer-to-peer streaming. P2P streaming isn't very widespread yet, though some P2P video platforms are now trying to compete with giants like YouTube, but the concept is a heavily debated topic in current research (Ramzan, 2012).

Another approach in the area of sustainable development is to use the heat produced by computers and servers for heating purposes. Computers and data servers radiate an enormous amount of heat. At present, this heat is simply lost, instead of being fed into heating systems, for example. Research into such solutions has been ongoing for some time now (Brouet, 2016), and companies and startups are already bringing the first devices to market (Hodson, 2015). Apart from the attempts to make data centres 'greener' in general by using renewable energies, the outlined approaches are currently the most promising concepts in the field of sustainable development.

2.7 A word from the scientists: Interview with Dr Benoit Mattlet

Benoit Mattlet is a civil and electrical engineer. He graduated from the École Polytechnique in Brussels in 2012. From 2012 to 2018, he worked as an assistant at the École Polytechnique, where he was responsible for supervising internships in the field of 'electrical machines'. He also wrote his doctoral thesis during this period, on the topic of future challenges of the power grid within the context of the current energy transition.

Since 2018, he has been working at Nexxtlab. As a key enabler of the energy transition, the Luxembourg-based company facilitates interaction between all players within the electricity grid. At Nexxtlab, Benoit develops the algorithms that form the core of the tools offered by the company.

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References:

Abiteboul, Serge, & Berry, Gilles. (2021). 5G : le temps des questionnements. *Binaire. Le Monde.* https://www.lemonde.fr/blog/binaire/2021/10/22/5g-le-temps-des-questionnements/

Abiteboul, Serge, & Dowek, Gilles. (2017). Le Temps Des Algorithmes Paris: Le Pommier.

Brouet, Anne-Muriel. (2016). Using servers for home heating. *Phys.org.* https://phys.org/news/2016-07-servers-home.html

Hodson, Hal. (2015). The computer that crunches cloud data to heat your home. NewScientist. https://www.newscientist.com/article/mg22530072-800-the-computer-that-crunches-cloud-data-to-heat-your-home/#ixzz7U8zhGe79

Obringer, Renee, Rachunok, Benjamin, Maia-Silva, Debora, Arbabzadeh, Maryam, Nateghi, Roshanak, & Madani, Kaveh. (2021). The overlooked environmental footprint of increasing Internet use. *Resources, Conservation and Recycling*,167. https://doi.org/10.1016/j.resconrec.2020.105389

Pitron, Guillaume. (2021). *L'enfer numérique. Voyage au bout d'un like. Les liens qui libèrent.* LLL, Les liens qui libèrent.

Pitron, Guillaume. (2021a). Quand le numérique détruit la planète. *Le Monde diplomatique.* https://www.monde-diplomatique.fr/2021/10/PITRON/63595

Ramzan, Naeem, Park, Hyunggon, and Izquierdo, Ebroul. (2012). Video Streaming over P2P Networks: Challenges and Opportunities. *Signal Processing. Image Communication*, 27(5), 401-411. https://doi.org/10.1016/j.image.2012.02.004

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