FUTURE Problem Solving™

Invasive Species

Science & Technology

RESEARCH UNIT

- Research
- Readings
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GRADES 4-12

Practice Problem 1 | 2025-2026

This publication is a compilation of the hard work of many people. Special thanks are extended to our curriculum author Kate Wolf.

Topic Contents

Invasive Species

How will we safeguard the biodiversity of our ecosystems against the rising threat of invasive species in the future?

Research

Readings

Resources

Supplemental: Problem-Solving Tools

We strongly advise Future Problem Solving coaches and others using this content to review their educational organization's policies on appropriate content, and to screen any materials before making them available to students.

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Introduction

Background
Invasive species are non-native organisms that, when introduced to a new environment, can cause harm to native ecosystems, biodiversity, and even economic activities. Due to a lack of natural competitors or predators, these species often outcompete or prey upon native plants and animals, disrupting the delicate balance of local ecosystems. Invasive species can be plants, animals, or microorganisms, and they are typically introduced through human activities, such as trade, travel, or deliberate release.

Context
The impacts of invasive species are far-reaching and can result in habitat degradation, loss of native species, and economic losses in agriculture and forestry. Prevention, early detection, and management efforts may lessen the damage caused by the invasive species. Management includes the removal of invasive species and restoration of affected ecosystems. This can be time-consuming, economically punishing, and not always successful. It is a critical challenge in conservation and environmental management, emphasizing the importance of vigilance and responsible practices to protect the integrity of natural environments.

Questions to Explore
When an invasive species is introduced to an ecosystem, whether deliberately or by accident, what are the repercussions?
Can species introductions and spread be predicted?
How do scientists predict the introduction and spread of invasive species?
How do invasive species impact social, economic, and cultural environments?
How can we protect our environments from invasive species in the future?

Use this publication as a starting point for research as your students gather knowledge about the topic of study. By the time of distribution, some of the information may change or become out-of-date. Keep in mind, however, that observing and studying the changes that take place in a given subject area over a few months or years can be an incredible asset to problem solvers who work with scenarios set in the future.

Themes and Concepts

Themes and concepts assist in organizing a lot of information into manageable threads or ideas, providing a complete picture or understanding of the subject.

CENTRAL THEME #1

What makes an invader?

Not every non-native species is invasive, but all invasive species are outside their natural range for some reason or another. Some species have recently migrated naturally into more suitable ecosystems, while many others have hitched a ride or been transported purposefully by humans. Regardless, species that are harmless or have a low impact in their new environment are usually not considered invasive. Only those that start doing damage are classed as invasive.

Major Concepts

Climate change makes weather more extreme, and temperatures shift, causing more prolonged droughts and other changes. Some species are migrating because their natural range is no longer a livable environment for them. Some can expand their natural range now that temperatures are warmer, out-competing other species.

Humans often accidentally transport invasive species into new environments. Invasive zebra mussels attach themselves to ships and are brought to new waters, for example.

Humans also purposefully transport species to new environments. Many invasive plants started as ornamental garden plants. Cats and many species of invasive snakes are pets that may be released or escape from their humans' homes and cause destruction once free.

Some species cannot survive extreme changes; those that can adapt and survive are often the ones that become invasive. Because they are better adapted to shifting environments, they outcompete local species and spread quickly.

Themes and Concepts

CENTRAL THEME #2
Damage and destruction

The introduction of invasive species poses an urgent threat to the environment. Their ability to outcompete native species due to faster growth cycles, aggressive food acquisition, and rapid seed dispersal can lead to the takeover of ecosystems. This jeopardizes local species' survival and causes significant damage to human-made environments, including agriculture and infrastructure.

Major Concepts

Cats and rats are some of the most destructive invasive species on the planet. Both are responsible for the extinction of hundreds of island birds; when they arrive on islands on human ships, they can wipe out native populations of birds that previously had no local predators.

Invasive species can cause costly damage to human infrastructure and projects. Many pests damage crops, causing greater food insecurity. Termites eat anything containing cellulose, especially wood, which damages buildings and can even destroy homes.

In many communities, invasive species cost peace of mind and space for leisure. Yellow crazy ants in Australia have taken over neighborhoods, making it difficult for children to play outside without getting bitten and moving into homes.

The global impact of invasive species is staggering, with an estimated annual cost of around $958 billion USD. This includes direct damage, prevention measures, and the expenses associated with their removal. Such a significant economic burden underscores the urgent need for effective management and control of invasive species.

Themes and Concepts

CENTRAL THEME #3
Combating invasive species

Many people are dedicated to preventing the spread of invasive species. These efforts are a huge factor in protecting biodiversity worldwide. It is often an uphill battle, with many species being here to stay despite eradication efforts and many more likely to enter new environments. In addition, some efforts at controlling invasive species have unintended consequences and can harm local species and environments.

Major Concepts

Prevention is the most effective method of controlling invasive species; once they have a foothold, they can be extremely hard to remove. Many local and international laws control the movement of exotic pets, seeds, and plants and even regulate cleaning boats and ships to ensure no hitchhikers can move into new waters.

Agencies and governments need the public's cooperation to help identify and remove invasive species. Many are working to educate the public on what species are native to their area and encourage people to report any alien species so they can respond.

Biocontrol involves introducing a biological agent, such as a virus or bacteria, that will infect the invasive species and reduce its numbers. Biocontrol can be highly effective, but it must be done carefully to ensure the disease cannot infect native species and cause broader damage.

Eating the problem is an increasingly popular movement. Many invasive species, from mimosa blossoms to Asian carp, are edible. If the supply chain is set up and these foods can be marketed, eating invasive species could help reduce their populations and increase food security in many communities.

Themes and Concepts

CENTRAL THEME #4

The ethics of management

Although invasive species can cause massive problems in new environments, they are still living beings. Destroying lives because they are in the wrong place at the wrong time raises many moral questions. The methods people use to remove them can also damage local species. Invasive species, like locals, are simply trying to survive —often in complex, human-made circumstances.

Major Concepts

Many animal rights groups call for the end of the term 'invasive species,' saying that it demonizes species that are only trying to survive.

The values of many indigenous cultures say that every living creature is valuable and should be considered an individual. Thinking of invasive species in this way can help spark more ethical ways of management, including relocating an animal rather than killing it or considering methods to help it fit better into its new environment.

Some invasive species in one area are endangered in their local environments. Removing them from their non-native environment might lead to their global extinction. Black rats, for example, are now likely extinct in their native Britain, but worldwide are targeted in many culling operations.

Animal rights and climate activists argue that willfully destroying the lives of thousands of individuals is a disaster no matter where it happens. Simply because humans have decided a species does not 'belong' in one place or another does not necessarily give us the right to kill them.

Overview

All species on Earth have their own natural habitat and geographical range. Boars, for instance, are native to Southeast Asia. The climbing vine kudzu hails from China and Japan, while zebra mussels originate from the Black and Caspian Seas. Animals and plants can naturally change their range over time, a testament to their resilience and adaptability. However, due to their exceptional ability to survive in changing environments, some species can take over in new places where they are introduced. Kudzu, for example, is now called 'the vine that ate the South,' a testament to its success in the southern United States, where it has wholly overrun forests and other ecosystems. Kudzu is just one of thousands of invasive species that cause harm to the environment and humans and even drive other species to extinction.

Our topics, determined with input from our global community as well as subject matter experts, represent important challenges from business, civics, society, science, and technology. We welcome ideas for future competition topics from everyone including students and coaches. Share your topic ideas and feedback at https://fpspi.org/topic-submission/

Any species living outside its natural geographical range is known as a non-native or alien species. However, not all non-native species are considered invasive. To be considered 'invasive,' a non-native species must meet some criteria:

1. It must be self-sustaining in the wild.
2. It must spread relatively quickly.
3. It must cause harm to its new environment or human health.

It is important to note that not all non-native species are invasive. Many have only minor impacts on their new ecosystems and can be beneficial. For example, some non-native species can fill ecological niches left empty when a local species went extinct. This highlights the potential for non-native species to contribute positively to their new environments, a perspective that encourages open-mindedness and consideration in our approach to conservation.

Overview

The damage that invasive species can do is widespread. One example is the yellow crazy ant, one of the most successful invasive species in the world. On Christmas Island (a territory of Australia), invasive yellow crazy ants can kill the island's iconic red crabs by attacking their eyes. The crabs usually clear away underbrush in the island's forest, so just a few years after the ants were introduced to Christmas Island, the plant growth of the forest had changed entirely. In human-populated areas, yellow crazy ants get into houses and electrical equipment and produce an acid that can cause severe burns on the skin. People in areas with a yellow crazy ant problem complain that they and their children cannot play outside anymore because of the risk of getting swarmed and burned. The domestic house cat is another invasive species that is much more popular with humans. When these pets are allowed outside or escape, they can destroy local bird populations. Cats are estimated to be responsible for the complete extinction of over 60 species of birds worldwide. A single pregnant housecat and her offspring caused the extinction of the Stephens Island wren, a flightless songbird once found on a southern New Zealand island.

Invasive species arrive in their new environments in a variety of ways. Sometimes, they are accidentally transported. Seeds can be picked up on the shoes' soles and transported to a new place. Often, species are moved purposefully, though. People bring exotic, decorative plants into their gardens, spreading outside and into the surrounding area. Pets like snakes and cats can also escape or be released by their owners and establish wild populations. That is precisely what has happened with Burmese pythons in the Florida Everglades; these escaped or released snakes thrive in Florida and cause enormous issues for native species. Some invasive species are even introduced to solve other problems. Kudzu vines were brought to the US on purpose during the Dust Bowl. The US government hoped this fast-growing plant would revitalize areas where plants had died due to drought.

Overview

Over the years, various methods have been employed to control invasive species, with prevention emerging as the most effective strategy. Many regions have implemented policies governing the transportation of animals and plants across their borders, along with initiatives such as boat-cleaning measures and limits on exotic pet ownership. Despite our best efforts, species often manage to move, leading to the introduction of new laws to keep pace with the increasing number of species being introduced.

Often, when invasive species get out of control, the central policy eradicates them. In some US states, for example, there are no limits to how many feral pigs a person can hunt and no limit to the time of year they can be killed. Some invasive species are eradicated with poison, which can also be dangerous to local species. Sometimes, biocontrol is used, which involves introducing either a disease or another species that preys on the invasive species to reduce its population. Biocontrol methods have unsurprisingly backfired several times, but they have also been successful in some situations. Where possible, many advocate eating the problem. Many invasive species are edible and could reduce food insecurity while reducing invasive populations.

It's important to remember that invasive species are not inherently malevolent. They are simply animals, plants, and microorganisms striving to survive in a changing environment. Controlling them, especially through potentially painful methods like poison or traps, should not be taken lightly. A balanced approach that considers the welfare of all species is crucial in this endeavor.

Even the phrase 'invasive species' is controversial. The definition of a species' "natural" range is somewhat arbitrary – a species is considered 'native' to a place if it was present 5000 years before today and not introduced to the area by humans. However, a range shift has always happened, and as climate change continues to damage ecosystems and change weather patterns, more and more species will be forced to shift to new places. We must consider the value of all living things and work to minimize loss of life when we tackle this problem.

Overview

Despite the ongoing debate, research demonstrates that invasive species are among the leading causes of biodiversity loss, on par with habitat destruction. As human populations continue to grow and encroach on more habitats, and climate change disrupts ecosystems and weather patterns, the threat from invasive species will only intensify. Our efforts to restore damaged ecosystems must keep pace to safeguard vulnerable plants and animals from extinction.

Vocabulary

alien species; non-native species: plants or animals that live outside their natural range

biodiversity: the variety of plant and animal life in the world or a specific area; a region with high biodiversity has a higher number of species

biofouling: organisms attaching themselves to ships' hulls or other vehicles, allowing them to move into and contaminate new environments

biological control; biocontrol: an attempt to control the population of an (invasive) pest species, usually by introducing new predators into the ecosystem

biosecurity: methods that are designed to help protect against biological dangers such as disease

climate change: the long-term shift in temperature and weather patterns worldwide, largely caused by greenhouse gas emissions

cull: to reduce the size of a population of animals by killing them, often by hunting

cultivated plants: plants that are grown by humans for produce, usefulness, or decoration

drought: a long period of lower-than-average rainfall, leading to water shortage

ecosystem: the community of living plants, animals, and microbes in an area, usually which depend on one another and on their physical environment to thrive

eradicate: to kill or remove every individual of one species in an area

extinction: when every individual of a particular species dies

feral: animals that were once domesticated, such as dogs, pigs, or horses, but have established wild, undomesticated populations

food web: a system of interdependent food chains

globalization: the expansion and interdependence of the world's economies and culture, including more trade and transportation across borders

Vocabulary

habitat: the environment with the specific conditions (e.g., temperature range, precipitation) that an organism needs to survive

habitat loss: a decrease in the amount of space where an organism or species can survive

herbicide: pesticides that are explicitly used to kill unwanted plants

interbreeding: the process of mating between different species

invasive species: a non-native species with a fast-growing population that causes environmental or economic damage to its new environment

lethal: deadly, leading to death

marine: related to or living in the ocean

monocropping: the practice of growing a single crop (e.g., wheat, soybeans) in an area; mono-crops are human-created monocultures

monoculture: an area where only one crop or plant grows; some invasive plants can establish monocultures by overtaking all local species of plants so that only the invasive plants survive

native species: a species that has inhabited a specific area for at least the last 5000 years *and* has not been introduced to the area by humans; a species can be native to multiple separate areas

natural range: the geographical area where a species has naturally lived (not introduced by humans) since about 5000 years ago; also known as ecological range or geographical range

non-lethal: a control method that does not cause the death of an organism

ornamental plants: plants that are cultivated by humans for their beauty for decoration, e.g., houseplants such as orchids

out-compete: to get more food, space, or other resources than another species in the same region, possibly wiping out the other species

Vocabulary

pest: a destructive insect or other animal that is harmful to humans or human economy

pesticide: chemicals that are used to kill pests, including insects, rodents, fungi, and plants

population growth: an increase in the number of individuals of a species in an area

range shift: when a species' range moves, usually due to competition from invasive species and/or due to climate change

restoration ecology: the field that aims to heal damaged ecosystems, including methods such as reforestation and pollution cleanup

self-sustaining: a species which does not need human intervention to keep its population steady or increasing

Interactivity:
A Quizlet containing all the topic vocabulary may be found here.

Use password: FPSPI
https://quizlet.com/939931331/invasive-species-flash-cards/?i=4351sf&x=1jqt

List of Articles - By Theme

A concerted effort was made to find recent articles from as many different perspectives as possible. While Future Problem Solving attempts to present a balance in the range of opinions, some sides of an issue are often more represented than others. This does not mean that Future Problem Solving supports that position. Future Problem Solving supports no position.

CENTRAL THEME #1: What makes an invader?

- Antarctica's looming threat
- Avoid spreading invasive alien species
- Five invasive species that wrought havoc in S. Korea
- Hazards of moving firewood
- How climate change drives the spread of invasive plants
- How invasive species spread
- Invasive species 'hitchhiking' on ships threaten Antarctica's unique ecosystems
- What's with these invasive "crazy" worms and why can't we get rid of them?

CENTRAL THEME #2: Damage and destruction

- How climate change affects invasive species
- Invasive alien species: A dual threat to biodiversity and economies
- Invasive alien species cost Africa's agricultural sector an estimated $65.58 billion a year
- Invasive species [1]
- Invasive species are causing hundreds of billions in economic damage. Is climate change to blame?
- Invasive species: The silent threat to our ecosystems
- Operational activities: Starlings and blackbirds
- These are the 5 costliest invasive species, causing billions in damages

CENTRAL THEME #3: Combatting invasive species

- Himalayan balsam
- Invasive Species Week: Meet the team dealing with Asian hornets, Japanese knot weed and coypus
- Invasive species [2]
- Prevention and early action: Yellow crazy ants
- Problem to plate: Could eating invasive species be a sustainability game changer?
- Scientists develop a plan to manage lionfish populations in the Mediterranean
- Using fungus to fight crazy ants
- Why confronting invasive species is one of the best ways to prepare for climate change

CENTRAL THEME #4: The ethics of management

- Detailed discussion of the ethical treatment of invasive species
- Growing plant trade may spread invasive species - but help ecosystems adapt to climate change
- "Is it good or bad?" Rethinking language around invasive species
- It's time to stop demonizing "invasive" species
- Panel of women researchers discuss ethics in managing invasive species
- Should we cull one species to save another?

List of Articles - Alphabetical Order

Antarctica's looming threat
Avoid spreading invasive alien species
Detailed discussion of the ethical treatment of invasive species
Five invasive species that wrought havoc in S. Korea
Growing plant trade may spread invasive species - but help ecosystems adapt to climate change
Hazards of moving firewood
Himalayan balsam
How climate change affects invasive species
How climate change drives the spread of invasive plants
How invasive species spread
Invasive alien species: A dual threat to biodiversity and economies
Invasive alien species cost Africa's agricultural sector an estimated $65.58 billion a year
Invasive species [1]
Invasive species [2]
Invasive species are causing hundreds of billions in economic damage. Is climate change to blame?
Invasive species 'hitchhiking' on ships threaten Antarctica's unique ecosystems
Invasive species: The silent threat to our ecosystems
Invasive Species Week: Meet the team dealing with Asian hornets, Japanese knot weed and coypus
"Is it good or bad?" Rethinking language around invasive species
It's time to stop demonizing "invasive" species
Operational activities: Starlings and blackbirds
Panel of women researchers discuss ethics in managing invasive species
Prevention and early action: Yellow crazy ants
Problem to plate: Could eating invasive species be a sustainability game changer?
Scientists develop a plan to manage lionfish populations in the mediterranean
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These are the 5 costliest invasive species, causing billions in damages
Using fungus to fight crazy ants
What's with these invasive "crazy" worms and why can't we get rid of them?
Why confronting invasive species is one of the best ways to prepare for climate change

Information is a summary of the original article. It is up to the reader to determine which facts and ideas to accept. Future Problem Solving encourages coaches and teachers to preview the article summaries and links to determine whether all information is appropriate for their students. Efforts were made to minimize the sensitivity of the summaries' contents; however, different standards of acceptability apply to each individual student, coach, and community. Please use your discretion with these materials. ***Information is listed in alphabetical order by article title.***

Article Summaries

Antarctica's looming threat

Researchers think that so far, eleven non-native animals have made it to Antarctic land. The Southern Ocean surrounding Antarctica is still free of invasive species. However, with increasing visitors and increasing climate change, that may only last for a while.

The currents surrounding Antarctica push most aquatic species away from the continent. Sea ice and cold water also present barriers to non-native species. However, warmer global temperatures mean less ice, and the water is becoming more survivable. In addition, Antarctica is getting more and more human traffic than ever, from researchers to fishing boats to tourists. In 1960, less than 100 ships traveled to Antarctica. In 2017, there were over 500 ships. All these visitors can threaten these waters that used to be so isolated; they can carry in non-native species. Biofouled ships can transport marine life forms into the region. When ships travel from the cold Arctic Ocean south to the Antarctic, the species that hitch a ride are already better adapted to the harsh conditions and cold water and may establish themselves more easily.

New species might also travel to Antarctica on 'rafts' of algae and kelp. Researchers have found four 'passenger' species so far on kelp. Scientists are concerned about the impact of non-native marine species on Antarctica's isolated, unique ecosystems. For example, Northern Pacific Sea stars, crabs, and bivalves can push out other species and reduce biodiversity. However, researchers also have difficulty finding out about the species that might be entering the region. The ocean is too big, and the sample size of ships being studied is tiny. One way to increase our knowledge might be by studying environmental DNA, which is the DNA shed into the water or air by organisms. It can help determine if a species is present in an area, even if it cannot be seen directly. Antarctica is exceptionally fragile with the threat of global warming and pollution. Reducing the risk of invasive species is vital to protecting it.

Lohan, T. (2024, January 4). Antarctica's looming threat. The Revelator. https://therevelator.org/antarctica-invasive-species/

Article Summaries

Avoid spreading invasive alien species

Alien invasive species are any plant, animal, fungi, or organism that has been moved into a new environment and, due to rapid growth, has changed the biodiversity of that environment. Alien species can be transported through imports or as stowaways on transportation or goods brought to new areas.

The Swedish Environmental Protection Agency has some guidelines about how to avoid spreading invasive species in Sweden. They can be spread purposefully or accidentally, and their guidelines aim to address both reasons for invasive species introduction. Invasive species compete with local species for nutrients and space and can harm humans and our infrastructure. Some guidelines include not bringing seeds or seedlings into the country, cleaning clothes, luggage, and equipment so they do not pick up insects, eggs, or seeds, and making sure to dispose of plant waste properly. Reducing the spread of invasive species is especially important in arctic areas of Sweden; as the climate gets warmer, more species will be able to survive further north and at higher elevations.

Avoid spreading invasive alien species. (n.d.). Natur Vardsverket. https://www.naturvardsverket.se/en/topics/invasive-alien-species/avoid-spreading-invasive-alien-species/

Article Summaries

Detailed discussion of the ethical treatment of invasive species

Humans have introduced animals and plants into new environments for centuries. Many, like cattle, still live in these new environments. Others continue to grow and spread, sometimes taking over the new environment and becoming invasive. There are efforts to control this spread, but often, the efforts ignore the rights of animals to avoid suffering.

A series of laws in the United States aim to control invasive species at both the federal (national) and state level. Federal laws include the Lacey Act of 1900, which regulates the movement of animal species over state lines; the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, which worked to control species like the zebra mussel; and more. State laws are typically more specific, and some urge the federal government to act more. Florida, for example, wants the Burmese python to be added to the Lacey Act. States like Florida, Texas, and Michigan regulate the ownership of exotic pets. The authors of this article looked at four case studies for invasive species management in the US: Asian carp, European starlings, black and white Tegu, and feral pigs.

These four case studies clearly show that there are few welfare considerations for invasive species. The public mostly believes that the only method of control is to eradicate invasive species. Animal welfare activists, on the other hand, argue that every individual has inherent value, and it is immoral to kill a living creature. Many states have anti-cruelty laws to protect animals but will exempt invasive species from these protections. This leaves the door open to unethical methods of killing them. Some invasive species, like boas in Florida, are protected by anti-cruelty laws. This means that trappers and hunters must limit pain and suffering to the animal.

Article Summaries

Detailed discussion of the ethical treatment of invasive species, *continued*

We can consider direct and indirect control when considering how to manage them. Direct action mainly involves hunting. Indirect control can involve other mechanisms like poisoning, deterrence, and containment. One of the most common is containing invasive species in one area. Unfortunately, this can also keep native species from moving naturally, which means that the invasive species have an even more significant impact in the small area where they are contained. Some are very difficult to contain. Putting toxic food in the environment or poisoning a water supply might be effective, but it can also poison other animals in the area. Laws need to acknowledge that current methods, like trapping in nets and some poisons, are cruel ways to kill animals. Since eradication is currently one of the only ways local environments are protected, looking at more humane choices is essential.

Varner, B. (2022). Detailed discussion of the ethical treatment of invasive species. Animal Legal and Historical Center; Michigan State University. https://www.animallaw.info/article/detailed-discussion-ethical-treatment-invasive-species

Article Summaries

Five invasive species that wrought havoc in S. Korea

Invasive species cost vast amounts of money to economies worldwide, and South Korea is no exception. The five species below are especially problematic there.

First are nutria, which are large rodents native to South America. They used to be farmed in South Korea for fur and meat, but they were released into the wild when the trade slowed down. They eat rice and plant roots, which are essential for stabilizing wetlands. Luckily, nutria numbers are declining in South Korea. The second species is the Louisiana crawfish, first found in South Korea in the 1980s. They were probably brought into a US military base. They damage rice fields with their burrows. Third is another species from North America, the bullfrog. They are not picky; they eat anything, including small mammals and snakes. They are also considered a nuisance due to their loud calls. Fourth is a type of turtle native to the Mississippi River, the red-eared slider.

These turtles first came to the country as pets and have since outcompeted native Reeves' turtles nearly to extinction. Finally, North America's largemouth bass has been in South Korea since the 1970s. They reproduce in such large numbers that native fish find it difficult to compete.

Hoon, M. K. (2023, September 9). Five invasive species that wrought havoc in S. Korea. The Korea Herald. https://www.koreaherald.com/view.php?ud=20230907000829

Article Summaries

Growing plant trade may spread invasive species - but help ecosystems adapt to climate change

Plants need to spread seeds to keep their species alive, but nowadays, humans are helping spread plants through seeds and cuttings faster than ever before. In some ways, this is helpful. As climate change makes some environments too hot or dry for native plants to thrive, moving them can help the species overcome climate change. Many plants also used to spread by being eaten by large mammals, but today, those animal populations are much smaller. Humans can take over as the primary way of dispersing seeds over long distances. However, humans can also spread invasive species which harm ecosystems. Of course, humans spread many cultivated plants on purpose, but we also spread many seeds accidentally.

In a study in Hungary, researchers studied potting soil. That study found that most potting soil bought at garden centers contains hundreds of seeds. Soil that contained manure as fertilizer had the most seeds, probably because livestock ate them, and then their manure was added to the soil. Most seeds did not grow, but since so much potting soil is sold and used worldwide, even a low percentage of growing seeds could lead to many plants growing in new locations. The use of purchased potting soil could lead to the spread of invasive species. Still, it also might help isolated populations of plants have more diverse genetic material and give them broader ranges to survive as climate changes.

Sonkoly, J., Bajomi, B. & Török, P. (2022, May 19). Growing plant trade may spread invasive species - but help ecosystems adapt to climate change. The Conversation. https://theconversation.com/growing-plant-trade-may-spread-invasive-species-but-help-ecosystems-adapt-to-climate-change-182450

Article Summaries

Hazards of moving firewood

One way that invasive species can enter an environment is through firewood. People may think that firewood is harmless, but it can be a significant risk to habitats in Canada. Firewood can be infested with insect eggs, larvae, and spores from invasive fungi. Firewood moved from one area to another, which can be a free ride for these species to enter a new place. However, by buying wood locally and asking sellers where their wood came from, we can play a crucial role in preventing this. Moving firewood can even violate the Plant Protection Act in some areas in Canada.

The Canadian Food Inspection Agency (CFIA) monitors invasive species in Canada and points out some species to be aware of:

1. The emerald ash borer can be found in Manitoba, Ontario, southern Quebec, New Brunswick, and Nova Scotia and has killed millions of ash trees throughout North America.
2. The Asian longhorn beetle threatens maple trees in the greater Toronto area.
3. The brown spruce longhorn beetle is now found in Nova Scotia and New Brunswick and targets spruce trees. After a few years of infestation, these beetles can kill a tree. Luckily, they spread relatively slowly; however, they can spread much faster if they are in firewood that is transported.
4. The spongy moth in eastern Canada can strip a tree of its leaves and, over time, kill it.

These insects can potentially cause severe and irreversible damage to Canada's natural parks and ecosystems. They can be transported via infested firewood or in freshly logged trees. This underscores the importance of the logging industry working closely with the CFIA to ensure they are moving wood safely.

Hazards of moving firewood. (2023, August 1). Canadian Food Inspection Agency; Government of Canada. https://inspection.canada.ca/en/plant-health/forestry/hazards-moving-firewood

Article Summaries

Himalayan balsam

Himalayan balsam is native to India and Pakistan and is one of the most invasive plants in the United Kingdom. It outcompetes native species and makes it hard for them to grow, which reduces biodiversity. It also causes damage to riverbanks because of this. Because it stops other plants from growing, when it dies back in the winter, it can leave banks of rivers and ponds without vegetation, which means they erode more quickly. Traditionally, it has been challenging to get rid of. It grows in inaccessible places or conservation areas where herbicides cannot be used.

In the late 2000s, researchers investigated the natural enemies of Himalayan balsam to see if any biocontrol methods might be effective. These include fungi and bugs that prey on the plant. Researchers decided that most would not be appropriate biocontrol methods because they were likely to impact other plants nearby. However, in 2010, the Centre for Agriculture and Biosciences International (CABI) began testing a rust fungus that infects seedlings and then spreads into Himalayan balsam leaves. They studied the effect of rust fungus on the Himalayan balsam, popular ornamental plants in the UK, crops, and UK-native species. In 2014, the rust fungus was approved by the Department for Environment, Food, & Rural Affairs (Defra). It was the first biocontrol method ever approved in the European Union.

Since then, the rust fungus has been released at over fifty sites throughout the UK. The rust works in all stages of Himalayan balsam's life cycle. The fungus's spores spread through wind and rain, infecting the seedlings' stems. As the plants grow, the fungus forms brown spots on their leaves, making photosynthesizing challenging. The rust spores can also survive the winter. When the Himalayan balsam dies back, the rust survives and can infect new seedlings in the spring. It has been effective overall, but not all populations of Himalayan balsam are vulnerable to the rust fungus that has been studied. Scientists need to research other strains of the fungus to see if they could also be used safely and effectively to reduce the spread of the plant.

Himalayan balsam. (n.d.). Invasive Species, Cabi.
https://www.cabi.org/invasivespecies/species/himalayan-balsam/

Article Summaries

How climate change affects invasive species

As the climate changes, some species are moving into new areas. Because temperatures are getting warmer, some plants have longer growing seasons, giving them a competitive edge. With higher atmospheric carbon dioxide levels, invasive plants can also grow faster. In addition, species can move north into environments that used to be too cold to survive. Mosquitos, Burmese pythons, and feral hogs are all moving north in the United States. Natural disasters can also create opportunities for invasive species to take over.

The arrival of invasive species in ecosystems can lead to significant disruptions. Native plants and animals find it challenging to compete with these intruders, resulting in a gradual decline in their populations. Diseases carried by invasive plants and animals can spread to new areas, exacerbating the problem.

There are some ways we can slow down the spread of invasive species. Pets like snakes, fish, and cats should never be released into the wild. In gardens, invasive plants should be dug up, and native flowers should be planted instead.

Marsh, J. (2022, September 21). How climate change affects invasive species. E, The Environmental Magazine. https://emagazine.com/how-climate-change-affects-invasive-species/

Article Summaries

How climate change drives the spread of invasive plants

With Earth's climate warming, the growth of alien species on every continent is projected to surge by 36% by 2050. As environments evolve, some species lose their adaptability to their native habitat, paving the way for invasive species to dominate. These invaders, thriving in warmer temperatures, often establish monocultures, leading to a loss of biodiversity. The alarming projection is that by 2074, over one million plant species could face extinction.

As human activities involve more movement and transportation of materials than ever before, invasive plants often hitch a ride. Sometimes, this is intentional. For instance, water hyacinth was introduced to Rwanda through the gardens of colonial officers, eventually covering Lake Victoria. Similarly, kudzu was brought from Japan to the United States for ornamental purposes and erosion prevention during the Dust Bowl. However, kudzu's rapid growth rate of up to twelve inches per day has led to it smothering forests annually. Many other plants have similar stories, including butterfly bushes and wisteria.

Invasive species have some benefits. Cities and urban environments are often difficult places for native plants to grow. Some people think it is better to have fast-growing invasive plants to provide shade, prevent erosion, and beautify the city than to have no plant life. However, these invasive plants can spread outside urban environments and cause problems in rural areas nearby.

The best way to manage invasive species is to prevent them from arriving in vulnerable environments in the first place. Biosecurity laws are necessary to regulate this. However, as of 2024, 80% of countries did not have laws regulating invasive species. If invasive species cannot be prevented, it is sometimes possible to eradicate them. Chemical herbicides are one way, though they can harm whole environments, including humans. Biological control is also sometimes an option.

The world is changing, and environments cannot return to the past. It is not likely that non-native plants can or should be removed from all new environments. However, biodiversity is still hugely important and must be maintained.

Cho, R. (2024, March 12). How climate change drives the spread of invasive plants. State of the Planet, Columbia Climate School. https://news.climate.columbia.edu/2024/03/12/how-climate-change-drives-the-spread-of-invasive-plants/

Article Summaries

How invasive species spread

National Park managers in the US must understand how invasive species arrive in new environments to keep them out. They compiled a list of the most common ways invasive species enter national parks and how to prevent them from entering.

1. Many invasive species hitch a ride on vehicles like boats and cars. Seeds can attach to dirt on vehicles, and insects can lay sticky eggs on them. That is why it is so important to keep vehicles clean.
2. Insects, eggs, and fungi can be found in firewood that visitors bring to the park. The managers recommend only bringing in local firewood instead of wood from visitors' homes.
3. People who fish often use live bait. However, many bait species are invasive and can also cause invasive diseases. It is essential to avoid dumping leftover bait into the water.
4. People's pets and plants can be invasive. Ornamental plants can outgrow your garden, and pets (exotic or even common pets like cats) can become an issue if allowed outside or abandoned.
5. We can accidentally transport invasive species in our clothes and boots without realizing it. Plant seeds, insects, fish eggs, and microscopic animals can become attached to us and our equipment, so it is vital to make sure your clothes and gear are clean before entering a new environment like a national park.

How invasive species spread. (2024, February 26). National Park Service. https://www.nps.gov/subjects/invasive/how-invasive-species-spread.htm#:~:text=The%20very%20things%20that%20we

Article Summaries

Invasive alien species: A dual threat to biodiversity and economies

Every year, around 200 species are recorded entering new environments. Worldwide, more than 37,000 species are considered non-native species; 3,500 are considered invasive. Invasives are often the leading cause of extinction for vulnerable species.

Invasive species can also significantly damage global economies. They affect Indigenous populations and marginalized groups even more drastically. For example, the invasive apple snail damages rice and taro crops in Southeast Asia. Small farmers and their local communities predominantly suffer the losses.

Prevention is the best cure for invasive species. We need more robust biosecurity measures, like quarantines and surveillance, to ensure we track and prevent invasive species from entering new environments. Eradication has been successful in some places, especially on small islands.

Biocontrol uses natural enemies of invaders to reduce their numbers. Physical and chemical controls can also be used, but sometimes, they have unintended consequences. Additionally, large-scale eradication efforts can be costly.

Developing countries, often unable to provide funds for eradication, are at an increased risk from invasive species. The economic impact of these invaders can be even more severe on smaller economies. Financial institutions that work to secure funding for eradication serve an essential role in protecting the environment.

Ricciardi, F. (2023, October 16). Invasive alien species: A dual threat to biodiversity and economies. Asian Development Blog. https://blogs.adb.org/blog/invasive-alien-species-dual-threat-biodiversity-and-economies

Article Summaries

Invasive alien species cost Africa's agricultural sector an estimated $65.58 billion a year

The Centre for Agriculture and Bioscience International (CABI) investigated the economic impact of invasive species in Africa. They estimate that invasive species cost the continent over $65 billion US dollars per year. One reason invasive species damage the economy is that they can cause crop failure. Farmers lost corn, tomatoes, cassava, mango, banana, and other crops and livestock because of invasive species.

CABI scientists highlighted the importance of preventing new invasive species from moving in and suggested using biocontrol to manage existing invasives. They also noted that some costs were not included in the calculation of impact costs. Women and children often weed the fields. This work is not measured as part of the economy despite its impact on people's lives and nations' productivity levels.

The long-term effects of invasive species were made worse by the COVID-19 pandemic, which made the agricultural sector and food supply chain less stable. Scientists say governments need to implement emergency measures to fight invasive species, just like they did to get through the pandemic. Africa's population is expected to double to 2.5 billion people by 2050, and a stable food supply chain is vital to support the growing number of people.

Invasive alien species cost Africa's agricultural sector an estimated USD $65.58 billion a year. (2021, August 19). CABI.org. https://www.cabi.org/news-article/invasive-alien-species-cost-africas-agricultural-sector-an-estimated-usd-3-6-trillion-a-year/

Article Summaries

Invasive species [1]

An invasive species can cause harm to an ecosystem it invades. Some non-native species, like wheat and tomatoes, are not native to the regions where they are grown but are not invasive. To be considered invasive, a non-native species must adapt to the new area, reproduce quickly, and cause harm. For instance, nutria (a large rodent native to South America) was introduced to the northern United States. Now, they eat the tall grass in Maryland's wetlands. The plants provide food, shelter, and secure soil in the region, so the local habitat and food web suffer when nutria eat them. Invasive species can harm economies, too. Water hyacinths, which people grow for decoration, spread quickly. In Lake Victoria in Uganda, the water hyacinths grew so quickly that boats could not enter the water, and ports were forced to close.

Sometimes, species like zebra mussels are introduced to a new area accidentally. Other times, they are brought over deliberately as pets, pest control, or decoration. In Florida's Everglades, escaped pet Burmese pythons have created a growing wild population, endangering local species of birds.

Some invasive species outcompete locals by being faster, stronger, or having shorter breeding cycles. Other invasive species have no natural predators in the new environment, so they have nothing to keep the population growth in check.

Different methods are used to try to get rid of invasive species. Sometimes, officials will use chemicals or introduce a disease to target them. Sometimes, they will try to bring in a predator or an organism that eats the invasive species. This solution can backfire, though. For example, if officials bring an insect to eat invasive plants, the insects might also damage local plants and animals.

Invasive species. (2024, August 29). National Geographic Education. https://education.nationalgeographic.org/resource/invasive-species/

Article Summaries

Invasive species [2]

Invasive species are often introduced to new environments accidentally, and they can cause harm where they end up. Invasive species can do a lot of damage to islands.

A few common invasive species are nutria, cheatgrass, brown treesnakes, mosquitos, elodea, rats and mice, the American bullfrog, and feral pigs. Nutria are large rodents that have damaged marshlands in Maryland and carry diseases that can be dangerous to humans and livestock. Non-native mosquitos in Hawaii spread avian (bird) malaria and avian pox, which have caused the extinction of native Hawaiian birds. The other species above all have caused habitat destruction or out-competed native species.

The US Fish and Wildlife Service has some projects to help control the spread of invasive species. They managed to eradicate black rats from the Palmyra Atoll National Wildlife Refuge, which has reduced the invasive species of mosquitos. At Blackwater National Wildlife Refuge in Maryland, they are finishing a project to eradicate nutria. They have also removed or eradicated yellow crazy ants from Johnston Atoll National Wildlife Refuge, feral horses and burros from Sheldon National Wildlife Refuge in Nevada, and black rats from Desecheo National Wildlife Refuge in Puerto Rico. Other projects are starting soon, hopefully allowing native ecosystems to recover.

Invasive species. (n.d.). U.S. Fish and Wildlife Service. https://www.fws.gov/program/invasive-species/what-we-do

Article Summaries

Invasive species: The silent threat to our ecosystems

Many non-native species in Britain are harmless. They are brought from all over the world and do no damage. However, 10-15% of non-native species spread and become invasive. The Animal and Plant Health Agency (APHA) highlights ways people can help prevent the spread of invasive species in Great Britain.

One way is by keeping a garden full of native plants. It's best not to bring plants from abroad or use ornamental plants that are not native to your area. Another way is by keeping an eye out for 'alert' species. These species are non-native and could become invasive if we are not careful. These include animals as well as plants. For example, raccoon dogs are invasive in Europe. It has been a popular exotic pet, but raccoon dogs are predators that can impact native animals and carry diseases. Asian hornets, another invasive species, are controlled by the APHA National Wildlife Management Centre, which responds to confirmed sightings and destroys hornet nests.

Cornwell, L., & Stewart, J. (2023, May 15). Invasive species: The silent threat to our ecosystems. APHA Science Blog, Gov.uk. https://aphascience.blog.gov.uk/2023/05/15/invasive-species-the-silent-threat/

Article Summaries

Invasive species are causing hundreds of billions in economic damage. Is climate change to blame?

The United Nations Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) conducted a four-year study worldwide to investigate the economic impact of invasive species. They discovered that the global economic cost is nearly 400 billion euros (about 420 billion US dollars) annually. Invasive species can also affect human food security and health and damage infrastructure.

Around 37 thousand non-native species have been introduced to new habitats by humans. Human activity and climate change are the two leading causes of invasive species spread. People accidentally and sometimes purposefully bring species into new environments. Warmer temperatures globally are likely to make the problem worse in the coming years.

Euronews Green. (2023, May 9). Invasive species are causing hundreds of billions in economic damage. Is climate change to blame? Euronews. https://www.euronews.com/green/2023/09/04/invasive-species-costs-global-economy-391bn-per-year-un-report

Article Summaries

Invasive species 'hitchhiking' on ships threaten Antarctica's unique ecosystems

Antarctica's ecosystems face yet another threat from climate change: marine species that travel on human ships. The British Antarctic Survey and the University of Cambridge found that Antarctica's oceans are connected to all the world's oceans via a complex trade network of over 1,500 ports. From these ports, mussels, barnacles, crabs, algae, and other organisms can attach themselves to ships' hulls. This contamination of species is known as biofouling. The ships that enter Antarctic waters can be fishing vessels, research ships, or even a growing number of tourists. Tourist ships tend to come from distant ports and are more likely to be biofouled. Research and fishing vessels are likely to stay in Antarctica for extended periods, though, and longer stays are associated with a higher risk of introducing a new species to the environment. Researchers are especially worried about species moving from the north pole to the south, and vice versa, because these species can already survive the cold temperatures.

Because Antarctica is so isolated, the environment is unprepared to deal with the significant changes that new species can bring. For example, mussels and shallow-water crabs have no competitors in Antarctica and might easily take over. The Southern Ocean has a unique mix of life and is currently the only marine region in the world with no known invasive species. More ships in the area means a much higher risk of that changing. Besides the environment, invasive species pose a threat to krill fisheries that operate in the southern oceans. The researchers called for stricter biosecurity measures, especially as oceans get warmer due to climate change.

Press Office. Invasive species 'hitchhiking' on ships threaten Antarctica's unique ecosystems. (2022, January 10). British Antarctic Survey. https://www.bas.ac.uk/media-post/invasive-species-hitchhiking-on-ships-threaten-antarcticas-unique-ecosystems/

Article Summaries

Invasive Species Week: Meet the team dealing with Asian hornets, Japanese knot weed and coypus

Jersey, an island in the English Channel, deals with over a hundred invasive species. Invasive species management is different in different seasons. Jersey's Invasive Species team is preparing for the UK-wide Invasive Species Week in the spring. They aim to educate the public on managing invasive species. During the summer, they monitor Asian Hornets and work on destroying nests. In autumn, they shift their focus to plants like Japanese knotweed. During the winter, they collaborate with experts on the nearby island of Guernsey to look at new invasive species that may pose a threat in the future. Year-round, they respond to reports from the public about invasive species and manage volunteers who help track and remove them.

Deciding which new species to remove is complex; sometimes, the team must fight public opinion. People were fond of coypu when pictures spread on social media, but these fuzzy rodents breed quickly and damage local ecosystems. They came to Jersey from nearby France, and in France, they caused vast amounts of damage.

The team cannot deal with invasive species alone. They rely on the public to help prevent their spread. First, it is vital to clean and dry clothes, shoes, boats, and equipment used in the water. Also, garden and aquarium plants and pets must stay contained; it is essential not to let them escape into the wild. They urge people to watch for invasive species, report them to the team if spotted, and volunteer with a local action group.

Sharman, K. (2024, May 19). Invasive Species Week: Meet the team dealing with Asian hornets, Japanese knot weed and coypus. Official Government of Jersey Blog. https://blog.gov.je/2024/05/19/invasive-species-week-meet-the-team-dealing-with-asian-hornets-japanese-knot-weed-and-coypus/

Article Summaries

“Is it good or bad?” Rethinking language around invasive species

Invasive species tend to grow and spread quickly and displace other species. They can cause habitats to break down and have other harmful effects. But these species are alive, and the Minnesota organization Friends of the Mississippi River is working with local Indigenous organizations to work on our relationship with the living world and how we talk about it. The language we use to discuss invasive species is often hostile and violent. And that language can have serious consequences.

First, it is essential to note that not all non-native or introduced species are invasive. Many are harmless and can even help their new ecosystems. For example, Dutch clover provides nectar for bees. Also, invasive species are not the only ones that can cause damage. Native species can also spread rapidly and crowd out other species. One example in Minnesota is smooth sumac.

Many ask if a plant is ‘good or bad,’ a harmful binary. Plants are not bad; they are trying to survive, and many factors influence their success. Some species introduced into new environments can lead to lower-quality habitats that impact other species and reduce biodiversity in an area. So, it is important to manage their adverse effects, but it is not helpful to demonize them. The names we use for species influence how we think about and treat them. One way that our language has already changed is that we use the terms ‘exotic’ and ‘alien’ less now than in the past because those terms mimic anti-immigration speech.

Indigenous organizations like Wakaŋ Tipi Awaŋyaŋkap use ‘displaced plant relatives’ instead of ‘invasive species.’ This lens shows the relationships between all plants, regardless of whether they were ‘introduced’ or have been found in an area for centuries. Similarly, the Better Common Names Project is working on identifying and changing problematic species names. Restoration ecology organizations are trying to move away from language that sounds military and towards language that acknowledges relationships between species. Being more careful with language allows us to do more open, respectful work to improve our relationship with the earth.

“Is It good or bad?” Rethinking language around invasive species. (n.d.). Friends of the Mississippi River. https://fmr.org/updates/conservation/it-good-or-bad-rethinking-language-around-invasive-species

Article Summaries

It's time to stop demonizing "invasive" species

Species around the world are moving to different habitats as the climate changes. Ecologists expect that climate change will only increase the shift of species, but the long-term effects are hard to predict. According to scientists, habitat shift is not a bad thing. It prevents species from going extinct, as they might if forced to remain in areas with higher and higher temperatures. Many non-native species do not cause problems in their new environments. In any case, there are no 'pure' ecosystems in the 21st century. Climate change and human intervention have disrupted life, so it is not a simple ethical question to remove all species that have moved into new habitats. Some scientists argue that range-shifters should be seen as climate refugees rather than invaders.

People worry that invasive species harm the 'genetic integrity' of native species. When they reproduce with natives, the offspring are considered 'hybrids' and seen as less valuable than the 'pure' native species. In North Carolina, for example, efforts have been made to prevent coyotes and red wolves from breeding. Interbreeding does not harm red wolves or coyotes, and the attempt to stop mixing has uncomfortable similarities to eugenics policies.

The needs of the 'invasive' species themselves are rarely, if ever, considered in invasive species management. In Australia, one researcher notes that animals are killed in violent, often cruel ways in the name of conservation. By contrast, 'compassionate conservation' views each animal as an individual with value instead of just one of many. Viewing all non-natives as pests that must be killed also goes against some stated conservation goals. Some species are endangered or threatened in their native environment but treated as pests and invaders in other areas where they have migrated. Non-native habitats can be part of the solution for protecting endangered species. In some cases, they have created new and fascinating ecosystems.

Conservation efforts always require judgments, and it is essential to consider other perspectives and to get outside the common framework of 'native' and 'invasive.' Indigenous knowledge is central to this. People have a responsibility to find out why species are migrating. In any case, life is constantly shifting. Humans and all other species will have to adapt to changes.

Bolotnikova, M. (2021, November 28). It's time to stop demonizing "invasive" species. Vox. https://www.vox.com/down-to-earth/22796160/invasive-species-climate-change-range-shifting

Article Summaries

Operational activities: Starlings and blackbirds

There are about ten species of blackbirds native to North America. European starlings are very similar to blackbirds in their behavior, often found in the same flocks as blackbirds. However, starlings are not native to North America and are considered an invasive species there. Blackbirds and starlings can do severe damage to urban areas. Because the flocks are so big, their feces can cause property damage. They cause a terrible smell, and the feces can be slippery, a safety risk. Blackbirds and starlings are also estimated to cause over USD 150 million loss in damage to crops, including grain and fruit, in North America. They also often eat feed intended for cattle, which harms dairy farms. When they congregate around cattle and other livestock, they can spread disease. Their huge flocks can even be a danger to planes. In 1960, a flock of starlings caused a plane crash that killed 62 people. Finally, starlings and some blackbirds outcompete native bird species.

Several non-lethal methods are used to manage pest birds like starlings and blackbirds. A standard method is harassment, mostly annoying the birds until they move away. People can use laser lights at night to encourage them to leave the area. Pyrotechnics and other frightening devices, such as scarecrows, are often also helpful. Farmers can also limit how much food and water is available to the birds by changing their livestock feeding schedules and reducing tank water levels.

As a last resort, trained Wildlife Services staff sometimes use a lethal pesticide that only affects birds. Sometimes, they also trap birds. Overall, using several methods at once is usually more effective in preventing damage to agriculture. Because European starlings are an invasive species, they are not protected by Federal law in the United States, though some states have restrictions on hunting seasons and require permits to hunt them. Blackbirds do have some protection from the US government.

Operational activities: Starlings and blackbirds. (2024, April 8). Animal and Plant Health Inspection Service, US Department of Agriculture. www.aphis.usda.gov/operational-wildlife-activities/starlings-blackbirds.

Article Summaries

Panel of women researchers discuss ethics in managing invasive species

The University of Hawai'i at Hilo hosted a roundtable on how invasive species are managed and discussed. The panelists included an author who works for a US Department of Forest Service agency, restoration ecologists, a professor of philosophy, and a professor of biology, both from UH Hilo.

Four of the authors have worked on a project that aims to restore Hawaiian lowland wet forests. The project uses native and non-native species. They discussed how human language can carry meaning that goes beyond literal meaning. One panelist argued that invasive species "is a first-world problem." Many developing nations do not have the luxury of valuing some plants over others. Non-native species can also generate value, especially in areas where it is hard to grow anything. The panel also pointed out that people often talk about invasive species similarly to how they talk about human immigration. Many meanings are associated with being 'native' or 'non-native,' documented, undocumented, and 'an immigrant.'

Humans make choices about natural ecosystems, and these choices change those ecosystems. It is impossible to 'restore' ecosystems to their former state before human involvement. We have fundamentally changed the world's ecology.

The panelists also noted that ecological restoration must consider many factors outside of trying to prevent non-native species from invading. We must consider climate change, seed dispersal, what animals can help with it, what trees can provide cover for, and many more factors. They do not say that invasive species are harmless or have no impact but argue that we must stop thinking in a binary that says that native species are good and non-native are bad.

Hemmerly, J. (2022, April 11). Panel of women researchers discuss ethics in managing invasive species. UH Hilo Stories; University of Hawai'i Hilo. https://hilo.hawaii.edu/chancellor/stories/2022/04/11/panel-ethics-in-managing-invasive-species/

Article Summaries

Prevention and early action: Yellow crazy ants

The Invasive Species Council is working to fight against yellow crazy ants in Queensland, Australia. They began in 2018 when the problem was so bad that the ants could injure and even kill large animals like kangaroos. After two years, they completely eradicated yellow crazy ants from the area of Nome. They are still working on getting rid of the ants in nearby areas and have a ten-year plan to tackle the problem in Townsville, Queensland.

In Cairns, the fight against yellow crazy ants began in 2001. Despite the long battle, significant progress has been made with the help of odor-detection dogs. Today, approximately 85% of Cairns is free from the infestation.

Yellow crazy ants spray formic acid rather than biting. If they are in a large colony, this acid can be a severe threat to people and pets, as well as to electrical infrastructure. Yellow crazy ants encourage sooty mold growth, damaging crops like fruit trees and sugar cane. Local governments will have to fund further efforts, but many recognize that the damage the ants can do will cost much more than the price of eradicating them.

Prevention and early action: Yellow crazy ants. (2022, January 5). Invasive Species Council. https://invasives.org.au/blog/prevention-and-early-action-yellow-crazy-ants/

Article Summaries

Problem to plate: Could eating invasive species be a sustainability game changer?

Invasive species cause costly damage. Most efforts to eliminate species like green crabs and copi (a type of carp) in North America are difficult and expensive. A different kind of solution might be possible: eating them.

In Spain and Italy, green crabs are a common dinner item. But around the world, they have become invasive on most continents. The bad news is that they out-compete and often destroy local shellfish and crab populations. The good news is that they taste great and can be substituted into many local recipes worldwide. There is also a shallow risk of overfishing them because even dedicated efforts to remove them have failed.

On the other hand, the public perception of invasive species as 'pests' or 'undesirable' makes it difficult to market them as quality food. Some places are still trying. Illinois even changed the name of invasive Asian carp to 'copi' to make them more popular with consumers. This rebranding is not unheard of. In the early 1900s, lobster was considered low-quality, trash food. Now, it is widely regarded as fine dining. If people do not eat certain species, there may be a place for them in the pet food industry. The danger of creating the demand for invasive species as food is that people may begin farming and spreading them to increase supply. It will be essential to maintain sustainability.

Borts-Kuperman, L. (2024, March 11). Problem to plate: Could eating invasive species be a sustainability game changer? Agriculture Dive. https://www.agriculturedive.com/news/invasivorism-advocates-seek-consumer-traction-for-sustainable-future/709886/

Article Summaries

Scientists develop a plan to manage lionfish populations in the Mediterranean

In 2012, lionfish were first noted in the Mediterranean Sea. More have entered since then. Between 2018 and 2020, researchers saw that the population got four times bigger in Cyprus's Marine Protected Areas. Researchers in the UK and Cyprus have published a guide to lionfish management. Their recommendations are part of RELIONMED. This four-year project is part of the European Union's LIFE programme (L'Instrument Financier pour l'Environnement). They do not expect to be able to eradicate lionfish in the Mediterranean, but they are hoping to improve biosecurity in the Suez Canal to control their spread.

RELIONMED shared some key recommendations. They have other suggestions besides changing local and international laws to reflect the potential of lionfish's impact. These include targeting lionfish quickly and allowing them to be caught and sold by commercial and recreational fishers. They also suggest creating a supply chain for lionfish products so they can be sold at a profit and generate public interest in both eating lionfish and working to manage their population.

Williams, A. (2022, April 11). Scientists develop a plan to manage lionfish populations in the Mediterranean. University of Plymouth. https://www.plymouth.ac.uk/news/scientists-develop-a-plan-to-manage-lionfish-populations-in-the-mediterranean

Article Summaries

Should we cull one species to save another?

Note: The full article includes descriptions of animal death and may not be suitable for all readers.

In the 1800s, mice on human ships were introduced to Gough Island for the first time. Now, mice are the island's top predators. They eat seabirds, including endangered albatross chicks and Gough buntings. Plans were made to poison the mice in hopes of stopping the destruction of these endangered populations. However, many animal rights activists protest that this method of killing the mice will make them die slowly and painfully, and we should not value one animal over another. They argue that it is not suitable for humans to decide which animals live and which do not based on our preferences. Ironically, there is usually only widespread protest to protect charismatic and popular invasive species. In Britain, people protested culling badgers, which spread tuberculosis and wild boars. However, people in Britain support the culling of grey squirrels because they carry a virus that infects the more beloved red squirrels. The teams responsible for eradicating mice on Gough Island agreed that it is not ideal to kill them but argued that the problem is too urgent to wait for slower solutions. Removing invasive species can save entire food webs from being destroyed and maintain biodiversity.

The poison used on Gough Island causes death after two or three days of illness. It can also move up the food chain if another animal eats the mouse. However, Faster-acting poisons can mean that rodents that survive are more challenging to kill later because they are more wary of bait set out by humans. Both activists and the teams eradicating the mice agree that using the most humane method is essential.

Eradicating animals can also have unintended consequences. For instance, black rats were eradicated on the Shiant Islands (off the coast of Scotland) in 2015, but it was not clear if they were damaging local puffin populations. In 2006, rats were eradicated from another Scottish island. As a result, the rabbit population there grew so large that the rabbits also had to be culled. Black rats are the most endangered mammal in Britain, and by removing them from the Shiants, we lost a population of rodents where we might study tick-borne diseases.

Barkham, P. (2020, June 28). Should we cull one species to save another? The Guardian. https://www.theguardian.com/environment/2020/jun/28/should-we-cull-one-species-to-save-another-huge-mice-killing-birds-gough-island

Article Summaries

These are the 5 costliest invasive species, causing billions in damages

Between 1970 and 2017, invasive species are estimated to have cost the global economy at least $1.2 trillion. Some of these costs are from damage to ecosystems, crops, and infrastructure. Others are the costs of prevention efforts and invasive species management. Researchers at the French National Museum of Natural History estimated the cost of different species. They want to raise awareness among the public. There are some gaps in the data, and agricultural pests are overrepresented. However, the global perspective is still critical and shows the massive problem of invasive species. The top five invasive species and their estimated annual global costs are below. Costs are in US dollars.

- Aedes mosquitoes: ~$149 billion

Native to Asia and sub-Saharan Africa, these mosquitoes arrived in North America in the 1980s and are now common worldwide, including in Europe, South America, Africa, and Australia. They transmit a range of diseases, including Zika and yellow fever, which are expensive to treat and can be deadly.

- Rats: ~$67 billion

Rats have been on human boats for about 3,000 years, and in that time, they have made many other species extinct. The Pacific rat has caused the extinction of 1,000 species of island birds. They also damage crops and property and spread disease.

- Cats: ~$52 billion

Cats are native to Europe and the Middle East. They are found on every continent except Antarctica and kill many small animals, insects, and birds. They can have a devastating effect on biodiversity, especially on islands.

Article Summaries

These are the 5 costliest invasive species, causing billions in damages, *continued*

- Termites: ~$19 billion

Subterranean termites come from East Asia but can spread wherever there is wood and moisture. They destroy houses, bridges, crops, and tree farms worldwide.

- Fire ants: ~$17 billion

These South American ants often outcompete local ant species because they are aggressive. They can impact local crops like soybeans and bite humans and livestock.

Lambert, J. (2021, March 31). These are the 5 costliest invasive species, causing billions in damages. Science News. https://www.sciencenews.org/article/invasive-species-cost-billions-damages-global-economy

Article Summaries

Using fungus to fight crazy ants

In Texas, researchers have made a breakthrough in fighting tawny crazy ants, an invasive species native to South America. They started spreading across Texas in 2002 and have developed into huge, difficult-to-wipe-out colonies. However, in 2015, researchers discovered a fungus called *Myrmecomorba nylanderiae*, which might be a solution. The fungus creates spores that infect the ants' fat cells. Over eight years, 62% of ant colonies infected with the fungus died out. Even better, the fungus does not seem to affect any Texas species other than tawny crazy ants. They began testing this biocontrol method in the Estero Llano Grande State Park in 2016. The park's ant infestation had become severe, killing local species, including reptiles and mammals. The researchers introduced infected ants into the park. Then, they used hot dogs to encourage tawny crazy ants already in the park to approach the infected ants. The results were encouraging, and after two years, the crazy ant population decreased. The team is working on using the same method to eradicate crazy ants from other sites in Texas.

Handsley-Davis, M. (2022, March 29). Using fungus to fight crazy ants. Cosmos Magazine. https://cosmosmagazine.com/nature/animals/fungus-fight-crazy-ants/

Article Summaries

What's with these invasive "crazy" worms and why can't we get rid of them?

Jumping worms are becoming a noticeable problem in the United States. These unusual worms move fast and lay up to twenty cocoons per month, spreading quickly. They have been spotted in more than half of US states and Canada. Because they move quickly, jumping and wriggling through the soil, they disturb natural soil decomposition. They can also damage plants by stirring up topsoil. In addition, they might be tied to the decline of European earthworms, which are essential to maintain healthy soil. However, European earthworms are not considered a native species in North America, either; they did not arrive until the 1600s. They also changed the environment but are considered mostly beneficial rather than invaders.

On the other hand, jumping worms only arrived in the last 100 years or so. Researchers are still determining why they have only started spreading now. One reason might be that we are more aware of them; they can look alarming in large groups, and social media has raised awareness. Climate change might also play a part in their spread.

It is hard to know how problematic jumping worms are. They do not help mix soil the way that European earthworms do. They stay near the top of the soil and leave their castings on the surface, which can cause issues with plant growth. Jumping worms also seem to outcompete European earthworms, though researchers are unsure how.

Some states are trying to reduce the number of jumping worms, but most methods are inefficient. Gardeners try to keep them out by putting up barriers of metal flashing underground. It is recommended to avoid picking up compost, mulch, or plants from unknown sources to avoid bringing in jumping worms from other sources. Unfortunately, the worms are here to stay.

Courage, K. H. (2021, June 16). What's with these invasive "crazy" worms and why can't we get rid of them? Vox. https://www.vox.com/2021/5/5/22408390/crazy-jumping-worms-invasive-earthworm-garden-soil

Article Summaries

Why confronting invasive species is one of the best ways to prepare for climate change

A new National Academy of Sciences study found that invasive species' ecological effect is like warming global temperatures. The three factors of invasive species, drought, and changes in the nitrogen cycle (a vital part of plant growth) are some of the most significant challenges we face in damage to our natural world.

The researchers were surprised to find that the effects of invasive species were different and less severe than they had predicted before the study. They expected the three factors above would worsen each other, creating a negative feedback cycle. However, the research showed that these factors interacted negatively only about a quarter of the time. Surprisingly, environmental change and invasive species did not make each other worse. Instead, the combination was only about as damaging as the effect of invasive species alone. The researchers concluded that managing invasive species locally would have the most impact. Progress is already being made, especially in preventing the spread of invasive species before it begins.

Miller, D. (2022, June 1). Why confronting invasive species is one of the best ways to prepare for climate change. University of Massachusetts Amherst. https://www.umass.edu/news/article/why-confronting-invasive-species-one-best-ways-prepare-climate-change

Additional Media Links

32 COMMISSION-MANAGED LANDS INTERACTIVE MAP

Description: This map of Florida highlights lands managed by the Florida Fish and Wildlife Conservation Commission and links to pages that specify hunting regulations throughout the state and strategies for tracking invasive pythons in Florida.
Florida Fish and Wildlife Conservation Commission. (2022). 32 commission-managed lands interactive map. [Map]
Retrieved from https://storymaps.arcgis.com/stories/78845fa10bc9445bacae4c3b5dd504d7

AUSTRALIA HAS A CRAZY ANT PROBLEM

Description: This video shows Australia's invasive yellow crazy ants, why they are so successful, the damage they are doing to ecosystems, and how humans are spreading them further.
ABC News In-Depth. (2021). Australia has a crazy ant problem. [Video]
Retrieved from https://www.youtube.com/watch?v=MY0EjUMlOSU

AUSTRALIA'S INVASIVE SPECIES PROBLEM

Description: This video introduces the many invasive species taking over Australia, their history, and how Australia attempts to control them.
BioArk. (2021). Australia's invasive species problem. [Video]
Retrieved from https://www.youtube.com/watch?v=ml6OrO8Vwl0

BIG ISLAND INVASIVE SPECIES

Description: This is the official Instagram account for the Big Island Invasive Species organization, working to protect Hawaii from invasive pests.
Big Island Invasive Species. (n.d.). [Instagram account]
Retrieved from https://www.instagram.com/bigislandinvasivespecies/

CATS: INVASIVE SPECIES?

Description: This podcast discusses how cats can be destructive to local ecosystems and what responsible pet owners can do to minimize their effects.
Stuff You Should Know. (2022). Cats: Invasive species? [Podcast]
Retrieved from https://pca.st/e7jo2f7w

Additional Media Links

CABI COMPENDIUM - INVASIVE SPECIES

Description: This compendium allows readers to search for any invasive species to learn more about its effects, environment, and other important details, including range maps.
CABI Digital Library. (n.d.). CABI Compendium - Invasive species. [Digital encyclopedia]
Retrieved from https://www.cabidigitallibrary.org/product/QI

EATING INVASIVE SPECIES

Description: This podcast episode explores the creative ways that people from Belize to Tennessee tackle invasive species by adding them to their diets and integrating them into the supply chain.
People Fixing the World, BBC News World Service. (2023). Eating invasive species. [Podcast]
Retrieved from https://pca.st/n5r8bc9j

EXPLORE YOUR AREA: NBN ATLAS

Description: By entering a postcode or location in the UK, you can view all the species in that area. By clicking on the species name and then 'species profile, ' you can see if the species is native to the area in the 'establishment means' section at the top of the page.
National Biodiversity Network Atlas. (n.d.). Explore your area. [Map]
Retrieved from https://records.nbnatlas.org/explore/your-area

HOW GUARDIANS FIGHT INVASIVE SPECIES

Description: The Imaryuk Monitors and the T'sou-ke Nation Marine Team show their work protecting Canada's ecosystems from invasive species.
Land Needs Guardians. (2024). How guardians fight invasive species. [Video]
Retrieved from https://www.youtube.com/watch?v=cgG0lk81i1k

HOW THIS DRUG LORD CREATED A HIPPO PROBLEM IN COLOMBIA

Description: This video explores how Pablo Escobar's private zoo resulted in a damaging, potentially invasive population of hippos far outside their native range.
Vox. (2018). How this drug lord created a hippo problem in Colombia. [Video]
Retrieved from https://www.youtube.com/watch?v=R_ViOLgvsuY

Additional Media Links

HOW TO EAT THE WORLDS MOST INVASIVE PLANT

Description: Alexis Nikole, who uses her social media platforms to educate about foraging for food and what local plants can be eaten safely, introduces Japanese knotweed and how it can be eaten.
Alexis Nikole (2022). How to eat the world's most invasive plant. [Video]
Retrieved from https://www.tiktok.com/@alexisnikole/video/7088097090487864618?lang=en

INVASIVE PLANT REMOVAL IN ZION NATIONAL PARK

Description: The park rangers in Zion, US, describe how they use herbicides to control invasive plants in the park.
Zion National Park (2023). Invasive plant removal in Zion National Park. [Video]
Retrieved from https://www.youtube.com/watch?v=BYc3q32DiKw

INVASIVE SPECIES COUNCIL

Description: This is the official Instagram account for Australia's Invasive Species Council, an NGO dedicated to protecting biodiversity in Australia.
Invasive Species Council. (n.d.). [Instagram account]
Retrieved from https://www.instagram.com/invasive_species_council/

INVASIVE SPECIES WEEK

Description: This video playlist aims to raise awareness and teach the public how to tackle invasive species in Maryland.
Maryland Department of Natural Resources (2024). Invasive Species Week. [Video playlist]
Retrieved from https://www.youtube.com/playlist?list=PLhH8UZZcY4XTEwJgNaiFHOCc-hus3asn5

MAP OF PRIVATE EXOTIC PET OWNERSHIP LAWS

Description: This map of the US details the states that restrict the ownership of 'exotic pets', including non-domesticated carnivores, reptiles, and primates. Clicking on each state links to a list of animal ownership laws in that state.
Animal Legal & Historical Center, Michigan State University (2024). Map of private exotic pet ownership laws. [Map]
Retrieved from https://www.animallaw.info/content/map-private-exotic-pet-ownership-laws

Additional Media Links

RACE TO SAVE SINGAPORE'S WILDLIFE: JUST HOW BIODIVERSE ARE WE? | IT'S IN OUR NATURE | PART 1/2

Description: This documentary introduces some of Singapore's rare wildlife and the experts who are working to preserve Singapore's biodiversity. (Note: this does not go into depth on invasive species but serves to highlight the importance of biodiversity as a whole.)
CNA Insider. (2021). Race to save Singapore's wildlife: Just how biodiverse are we? | It's in our Nature | Part 1/2 [Video]
Retrieved from https://www.youtube.com/watch?v=4Ey9xXrzmnQ

RELEASING INVASIVE SPECIES ON PURPOSE

Description: This video describes how biological control methods are intended to work, what has happened when they go wrong, and a few success stories.
SciShow. (2023). Releasing invasive species on purpose. [Video]
Retrieved from https://www.youtube.com/watch?v=IF8VveNsGEI

SPACE INVADERS: SOLVING THE INVASIVE SPECIES EXPLOSION

Description: This video shows the spread of invasive blue crabs through the Suez Canal into the Mediterranean Sea, and some of Italy's solutions for the spread.
National Geographic. (2024). Space invaders: Solving the invasive species explosion. [Video]
Retrieved from https://www.youtube.com/watch?v=CxsfIZ-I-8U

THE TROUBLE WITH TUMBLEWEED

Description: This animation shows how tumbleweeds spread from their native Russia into the western United States, where they are now so common they are iconic.
CGP Grey. (2020). The trouble with tumbleweed. [Video]
Retrieved from https://www.youtube.com/watch?v=hsWr_JWTZss

THE TRUTH ABOUT INVASIVE SPECIES | SCISHOW COMPILATION

Description: This video covers the range of invasive species worldwide, introducing some specifics, their benefits, and their problems.
SciShow. (2021). The truth about invasive species | SciShow Compilation. [Video compilation]
Retrieved from https://www.youtube.com/watch?v=dB3dvHHJNlA

Additional Media Links

THIS IS "IMPOSSIBLE", BUT NEW ZEALAND IS TRYING ANYWAY

Description: The host talks with the Predator Free Wellington team, which is working to eradicate invasive predators like rats, stoats, and weasels in New Zealand.

Tom Scott. (2023). This is "Impossible", but New Zealand is trying anyway. [Video] Retrieved from https://www.youtube.com/watch?v=wcp1BfPUeOc

We check all digital resources at the time of publication to ensure that all provided links are active. However, changes occur online continuously and these links may change.

Discussion Topics

1. Are there any invasive species in your area? What efforts are being taken to combat them?
2. What are some essential species in your area's ecosystem? What would happen if important species in your area disappeared?
3. How many types of ecosystems can you name? What makes them different? Do these ecosystems all have the same species, or do they have different species?
4. How has climate change affected your area? Do you notice animals behaving differently than they have in the past? Do plants grow at different times of the year than before?
5. Have you ever eaten an invasive species? Would you eat an invasive species?
6. Do you have any pets? Do you keep them in the house?
7. What organizations address invasive species in your area? Have you ever been involved with them?
8. How do you interact with your environment as a human? How do other species interact with it differently?
9. Have you been to a forest? Did you check your shoes before you went in? Did you check your shoes when you came out?
10. Have you ever traveled overseas? Did you report any plants, fruits, seeds, or anything else at customs?

Use these prompts to spark thinking before, during, and after engaging in the research activities. All of the prompts can be adapted to either discussion or writing.

Learning Prompts - Activating

1. What is an alien species? How does it differ from an invasive species?
2. What are the three criteria for a species to be considered invasive?
3. What are different methods to control populations of invasive species? Identify at least 3 methods.
4. How can invasive species affect an environment? Identify at least 3 ways.
5. What are some actions you can take in your community to reduce the spread of invasive species?
6. How can alien species make their way to new areas?
7. Do all non-native species become invasive?
8. What is the ethical conflict about invasive species? What are reasons for each side?
9. How do invasive species cause damage? List at least 5 ways.
10. What is monocropping? How does it differ from a monoculture?

Learning Prompts - Open Response and Writing

1. Identify an invasive species in your area. Describe how you would reduce its effects on the ecosystem. Would you cull it? Would you relocate it? Explain your reasoning.
2. What are ways to increase community knowledge and involvement in controlling invasive species?
3. How could scientists prevent the introduction of new species to Antarctica?
4. Why do some non-native species become invasive and others do not?
5. What are the risks and benefits of introducing a species to a new environment? When is it justified? When is it not justified?
6. Research an invasive species in your area. What methods are being taken to control it? Are these methods effective?
7. How can the spread of invasive species be reduced ethically? What methods do you think are appropriate to deal with invasive species?
8. How can invasive species damage ecosystems?
9. Choose an invasive species. Describe how it came to the new area, how it damages the ecosystem, and how it is being controlled.
10. Is it ethical to cull invasive species? Consider different perspectives and write an essay explaining your decision.
11. What should you do if you find an invasive species? Research your area's suggestions for what to do when you find an invasive species.

Assessment - Multiple Choice

Name _____

1. Choose all answers that apply. A species' "natural" or "native" range includes which of the following:

a. The species was found in the area 5000 years ago.
b. The species was not introduced to the area by humans.
c. The species was an important part of the area's ecosystem.
d. The species was introduced to the area by humans.

2. Which method below is NOT accepted to control invasive species?

a. Culling populations
b. Biocontrol
c. Doing nothing
d. Relocation of the species

3. Which of the following is NOT a significant cause of biodiversity loss?

a. Habitat loss
b. Diversifying species
c. Climate change
d. Invasive species

4. Which of the following is not one of the three criteria to be an invasive species?

a. The species has caused at least one other species to go extinct.
b. The species is self-sustaining in the wild.
c. The species causes harm to its new environment or human health.
d. The species spreads relatively quickly.

5. Biofouling is when...

a. organisms pollute the environment with their waste, affecting the ecosystem.
b. organisms die, and decomposers cannot keep up with biomatter.
c. organisms produce repulsive smells, disrupting an ecosystem.
d. organisms attach themselves to vehicles, allowing them to move into and contaminate new environments.

6. What percentage of non-native species are considered invasive?

a. 6%
b. 12%
c. 18%
d. 24%

7. What is the most effective way to deal with invasive species?

a. Eradication
b. Prevention
c. Relocation
d. Consumption

Assessment - Multiple Choice

8. Some of the deadliest invasive species are...

a. Cats
b. Rats
c. Aedes mosquitoes
d. All of the above

9. Which of the following is not considered a non-lethal method to manage pest birds?

a. Posting scarecrows in fields
b. Limiting available food and water
c. Poisoning water supplies
d. Annoying birds with laser lights or pyrotechnics

10. Invasive species can cause damage in which of the following ways?

a. Damaging crops
b. Destroying homes and buildings
c. Harming people physically
d. All of the above

11. As of 2024, what percentage of countries did not have laws regulating invasive species?

a. 20%
b. 40%
c. 60%
d. 80%

12. In Texas, researchers have used what to reduce the number of tawny crazy ant colonies?

a. Fire
b. Fungus
c. Poison
d. Water

13. Which of the following invasive species is not edible?

a. Copi
b. Nutria
c. Green crabs
d. Lionfish

14. Yellow crazy ants do which of the following?

a. attack crabs, causing underbrush to grow since the crabs are not there to clear it.
b. create an acid that burns skin and electronics.
c. swarm children playing outside.
d. encourage sooty mold growth, damaging crops like fruit trees and sugar cane.

15. A feral animal is...

a. A domesticated animal that has behavioral issues.
b. An animal that was once domesticated, but belongs to a population that is wild.
c. A wild animal that spreads disease.
d. An animal that is hostile to humans.

Assessment - True/False

Name _____

_____ 1. Invasive species are not the same as alien species.

_____ 2. Scientists all agree that “invasive species” is the best term.

_____ 3. A species’ “natural” range describes all areas in which it lives.

_____ 4. Often, culling methods do not affect native species; they only affect the invasive species.

_____ 5. Invasive species are a major culprit of biodiversity loss.

_____ 6. The best way to manage invasive species is to prevent them from arriving in the first place.

_____ 7. Habitat loss can cause species to migrate and become alien species.

_____ 8. Invasive species are evil.

_____ 9. Culling their populations is the only way to control invasive species.

_____ 10. All invasive species are introduced accidentally.

_____ 11. Antarctica cannot sustain non-native species, making it safe from the threat of any invasive species.

_____ 12. Invasive species cannot be endangered in their natural range.

_____ 13. Monoculture only happens when farmers choose to create them.

_____ 14. Invasive species affect all areas the same, regardless of the area's economic strength.

Assessment - True/False

Name _____

_____15. Some invasive species are introduced to solve other problems.

_____16. The Southern Ocean is currently the only marine region in the world with no known invasive species.

_____17. Household pets, like cats and snakes, are not considered invasive species.

_____18. Invasive species cannot be considered a food source.

_____19. The economic impact of invasive species is less severe on smaller economies.

_____20. Higher atmospheric carbon dioxide levels encourage invasive plants to grow faster.

Assessment - Fill-in-the-Blank

Name _____

1. Every year, around _____ species are recorded entering new environments. Worldwide, more than _____ species are considered non-native species; of those, _____ are considered invasive.
2. Invasive species arrive in their new environments in various ways. Sometimes, they are transported accidentally. _____ can be picked up on the soles of shoes and then transported to a new place. Often, species are moved purposefully, though. People bring _____ into their gardens, spreading outside and into the surrounding area. _____ can escape or be released by their owners and establish wild populations.
3. Yellow crazy ants are an invasive species on Christmas Island. They kill _____, which usually clear away underbrush in the island's forest. A few years after the ants were introduced, the growth of the forest had changed completely.
4. _____ are large rodents that have damaged marshlands in _____, and carry diseases that can be dangerous to humans and livestock.
5. Non-native _____ in Hawaii spread avian malaria and avian pox, which have caused the extinction of native Hawaiian birds.

Assessment - Fill-in-the-Blank

6. The danger of creating demand for invasive species as food is that people may begin _____ and _____ them to increase supply. It will be essential to maintain sustainability and regulations so that their populations do not become more unmanageable.

7. Invasive plants that take over native plant life create _____ that reduce biodiversity.

8. The _____ _____, a plant native to India and Pakistan, is one of the most invasive plants in the United Kingdom.

9. The global impact of invasive species has an estimated annual cost of $_____.

10. _____ introduces a virus or bacteria to infect the invasive species and reduce its numbers.

Assessment - Answer Key

Multiple Choice

1. A and B
2. C
3. B
4. A
5. D
6. A
7. B
8. D
9. C
10. D
11. D
12. B
13. B
14. A, B, C, and D
15. B

True/False

1. T
2. F
3. F
4. F
5. T
6. T
7. T
8. F
9. F
10. F
11. F
12. F
13. F
14. F
15. T
16. T
17. F
18. F
19. F
20. T

Fill-in-the-Blank

1. 200; 37,000; 3,500
2. Seeds; decorative plants; Pets
3. Crabs
4. Nutria, Maryland
5. Mosquitoes
6. Farming; spreading
7. monocultures
8. Himalayan balsa
9. $958 Billion USD
10. Biocontrol

Use these assessments as formative or summative assessments. Consider assessing learners at the beginning of the unit as a pre-assessment, and again at the end as a post-assessment to see their progress. Teachers can use these as graded assignments if needed.

FUTURE Problem Solving

Additional curricular resources

We hope you find this edition of our activity unit series to be a valuable resource as your students gather knowledge about Future Problem Solving topics of study.

Invasive Species Activity Unit

Our activity unit on this topic contains step-by-step lesson plans for research-based independent and collaborative work for use with students in a variety of settings, including out-of-school time. The publication includes 3 extra topic-related future scenes for practice, a variety of tools, research, and metacognition activities, and a variety of specific problem-solving step activities.

Global Issues Champions Series

This series showcases student written work for the 2024 Global Issues world champion team and individual competitors by division. Their full evaluations are included. To use this publication as a coaching tool, first review the Air Quality future scene with your students. Then ask students to complete a booklet using the future scene. You can do this as a mock competition or step by step as practice. For students looking to deepen their understanding of evaluations, we recommend that you give each team a copy of the student work, step by step. Ask students to identify strengths and weaknesses in the sample work based on their understanding of the scoring rubric. Review the evaluation concepts identified in each step and look at the scores and feedback from evaluators together.

Education Standards

Our Future Problem Solving process fulfills a wide variety of education standards. We take connecting with these standards into account when developing our program materials. Teachers can easily tailor Future Problem Solving content to meet their specific education system and local requirements as needed.

How our topics are selected

Our topics represent important challenges from business, civics, society, science, and technology and serve as the thematic basis for given problem solving situations. Each school year, students get 3-5 opportunities to solve important near-future global issues based on their progress in local and regional competitions. To be considered, a topic must be broad enough to appeal to participants living around the globe, offer a range of themes and issues to explore, and be considerate of a variety of views. Lastly, of course, every topic must be accessible for all, from ages 8 to adult.

We welcome submissions of topic ideas from anyone year round. Our topics committee reviews, refines, and categorizes submissions into our diverse strands. Then options are narrowed down and screened by our regional affiliate leaders. They pre-select top candidates for each of the category strands to present to our entire global community for a vote. The community's input, including students, heavily influences the final selection. We announce topics for the upcoming competition season March 1.

About Future Problem Solving

Future Problem Solving proudly celebrates over 50 years of placing more than a million young people at the core of a dynamic, purposeful learning experience. Each year K-12 students around the world participate in a variety of challenges designed to empower curious youth to become changemakers. Problem solvers learn how to think, not what to think, and gain skills they need to succeed in work and life. Our programs help young people develop their own voices and the confidence to use them.

To learn more about Future Problem Solving, to submit a topic idea, or contact us, visit fpspi.org.

FUTURE Problem Solving™

Space Exploration

Science & Technology

RESEARCH UNIT

- Research
- Readings
- Resources
- Problem-Solving Tools

Supports all these programs

GRADES 4-12

Practice Problem 2 | 2025-2026

This publication is a compilation of the hard work of many people. Special thanks are extended to our curriculum author Kate Wolf.

Topic Contents

Space Exploration

How might space exploration change the way humanity exists on Earth and throughout our Universe in the future?

Research

Readings

Resources

Supplemental: Problem-Solving Tools

We strongly advise Future Problem Solving coaches and others using this content to review their educational organization's policies on appropriate content, and to screen any materials before making them available to students.

Cover Page: Freepix (Photo Credit)

Introduction

Background
Space exploration involves the investigation, discovery, and utilization of outer space, including celestial bodies like planets, moons, and stars. It uses spacecraft, satellites, and telescopes to observe and study the universe. It also includes missions to explore, land on, and perhaps even establish a human presence on other celestial bodies.

Context
Space exploration has yielded remarkable scientific discoveries, including understanding the universe's origins, the search for extraterrestrial life, and technological developments such as advancements in materials, computing, and telecommunications. Government space agencies and private companies worldwide are engaged in ongoing collaborative efforts to explore the vastness of space. Space exploration promises to unravel some of the universe's greatest mysteries while pushing the boundaries of human knowledge and achievement.

Questions to Explore
What type of discoveries will continued space exploration lead to?
How might space exploration increase global collaboration in the future?
Are humans likely to be able to settle on the Moon, Mars, or other planets or moons?
Will we be able to save or supplement the Earth’s resources with resources from the Moon, asteroids, or beyond?

Use this publication as a starting point for research as your students gather knowledge about the topic of study. By the time of distribution, some of the information may change or become out-of-date. Keep in mind, however, that observing and studying the changes that take place in a given subject area over a few months or years can be an incredible asset to problem solvers who work with scenarios set in the future.

Themes and Concepts

Themes and concepts assist in organizing a lot of information into manageable threads or ideas, providing a complete picture or understanding of the subject.

CENTRAL THEME #1
Innovations from the space race

Space missions have improved life on Earth in many ways. Partly because space exploration is mostly publicly funded, the innovations used to keep astronauts alive and healthy are incorporated into other technology, from medicine to fabric, and have improved the lives of humans who will never leave Earth.

MAJOR CONCEPTS:

Due to microgravity, cosmic radiation, and stress, space travel is incredibly hard on human bodies. Studying the effects and trying to minimize them has led to tremendous leaps forward in medicine. Scientists can now study how radiation affects the human body in cancer treatment, while imaging systems used to observe distant planets have led to developments in scanners like MRIs and CAT scans.

Space agencies must have effective insulation, water purification, and long-lasting food to keep astronauts alive; all these innovations have been incorporated into our lives.

Some people go to space with experiments that are directly intended to improve technology on Earth, such as using cosmic radiation to alter seeds and seedlings, which can make for more resilient crops that can feed more people. China's second-most common strain of wheat is space-bred.

Astronauts who travel to space repeatedly report becoming more protective of Earth's environment when they return. The Overview Effect describes this phenomenon, in which seeing Earth from the outside shows how interconnected and fragile life is; in this way, traveling to space can encourage better environmental protection.

Themes and Concepts

CENTRAL THEME #2
Ethical exploration

It is an open and long-running debate whether space exploration is worth the time, resources, and effort it takes to get there. Many argue that we are better off focusing our resources on the pressing problems of global inequality and climate change. In contrast, others point out that space exploration has already improved life on Earth. Either way, as we explore, we face the question of what it means for humanity and how we can care for the environment on and off our planet.

MAJOR CONCEPTS

Spacecrafts create massive pollution; one fifteen-minute trip to space produces about as much carbon as the average person will make in their entire life. It is an ongoing question of how we can explore space without further damaging our planet.

There are microbes on Earth that can survive the vacuum of space, and no matter how careful we are, space agencies have not managed to eliminate them from spacecraft. These microbes could contaminate other celestial bodies. If life exists elsewhere in the universe, our microbes could threaten them.

Going to space is expensive, and many argue that we should focus our efforts closer to home. It is difficult sometimes to justify spending enormous amounts of money on capturing images of the stars when people face more pressing problems like disease, violence, and starvation.

Much of the talk about space exploration centers on the ‘colonization’ of other planets, even though colonization is a violent concept that has caused enormous suffering. Indigenous attitudes towards exploration and stewardship of our wider space environment provide an alternative framework for considering our missions to the stars.

Themes and Concepts

CENTRAL THEME #3

What are we looking for?

Space exploration has diverse goals from different governments, companies, and individuals. Scientists are looking for answers about how stars form, what other planets might look like, and what the universe looked like billions of years ago. Some agencies are looking for materials to mine, and others hope to develop space tourism as an industry.

MAJOR CONCEPTS

The search for life somewhere other than Earth has captured the public imagination. Scientists are searching Mars for signs of life, past or present, and categorizing exoplanets that might be candidates for holding life. The focus is on life, like life on Earth, which requires liquid water.

In exploring space, some people are looking for a 'backup planet' in case we make Earth uninhabitable or a massive disaster like an asteroid strike destroys it. Others argue that the concept of a 'Planet B' does not exist; we and all other living things evolved on Earth, are not well adapted to living anywhere else, and we must focus on caring for our home.

In many ways, we do not know what we are searching for until we find it. In exploring space, scientists open doors we never knew existed, and discoveries impact areas from medicine to communications and beyond.

Themes and Concepts

CENTRAL THEME #4

Pushing the limits

Exploring space pushes us to the pinnacle of innovation, coordination, and ingenuity. There are countless challenges to overcome, from finding the most efficient fuel to protecting astronauts from radiation and the effects of microgravity. Space missions often take years from concept to launch and rely on the cooperation of scientists, engineers, lawmakers, and many others. Many seemingly impossible challenges can and have been overcome, but there are others that we may never be able to tackle.

MAJOR CONCEPTS

The International Space Station is a fantastic example of international cooperation, but legally, space exploration is complex. While the Outer Space Treaty prohibits any nation from claiming property in space, countries are still looking into exploiting resources, and competition could intensify.

Human bodies are meant to be on Earth, and we do not fully understand how being in space affects us. Radiation and microgravity take their toll on human organs, eyes, bones, and mental functions. For a multi-year mission to space, which would be required to make it to Mars or further, we must be able to keep astronauts healthy despite these conditions.

Our biggest challenge is the scale of the universe. Alpha Centauri is the closest solar system to ours, four light-years away. At the speed of our fastest spacecraft, we would take 148,000 years to reach this solar system. Since we do not know if it is possible to travel near the speed of light, making it to any solar system outside our own is out of the question for now and maybe forever.

We are constantly innovating, improving technology, and beating records. Sixty years ago, we did not even have proof that it was possible to leave Earth's orbit; today, five spacecraft have left Earth's orbit and the solar system. Time and time again, people have proven that our ingenuity and enthusiasm for discovery can lead to massive leaps forward in space exploration.

Overview

The first spacecraft, Russia's Sputnik satellite, left Earth's atmosphere for space in 1957. Since then, our interest in and exploration of space has exploded. In 2024, around ten thousand satellites will orbit Earth, and more spacecraft will be much further away, discovering distant moons, planets, and even our sun. Although space missions come at a high cost, space agencies and companies worldwide show no signs of slowing down. Interest in space is higher than ever, with more and more private companies taking flight.

Space exploration today looks very different than it did in the early days of the space race. When we say 'space exploration,' many people think of astronauts in space suits walking on the surface of the Moon or beginning a colony on Mars. But no human has set foot on the Moon since 1972, and we are still years away from a crewed mission to any other planet. The truth is that today, our exploration of space is almost entirely robotic.

Autonomous spacecraft and landers have some huge advantages over human astronauts. They require much less life support, making for lighter payloads and less fuel. Humans need food, water, oxygen, toothbrushes, and clothes, all of which add up. Another thing is that space is deadly even when our best technology protects us. Even very short missions pose serious health risks to humans. Earth's magnetic field protects those of us on Earth from dangerous cosmic and solar radiation. Outside that field, we suffer the effects, including a much higher risk of developing cancer. Microgravity causes muscular degeneration and changes the shape of our eyes, which can lead to vision problems. Other risks are still unknown to us. We know that the astronauts who landed on the Moon had adverse reactions to moon dust, which irritated their lungs and skin. We have no idea what the long-term effects might be. Finally, unlike humans, robots can be abandoned at their destination when they run out of power or break. While some humans claim to be up for a one-way ticket to Mars, most agencies take their responsibility to return astronauts home seriously. All of this adds increased cost and risk to crewed missions.

Our topics, determined with input from our global community as well as subject matter experts, represent important challenges from business, civics, society, science, and technology. We welcome ideas for future competition topics from everyone including students and coaches. Share your topic ideas and feedback at https://fpspi.org/topic-submission/

Overview

Despite the challenges, many are working to get humans back onto the surface of the Moon in the next few years. NASA claims it will send humans to Mars by 2040, and some private companies like SpaceX are competing with that timeline. Even though it is risky and difficult, humans have some advantages over robots in terms of exploration. Rovers and robots are great at answering specific questions, like the chemical composition of certain rocks. However, human presence and curiosity are invaluable for the 'unknown unknowns,' questions we do not know to ask until we see something unexpected.

Space is immense, so there are many reasons for different groups to learn more about it. Some search for answers to big scientific questions, like how stars form, while others look for signs of life, perhaps on Jupiter's icy moons or distant exoplanets. We still have no idea if we are alone in the universe or if life exists elsewhere. Some want to profit off the minerals that might be mined on the Moon or asteroids, rich in materials that are hard to find on Earth. Still, others claim to be searching for, or trying to create, a 'Planet B,' a place for humans to retreat if Earth becomes uninhabitable. These questions raise other ethical questions. While the Outer Space Treaty prohibits any nation from claiming ownership of any territory in space, this is likely to be challenged as more for-profit companies start going to space. Colonizing other planets might be popular, but our presence could destroy any tiny life that might be present somewhere else. In addition, rockets create massive carbon emissions and cost a considerable amount of resources to build. It is not always easy to justify jetting off to distant worlds (or to watch a billionaire take a joyride above the atmosphere) when those resources could be dedicated to creating renewable energy and restoring our planet.

Overview

But realistically, space agencies take only tiny fractions of most governments' budgets, and the return on investment is robust. Going to space shows us how precious our planet is, how ingenious and creative humans can be, and gives us access to wonders no one could have dreamed of a century ago. Indeed, everything we find is impressive- exoplanets covered in lava and silica clouds, the possibility of massive underground oceans on Jupiter's moons, the swirling surface of clouds of our gas giant neighbors, the remnants of dying stars, even the sound of cosmic radiation echoing through space from the Big Bang. Even with the most advanced, precise instruments, scientists cannot always predict what we will find next. The only way to find out is to keep pushing the limits of where we can go and what we can see, keep innovating, and keep exploring.

Despite the ongoing debate, research demonstrates that invasive species are among the leading causes of biodiversity loss, on par with habitat destruction. As human populations continue to grow and encroach on more habitats, and climate change disrupts ecosystems and weather patterns, the threat from invasive species will only intensify. Our efforts to restore damaged ecosystems must keep pace to safeguard vulnerable plants and animals from extinction.

Vocabulary

alien species: plants or animals that live outside their natural range

alloy: a metal that is made of two or more elements, which is usually more robust and more resistant to corrosion than each element, e.g., steel, an alloy of carbon and iron

artificial satellite: a satellite made by humans and put into orbit around the Earth, Moon, or other planet; we create satellites for communication and collecting information

asteroid: small, rocky objects that orbit a star; asteroids are smaller than planets

astronaut; cosmonaut; taikonaut: a human who travels to space; astronaut is used for space travelers from the US, Canada, Japan, and Europe; cosmonaut is used for Russian and Soviet space travelers; taikonaut is sometimes used for Chinese space travelers

celestial body: any object observed in outer space, including planets, moons, stars, asteroids, and galaxies

constellation: a group of stars visible from Earth, which often look like a particular shape; stars in individual constellations as seen from Earth are often very far from one another, and constellations visible from Earth do not look the same from the surfaces of other celestial bodies

crewed: a mission with humans on board; this is used instead of the term 'manned'

dwarf planet: a celestial body that orbits a star but is not big enough for its gravity to make it into a sphere and has not cleared its orbit of other similarly sized bodies; in our solar system, Pluto, Ceres, Haumea, Makemake, and Eris are dwarf planets

ESA: the European Space Agency

exoplanet: any planet outside our solar system

flyby: a space mission in which the spacecraft passes close to a planet or other celestial body but does not land on or go into orbit around it

galaxy: a huge collection of stars and their solar systems, as well as gas, dust, and other objects, all held together by gravity; our solar system is in the galaxy called the Milky Way

Vocabulary

gas giant: a large planet mostly made of helium and hydrogen gases surrounding a solid core; in our solar system, Jupiter and Saturn are gas giants

habitable: a place that has the elements needed to sustain life, including the right temperature, nutrients, and water

habitable zone: the distance from a star where liquid water could exist on a planet's surface

ice giant: a large planet mostly made of elements that are heavier than helium and hydrogen, such as oxygen, carbon, nitrogen, and sulfur; in our solar system, Uranus and Neptune are ice giants

International Space Station (ISS): a large spacecraft orbiting Earth that has a permanent rotation population of astronauts and cosmonauts from different countries and holds a laboratory for science experiments

lander: a spacecraft that lands on the surface of another celestial body, but does not move once it has landed

life support: the systems in a spacecraft or habitat that keep the crew alive, including oxygen, water, and food systems

lunar: on or related to the Earth's Moon

microgravity: the condition where gravity is very slight, or an object is in free fall (such as satellites orbiting Earth); objects in microgravity appear to float

moon: a natural satellite that orbits a planet, asteroid, or dwarf planet; the Moon (capitalized) refers to Earth's Moon

NASA: the United States National Aeronautics and Space Administration

orbit: the curved path of a satellite (natural or manmade) around a celestial body

orbital decay: when an object that is orbiting another object (e.g. a satellite orbiting a planet) gets closer and closer until it eventually falls to the surface, or the two objects collide

Vocabulary

Overview Effect: a shift in awareness experienced by some astronauts after viewing Earth from space

payload: the weight that a vehicle must carry

planet: an object that orbits a star, is big enough for its gravity to make it into a sphere, and big enough that it is the only object of a similar size near its own orbit

probe: an unpiloted spacecraft sent to gather information using scientific instruments and tools, usually controlled remotely

radiation: energy that moves in a form that is often described as waves or particles; solar radiation is emitted by the sun, and cosmic radiation travels throughout space, but Earth's magnetic field largely blocks both

regolith: the loose rock and dust on top of a layer of bedrock; on Earth, regolith includes soil, while on the Moon, most of the surface is covered in rock chips and mineral fragments

resupply mission: a mission to deliver cargo and supplies, including food, to a spacecraft already in space, such as the ISS

robotic mission; automated mission: un-crewed, a mission with no humans on board
rogue planet: a planet that does not orbit a star

rover: a vehicle that lands on the surface of another celestial body and moves around the surface to gather data

satellite: any object that moves around a larger object, e.g. the Earth is a satellite of the Sun, the Moon is a satellite of the Earth

solar system: the Sun and everything that orbits it, including the eight planets, their moons, asteroids, and other celestial bodies

space debris; space junk: any human-made object that is left in space and has no current or foreseeable future use

spacecraft: a vehicle used for traveling through space; spacecraft can be crewed or uncrewed

Vocabulary

star: a massive ball of hot gas; we refer to the star at the center of our solar system as the sun

subsurface: below the surface or top layer

terrestrial planet: a planet with a solid, rocky surface that is the size of Earth or smaller; in our solar system, Earth, Mercury, Mars, and Venus are terrestrial planets.

Interactivity:
A Quizlet containing all the topic vocabulary may be found here.

Use password: FPSPI
https://quizlet.com/963614652/space-exploration-flash-cards/?i=4351sf&x=1jqt

List of Articles - By Theme

A concerted effort was made to find recent articles from as many different perspectives as possible. While Future Problem Solving attempts to present a balance in the range of opinions, some sides of an issue are often more represented than others. This does not mean that Future Problem Solving supports that position. Future Problem Solving supports no position.

Central Theme #1: Innovations from the space race
- 13 advanced space technologies improving our lives on Earth
- How China is creating new foods in space
- How the GOES-U satellite will change Earth and space weather forecasts forever
- NASA's 10 greatest achievements
- What breakthroughs in medicine came from NASA?
- Why should we explore space? What are the benefits for us?

Central Theme #2: Ethical exploration
- Billionaire space race turns into a publicity disaster
- Making space for women: Gender, diversity, and outer space
- NASA and the Navajo Nation partner in understanding the universe
- The new space race
- On space barons and global poverty
- The path forward for sustainable space exploration
- Six moral dilemmas facing space exploration
- Space exploration is not a luxury, it's a necessity
- Treaty on principles governing the activities of states in the exploration and use of outer space, including the Moon and other celestial bodies

Central Theme #3: What are we looking for?
- 3 predictions for the future of space exploration - including your own trips
- Chang'e-6 is just the tip of China's ambitions for the solar system
- Exoplanets: Everything you need to know about the worlds beyond our solar system
- The future of space exploration: How astronomy, space travel and the search for life may change by 2049
- Mining in space: Can we do it?
- NASA reveals Webb Telescope's first images of unseen universe
- NASA sends more science to space, more strides for future exploration
- Opinion: The priorities of India in space are shifting toward national security
- The six moons most likely to host life in our solar system
- What will space exploration look like in 2050?
- Why we explore Mars - and what decades of missions have revealed
- Why we search

Central Theme #4: Pushing the limits
- Exploring risk assessment and safety considerations in space tourism: Lessons from deep-sea exploration and the case of the OceanGate submersible in 2023
- Space debris will block space exploration unless we start acting sustainably
- Space is deadly. NASA's Artemis mission will help us learn how to survive It.
- They went to space for eight days - and could be stuck until 2025
- What toll does spaceflight take on astronauts? Here's what we know
- Why Europe's astronauts are learning Chinese
- Why we'll never live in space

List of Articles - Alphabetical Order

3 predictions for the future of space exploration - including your own trips
13 advanced space technologies improving our lives on Earth
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What will space exploration look like in 2050?
Why Europe's astronauts are learning Chinese
Why should we explore space? What are the benefits for us?
Why we explore Mars - and what decades of missions have revealed
Why we search
Why we'll never live in space

Information is a summary of the original article. It is up to the reader to determine which facts and ideas to accept. Future Problem Solving encourages coaches and teachers to preview the article summaries and links to determine whether all information is appropriate for their students. Efforts were made to minimize the sensitivity of the summaries' contents; however, different standards of acceptability apply to each individual student, coach, and community. Please use your discretion with these materials. ***Information is listed in alphabetical order by article title.***

Article Summaries

3 predictions for the future of space exploration - including your own trips

Peggy Whitson was the first woman to command the ISS and has spent more time in space than any other American or female astronaut. She now works as the director of human spaceflight for the private company Axiom Space and spoke with NPR about her predictions for the future of space exploration.

First, she predicts it will continue to be a mix of private and public investment. Even NASA's return to the Moon relies on some private space companies. For example, Axiom Space is building spacesuits for NASA's astronauts. She also says that over time, space will be more accessible to people. This would follow the trend of new travel technology of the past. Flying in commercial planes used to be only for the very rich, and now it is common for many more people. She thinks that spaceflight will go the same way. Finally, Whiston notes that different people and countries have different goals regarding space. One private astronaut is working to develop STEM outreach materials for educators. NASA missions tend to focus on scientific investigations. Two astronauts from Saudi Arabia recently went to the ISS with specific outreach goals for Saudi and to inspire the youth in their own country. Where we go in space will depend on the goals of people exploring.

Marquez Janse, A., Kelly, M. L., & Ermyas, T. (2023, June 14). 3 Predictions for the future of space exploration - including your own trips. NPR. https://www.npr.org/2023/06/14/1181846983/axiom-space-travel-exploration-spacex-nasa-launch

Article Summaries

13 advanced space technologies improving our lives on Earth

Space missions are often criticized for being expensive, but the technology developed for them improves lives worldwide. Below are examples of technologies used or adapted to improve life on Earth.

1. NASA is working with a startup called SMART Tire to produce tires that do not need to be filled with air. These tires cannot be punctured, reducing rubber waste and car accidents.
2. Heat shields used on the Atlas V rocket were built to protect missions descending into Mars's atmosphere. However, they can also be used to create heat shelters that can be used to fight forest fires.
3. GPS technology is space technology, and every smartphone today uses GPS. It was first developed to track satellites; now, it is used for everything from location services to weather reporting.
4. A former NASA engineer is developing large zero-emission trucks, which can help mining become a more carbon-neutral industry. A former SpaceX engineer is also developing zero-emission power sources, working with micro nuclear reactors that could be used on Mars habitats and in remote locations on Earth that have no reliable source of electricity.
5. Memory foam, a popular material for pillows and mattresses, was first developed to protect NASA pilots during test flights.
6. Radiant Nuclear, a company co-founded by a former SpaceX engineer, is developing a nuclear microreactor to help power habitats for future Mars missions. These microreactors can also provide power to remote locations when electricity is not an option.
7. Robots designed to explore the Moon and Mars are now used to analyze disaster areas, helping first responders plan to address dangerous environments.
8. NASA's software for analyzing small cracks in space shuttles is now used globally in the aviation industry. This technology helps prevent crashes caused by cracks in airplanes.

Article Summaries

13 advanced space technologies improving our lives on Earth , *continued*

9. Water purification is vital for keeping the ISS running. The same technology is used in many countries, especially remote villages, to ensure the residents have safe drinking water.
10. Radiation is a significant risk factor for cancer, and astronauts are exposed to very high levels of radiation in space. As a result, NASA developed a diagnostic test for cancer, which is also used to detect cancer here on Earth.
11. Besides radiation, diet is a health concern for anyone going to space; astronauts do not have access to fresh food but need to be in peak physical condition. Scientists are working on supplements to ensure they have all the necessary nutrients, which could also improve Earth's diets.
12. Renewable energy, such as solar power, is an important innovation. Still, it does not provide a consistent energy source, so space missions need batteries when renewable energy is unavailable. NASA has developed a battery that only uses iron, salt, and water; these non-corrosive batteries could be a game-changer for energy storage.
13. Finally, space company Blue Origin claims it has developed a way to produce solar cells using only lunar regolith without bringing material from Earth. If the company proves the technology works, this development could also help make solar cells much more quickly on Earth.

Young, C. (2023, November 11). 13 Advanced space technologies improving our lives on Earth. Interesting Engineering. https://interestingengineering.com/lists/13-space-technologies-improving-earth

Article Summaries

Billionaire space race turns into a publicity disaster

In 2021, Elon Musk, Jeff Bezos, Richard Branson, and other billionaires invested considerable time and funding in traveling to space. However, the UK public thinks they should focus their resources on more critical problems like climate change. Even a very short spaceflight creates more carbon emissions than the average person will make in their lifetime. While Bezos and Musk did not say how much their spaceflights cost, we know they cost hundreds of thousands of dollars per person.

This careless display of wealth might be turning the public against space tourism. Astronauts expressed disappointment that space was being turned into a luxury destination instead of a site to pursue scientific public good. This negative public opinion has harmed some space tourism companies, including Branson's Virgin Galactic. Bezos's company, Blue Origin, is working on branding itself as flying research missions. Many of these companies claim they also attempt to reduce emissions and donate part of their profits to charity.

Williams, O. A. (2022, April 21). Billionaire space race turns into a publicity disaster. Forbes. https://www.forbes.com/sites/oliverwilliams1/2021/12/21/billionaire-space-race-turns-into-a-publicity-disaster/

Article Summaries

Chang'e-6 is just the tip of China's ambitions for the solar system

The Chang'e spacecraft landed on the far side of the Moon to gather soil samples in the summer of 2024. It communicated with Earth using China's relay satellite Queqiao-2 and touched down on the South Pole-Atken (SPA) basin on June 2, 2024. The samples collected will need to be blasted into orbit by an ascender, which will then be collected by an orbiter automatically; at the time of this article's publication, the ascender had taken off but not yet been caught by the orbiter. Afterward, the samples must be transferred to a reentry capsule, then sent down through Earth's atmosphere to land in Inner Mongolia.

The SPA basin is on the far side of the Moon, which could contain answers about the Moon's origins that we have never found before. All of NASA's lunar missions were to the near side of the Moon. This massively complex mission is a testament to China's growing space program. It is good practice for getting samples from Mars. NASA and the ESA are also working on a Mars sample return mission but are facing delays.

China announced that it aims to send astronauts to the Moon by 2030. One plan is to test how lunar soil can be used to make bricks for a lunar base. China and Russia are trying to attract other countries to work on an International Lunar Research Station.

As with all countries, the Chinese space program is complex. Space exploration is often seen as only scientific, but it also can encourage economic growth. In China, it has improved location-based technology, which in turn improves finance, agriculture, shipping, and other industries. Improvements in the space industry also boost countries' military capabilities.

China has announced a series of space missions after Chang'e-6, including collecting samples from an asteroid, collecting samples from Mars, and sending a probe to Jupiter.

Jones, A. (2024, June 4). Chang'e-6 is Just the tip of China's ambitions for the solar system. BBC. https://www.bbc.com/future/article/20240510-change-6-is-just-the-tip-of-chinas-space-ambitions

Article Summaries

Exoplanets: Everything you need to know about the worlds beyond our solar system

Exoplanets are any planets outside our solar system. We first observed an exoplanet in 1990; as of 2023, we have cataloged over 5,500 exoplanets. The closest to Earth is four light-years away; at our current fastest speed, it would take us over 114,000 years, so we cannot travel there.

Our solar system has terrestrial planets (like Earth), gas giants, ice giants, and dwarf planets, but many other types of planets exist in other solar systems. One type is called a hot Jupiter, a gas giant that orbits very close to its star. Because they are so large and close to their star, they are easy for us to see. As a result, many of the planets we have recorded are hot Jupiters. Terrestrial exoplanets, on the other hand, are closer to Earth's size and made of rock, silicate, water, and carbon. We are still determining if life can survive on any exoplanets. Still, terrestrial planets in their star's habitable zone are good candidates for life, especially if they have liquid oceans. Super-Earths are about twice our planet's size; some are terrestrial, while others are gas giants. Neptunian exoplanets are around four times Earth's size, and scientists think their cores are formed of heavy metals. Scientists have also observed planets that do not orbit any star, called rogue planets.

It is challenging to discover exoplanets because, unlike stars, they do not emit light. Instead, scientists usually try to observe the star and determine if it has any planets orbiting it using several methods. The most common today is the transit method. Scientists measure tiny variations in how much light we receive from a star. A planet orbiting the star will block a little bit of that star's light, and by measuring the dip in brightness, we can determine an exoplanet's orbit and size and use spectrometry to determine what the planet's atmosphere is made of. Other methods of detecting exoplanets are the radial velocity method, gravitational lensing, direct imaging, and astrometry.

Exoplanet research has changed significantly in the last twenty years. When we started to study exoplanets, the focus was on discovering them. Exoplanets are extremely common and diverse, so the focus has shifted to understanding their chemical composition, planet formation, and what makes a planet habitable.

Lea, R. (2023, November 14). Exoplanets: Everything you need to know about the worlds beyond our solar system. Space.com. https://www.space.com/17738-exoplanets.html

Article Summaries

Exploring risk assessment and safety considerations in space tourism: Lessons from deep-sea exploration and the case of the OceanGate submersible in 2023

Both space and the deep sea offer exciting opportunities for exploration. However, reaching these locations requires preparation and carries risks that must be evaluated carefully. The tragedy in 2023 with the OceanGate submersible has shown us that extreme exploration requires a clear understanding of the risks involved in such travel, and plans must be made to mitigate those risks. A risk assessment must include all stages of the space journey, including launch, microgravity effects, spacecraft malfunctions, re-entry challenges, and regulatory compliance.

As deep-sea and space exploration industries grow, lessons learned from past incidents must be incorporated into safety measures for future travel. Constant awareness and management of the risks involved with exploring extreme environments must be given to developing safety protocols. Risk assessment, communication channels, and collaboration among all stakeholders will be essential to the ongoing success of these ventures.

Kurtaran, N. P. (2024, June 7). Exploring risk assessment and safety considerations in space tourism: Lessons from deep-sea exploration and the case of the OceanGate submersible in 2023. https://spacegeneration.org/exploring-risk-assessment-and-safety-considerations-in-space-tourism

Article Summaries

The future of space exploration: How astronomy, space travel and the search for life may change by 2049

Space.com hosted a virtual panel to discuss the present and future of space exploration and astronomy with three panelists: an astrophysicist and professor, a director of the Giant Magellan Telescope (the world's largest optical telescope, still under construction), and a medical officer and former NASA astronaut. The panelists were excited over the discoveries made in the last 25 years, especially the James Webb Space Telescope. Astronaut Tom Marshburn noted that the vast innovations allowed humans to stay in space longer. To travel to distant planets, astronauts must be in space for over a year. They also noted that more small missions can happen simultaneously with private spaceflight companies. Big missions take decades to plan, so the missions can build off one another and change direction more quickly.

Mathewson, S. (2024, July 20). The future of space exploration: How astronomy, space travel and the search for life may change by 2049. Space.com. https://www.space.com/space-dot-com-virtual-anniversary-panel-next-25-years-space-exploration

Article Summaries

How China is creating new foods in space

Luyuan 502 is a variety of wheat grown in China. It was bred from seeds that were flown into Earth's orbit. The microgravity environment slightly changed the seeds' DNA, making them drought- and disease-resistant. Other types of food crops are being bred in space as well. Sometimes, the mutations caused by microgravity and cosmic rays damage the plants, but sometimes, they create helpful changes. Space-breeding might be the next step in creating resilient crops in the face of climate change. Luyuan 502 is the second-most common variety of wheat grown in China. Chinese scientists have also bred rice, corn, cotton, soybeans, and other fruits and vegetables in space. They even included rice seeds on the Chang'e-5 lunar mission in 2020.

Several factors cause the mutations. Solar and cosmic radiation damage the seeds' DNA, which causes mutations. On Earth, we are protected from this radiation by our magnetic field and atmosphere. Low gravity can also change the shape of cells and structures in plants. When they return to Earth, scientists screen the seedlings for advantageous mutations, then breed them further until they have an improved variety of plants. Space-breeding can significantly shorten the time it takes to develop new crop varieties. Since the 1920s, scientists have used a similar technique called nuclear mutagenesis, which uses X-rays to mutate seeds. Still, the process is complicated and requires expertise not to damage the seeds beyond repair. Though space-breeding is also complex and expensive, scientists say it produces more valuable mutations than nuclear mutagenesis.

Improving crop genetics is vital to China and the world if we are to feed our growing population. Other countries are taking notice, including the United States and the United Arab Emirates, although no other country is consistently using space breeding to improve crops.

Pultarova, T. (2022, July 10). How China is creating new foods in space. BBC. https://www.bbc.com/future/article/20220708-how-china-is-creating-new-foods-in-space

Article Summaries

How the GOES-U satellite will change Earth and space weather forecasts forever

NOAA's Geostationary Operational Environmental Satellites (GOES) have been aiding in weather forecasting since 1975. Three GOES satellites, each with more advanced technology than the last, are currently in orbit and provide information on storm development and strengthening. Data gathered from these satellites has helped develop new tools on Earth to aid in lightning prediction, severe weather warnings, and sea spray identification, which is essential for mariner safety.

The fourth and final GOES satellite, GOES-U, was launched in June 2024. It will provide nearly real-time imaging for faster weather warnings. A new sensor on board GOES-U, the Compact Coronagraph (CCOR), can monitor weather outside Earth's atmosphere that could impact our planet.

Space exploration, specifically the use and constant improvement of satellites, has dramatically improved our ability to forecast weather and monitor our environment over the last decade. These tools have enhanced from providing numerical models to generate forecasts to observation platforms with real-time imagery.

Garofalo, M. (2024, June 23). How the GOES-U satellite will change Earth and space weather forecasts forever. Space.com. https://www.space.com/goes-u-satellite-space-earth-weather-forecasts

Article Summaries

Making space for women: Gender, diversity, and outer space

For many nations worldwide, the age of space exploration and the age of equal rights have come around simultaneously. How we act now will be important in the future; we must promote gender equality and women's leadership in space exploration to ensure equality moving forward.

There are significant gender gaps in the space industry, from manufacturing to space command. Internationally, women only comprise 20% of the space workforce, and most are outside operations or leadership positions. We must also improve industry practices, from uniform design to gender-specific terminology. We use gendered language like 'for all mankind' and colonialist language when referring to 'colonizing the Moon.' These language practices contribute to gendered and exploitative systems. Language is how we understand one another, and so we must work to make it inclusive and non-violent. Resources like uniforms are also vital. In 2019, NASA canceled its first all-female spacewalk because it did not have two spacesuits that fit the women. This example is just one aspect of the lack of planning around different bodies. We also do not have sufficient studies about how space impacts women's bodies and whether the effects of radiation and microgravity are different than those of men.

We have seen that it is easier to build institutions that practice gender equality than to reform old institutions with unequal practices. Therefore, we must develop our space industry around diversity and gender equality.

Stephenson, E. (2023, March 14). Making space for women: Gender, diversity and outer space. UN Women – Asia-Pacific. https://asiapacific.unwomen.org/en/stories/feature-story/2023/03/making-space-for-women-gender-diversity-and-outer-space

Article Summaries

Mining in space: Can we do it?

We have yet to extract resources from the Moon or other celestial bodies, but as technology improves, that might change. Some asteroids have elements that are hard to find on Earth, like platinum and palladium. We need these elements to make most electronics and even medical implants. The Moon also has valuable resources: water (in the form of ice), which can be separated into hydrogen and oxygen and then used for spacecraft fuel, and helium-3, which might be able to power new fusion reactors.

Legally, mining in space is complicated. The Outer Space Treaty prohibits claiming celestial bodies or their resources. However, countries like the US are looking for loopholes in the treaty. One claim is that fishing in international waters (that is, oceans not owned by any nation) is permitted, so it should be like extracting resources from celestial bodies without technically 'owning' them. This idea of space mining has been supported by laws signed in 2015 and 2020, which support the commercial exploitation of resources in space. Other nations, including Russia, Japan, India, Europe, Luxembourg, and the United Arab Emirates, also have space mining objectives.

This sector mainly comprises private companies rather than publicly funded institutes like NASA or JAXA. Many such companies have failed due to bankruptcy; mining has yet to begin. Mining in space is highly complicated, even on our closest celestial body, the Moon. The extreme temperatures, cosmic radiation, and lunar dust present enormous challenges. Technology is improving, but a lot of work needs to be done to mine in zero gravity.

Henriquet, P. (2022, May 17). Mining in space: Can we do It? Polytechnique Insights; Institut Polytechnique de Paris. https://www.polytechnique-insights.com/en/braincamps/space/extraterrestrial-mining/mining-in-space-can-we-do-it/

Article Summaries

NASA and the Navajo Nation partner in understanding the universe

NASA and the Native American Navajo Nation have worked together in a cultural and scientific partnership since 2005. They develop educational activities that explore the universe's origins through the lens of NASA's scientific discoveries and Navajo cultural, traditional ways of knowing. A co-founder of the partnership notes the parallels between traditional cultural knowledge generation and scientific knowledge generation. Their most recent educational materials focus on how stars form and die, as well as the phases and tides of the Moon. The team worked on incorporating Western science's point of view into Navajo traditions and building a curriculum that meets state education standards. This curriculum is unusual; most science-education-outreach programs focus only on Western science and STEM and ignore cultural knowledge and tribal sovereignty. The team noted that the two systems of knowledge often reinforced each other. While this project is committed to Navajo tradition, team members encourage other tribes to build programs based on their traditions.

Bartels, M. (2019, February 25). NASA and Navajo Nation partner in understanding the universe. Space.com.
https://www.space.com/nasa-partnership-with-navajo-nation.html

Article Summaries

NASA reveals Webb Telescope's first images of unseen universe

NASA, the ESA, and the Canadian Space Agency (CSA) partnered to launch the James Webb Space Telescope (JWST). In 2022, it sent its first images back to Earth. The JWST has taken the most profound and most detailed images ever, and the scientists involved are excited to uncover the answers to questions about our universe. In the coming years, it will show us exoplanets, distant galaxies, and the history of the early universe.

The JWST development is the extraordinary culmination of decades of work. Its first images reveal its unique capabilities as a scientific tool. One infrared image of the distant universe shows the most distant galaxies we have ever observed. Another photo of WASP-96b shows signs of water in the atmosphere and is just the start of studies looking at other planets' atmospheres. An image of a group of galaxies in the Pegasus constellation can show us details of how galaxies interact with each other and trigger star formation.

Scientists worldwide can use JWST to observe objects within and outside our solar system. The Webb Telescope website offers a full array of its images for free.

NASA reveals Webb Telescope's first images of unseen universe. (2022, July 12). Webb Space Telescope. https://webbtelescope.org/contents/news-releases/2022/news-2022-028?Collection=First%20Images

Article Summaries

NASA’s 10 greatest achievements

The United States National Aeronautics and Space Administration (NASA) was launched in 1958. Since then, it has become a world leader in technological innovation. NASA's primary goal is to explore space and expand our universe's knowledge. This article outlines ten of NASA's most outstanding achievements.

10. Explorer 1 was the first US satellite launched, and its equipment helped study cosmic rays and cosmic radiation. It also helped us learn about the radiation belts surrounding Earth. Explorer 1 orbited our planet 58,000 times before burning up in the atmosphere in 1970.
9. The Hubble Space Telescope was one of the first and best instruments to show us images of objects in space that were not blurred by Earth's atmosphere. All the air and water surrounding our planet make faraway images unclear, so launching a telescope into space gave us images with ten to twenty times higher resolution.
8. Hubble launched in 1990 and is still taking pictures today. NASA launched the telescope with the European Space Agency (ESA). The Chandra X-ray Observatory is an X-ray telescope that observes higher-energy particles than visible light. Chandra has given us images of supernovas, quasars, and black holes and has been instrumental in helping scientists understand the life cycle of stars.
7. The Juno Spacecraft was launched in 2011, and five years later, it finally reached its destination: Jupiter. It has traveled further than any other solar-powered spacecraft, and now it is orbiting Jupiter and sending data back to Earth.
6. Apollo 13 launched in 1970, and 55 hours into its flight, when it was 200,000 miles away from Earth, an explosion shut down most of its life support, including electricity, water, oxygen, heat, and light. The astronauts on board were left in near-freezing temperatures, with very little water and food. NASA Mission Control devised a plan to get the lunar module on board to support the crew and coached the astronauts through jerry-rigging a solution using cardboard and tape. They then calculated how to use the Moon's gravity to adjust Apollo 13's trajectory and send it back to Earth. Six days after taking off, it landed successfully in the Pacific Ocean, with the entire crew safe.

Article Summaries

NASA's 10 greatest achievements, *continued*

5. The Space Shuttle was an innovation in space travel because it was the first reusable spacecraft. Most previous crafts splashed down in the ocean, meaning they were mainly ruined and could not fly again. However, the Space Shuttle Columbia could land on a landing strip like a plane. It and the other space shuttles made running the International Space Station possible.
4. Apollo 8 was a fly-by trip around the Moon in 1968. It reached lunar orbit on December 24th, and astronauts returned the iconic photograph of Earth above the lunar horizon. This photo inspired the environmental movement, showing our planet from the outside for the first time. Apollo 8 was also a vital stepping stone in getting humans onto the Moon's surface.
3. The Mars Science Laboratory is a probe that includes the famous Curiosity Rover. Curiosity uses plutonium rather than solar power. The Curiosity Rover is huge for a Mars rover: ten feet by nine feet and seven feet tall. Getting such a heavy rover onto the Martian surface was difficult. Since it touched down in 2012, it has found evidence of liquid water on Mars and other crucial information about its geology.
2. Freedom 7 was the first spacecraft to bring an American to space. The first human in space was a Soviet cosmonaut, Yuri Gagarin. A month later, the American astronaut Alan Shepard boarded Freedom 7. Shepard spent 15 minutes in Earth's orbit before splashing down in the Atlantic Ocean and paving the way for future space travelers.
1. Apollo 11 is the US's most famous mission, as it was the first time a human walked on the Moon. Neil Armstrong and Buzz Aldrin were the first; since then, only twenty-two other people have walked on the Moon. Half of those did so as part of the Apollo program. The most recent was Gene Cernan, on Apollo 17 in 1972.

Layton, J., & Mancini, M. (2024, February 27). NASA's 10 greatest achievements. HowStuffWorks. https://science.howstuffworks.com/ten-nasa-achievements.htm

Article Summaries

The new space race

Space exploration has effects on the politics of Earth. This was proven with the space race during the Cold War; today, more than 80 countries are launching into space. Space technology impacts our communication, economics, and military. By extension, it is essential in international politics. With the development of miniature satellites and reusable rockets, going to space is cheaper than before. Most space exploration is government-funded, including in the countries with the most significant space programs— Russia, China, and the US. But private investment is growing.

More countries and companies are drawn to the potential benefits of space exploration. The idea of profitable mining on the Moon is gaining traction. Countries relying on China for rare earth metals might one day opt to mine them from the Moon instead. The Moon could also hold reserves of helium-3, a rare resource on Earth that could revolutionize energy production through nuclear fusion. Furthermore, satellites in space are not just tools of war but also crucial for business. As countries strive to defend their satellites in military situations, they also open new opportunities for peaceful cooperation and economic growth.

If one country pulls ahead of the others in the space race, it will have much power. If they can establish a base on the Moon, for example, they will have access to the Moon's resources. They also might have an advantage in satellite placement. But tensions could come up, especially around satellites which provide early warnings of nuclear weapons. Disabling satellites would affect many aspects of daily life. The reverse of this is also true: collaboration in space is a massive benefit to all of us. The ISS is a fantastic example of what can be achieved through cooperation. However, the current tensions between the US, Russia, and China have thrown a wrench in the shared work on the ISS. As we continue exploring space and developing space technology, we will need new rules for how space is governed.

The new space race. (n.d.). Royal Museums Greenwich. https://www.rmg.co.uk/stories/topics/new-space-race-astropolitics-power-21st-century

Article Summaries

On space barons and global poverty

2021 started a new trend: billionaires in space. Before this decade, space flight was funded by the public on publicly defined missions. Now, some space missions are private ventures. Jeff Bezos and Sir Richard Branson are now considered the world's first space barons. Some people are excited that this change is renewing interest in space travel. Others argue that billionaires could invest in fighting poverty here on Earth.

There is an argument for funding technological innovation rather than giving money directly to people who need it. Some suggest that innovations like antibiotics have significantly improved life in developing nations compared to direct aid. Space tourism could foster moral support and further technological advances. However, while many space missions have resulted in sound technology, sending billionaires to space has yet to be a significant development. For-profit companies are less likely to benefit the public than publicly funded ventures like NASA.

Private space ventures must do more than create new technology and expect it to magically do good in the world. Technology can only improve lives if it is made accessible, practical, and spreads quickly enough for developing countries to get into people's hands. Laws need to provide reasonable restrictions on intellectual property protections. If regulated and shared well, space tourism could make massive changes for developing nations, providing a sense of security and reassurance. However, we have seen that trickle-down economics are ineffective for the people at the bottom, and we will have to work to spread the benefits of space travel beyond the most elite.

Onder, H. (2021, September 9). On space barons and global poverty. Brookings. https://www.brookings.edu/articles/on-space-barons-and-global-poverty/

Article Summaries

Opinion: The priorities of India in space are shifting toward national security

India's space program began in the 1960s and has continued to grow. In part, its goals will be focused on national security, especially around China's increasing space capability. The Indian Space Research Organisation (ISRO) is working towards missions to the Moon and Mars and its first human space mission, Gaganyaan. Many feel India should keep pushing its space program forward despite its other financial priorities.

Space exploration could improve India's overall technology and technical capabilities. It would also make India a viable partner for other nations' space programs, which could help build the Indian economy. India's military is also growing in response to security concerns. The space program can expand India's surveillance and observation capabilities using military satellites.

India first launched military satellites in 2008 in response to terrorist threats, but they have proven helpful in other military work. China has been working on anti-satellite technology since 2007, and India knows it must keep up to maintain national security. The nation has criticized the use of space technology for military purposes. India will need to strengthen ties with other countries and pass legislation that keeps space peaceful.

Verma, A. (2023, January 6). Opinion: The priorities of India in space are shifting toward national security. The Round Table; The Commonwealth Journal of International Affairs. https://www.commonwealthroundtable.co.uk/commonwealth/eurasia/india/opinion-the-priorities-of-india-in-space-are-shifting-toward-national-security/

Article Summaries

The path forward for sustainable space exploration

Governments and private companies are pushing space exploration further than ever before. Six new missions to the Moon were launched in the first half of 2024, including missions from India, Japan, and China. A primary goal is to establish a base on the Moon, which would be essential for further exploration of Mars. NASA's Artemis program is working to put astronauts on the Moon again by 2026. China and Russia are leading the International Lunar Research Station (ILRS), aiming to get humans on the Moon after 2030.

Some international agreements govern how nations can explore and use space. The Outer Space Treaty prohibits any country from claiming a celestial body or placing nuclear weapons in space and is an agreement to explore space peacefully. The Moon Agreement of 1979 limits how resources on the Moon can be exploited. The UN and NASA also have frameworks and principles guiding space exploration.

However, the recent increase in space missions presents some challenges with sustainability. Minimizing space debris and preventing contamination of celestial bodies will be essential. Along with the rules above, we will need an international framework for sustainability, cooperation, and ethics in space exploration.

The World Economic Forum presents some recommendations for space exploration:

1. Build a space-related environmental database containing information about the effects of space exploration on our environment.
2. Engage with all relevant global stakeholders, including the public, in discussing how space exploration impacts our environment. It will be essential to involve diverse groups in decision-making.
3. Define 'harmful contamination' to protect celestial bodies from biological, physical, and chemical contamination.

Article Summaries

The path forward for sustainable space exploration, *continued*

4. Incorporate recent scientific research into space exploration regulations. Our laws and guidelines need to be based on up-to-date science.
5. Ensure communications are transparent and keep data and mission findings open access, building public trust and allowing for more collaboration among researchers.
6. Coordinate regulations internationally to ensure that international laws do not contradict one another and that overlapping rules are clear.
7. Use media and social platforms to build public awareness about deep space exploration.

   We must be responsible and safeguard future generations as we explore space further.

Ehrenfreund, P., & Christensen, C. (2024, July 8). The path forward for sustainable space exploration. World Economic Forum. https://www.weforum.org/agenda/2024/07/sustainable-space-exploration-path-forward/

Article Summaries

The six moons most likely to host life in our solar system

Life, as we know, requires liquid water to survive. In 2005, the Cassini spacecraft found water on one of Saturn's moons, Enceladus. Since then, space agencies have focused more on looking for water on other planets' moons. The ESA's Jupiter Icy Moons Explorer (JUICE) is set to begin its mission in 2024. The Network for Ocean Worlds initiative (NOW) has a similar mission.

Some of Jupiter's moons might be great candidates for life. Similarly to how volcanoes on Earth vent lava, Europa vents water from below its surface. Europa's surface is exceptionally smooth, which suggests that it is unstable beneath the surface; there could be a massive ocean of liquid water just underneath the surface. It seems to have conditions like those underneath Greenland's ice sheets, where microbes thrive. Ganymede, another of Jupiter's moons, is also an intriguing case; it is so large that it is the only known moon with its own magnetic field. It has auroras (like our Northern Lights), which sway in a way that suggests it might also have a subsurface ocean. Jupiter's least dense moon is Callisto. It has giant craters, showing that it is not very geologically active. Those craters might hold a record of the very early solar system. JUICE is looking at Callisto's shape and gravitational field to determine if it might also have a subsurface ocean.

Saturn's moons are also intriguing. Enceladus's smooth surface and mist plumes suggest it is very geologically active. Titan, which is more like Earth than any other body in our solar system, was explored by Cassini's lander. It found evidence for hydrocarbon lakes, and Titan has a dense nitrogen atmosphere, liquid methane, and ethane, which behave like Earth's water cycle.

Finally, Neptune's moon, Triton, has a strange orbit that might mean it also has liquid water below the surface. It orbits backward compared to most celestial bodies. It was probably captured in Neptune's orbit and had a sharp change in trajectory, which might have heated it enough to melt ice below the surface into water.

Boyle, R., & Velasco, J. (2023, May 1). The six moons most likely to host life in our solar system. Scientific American. https://www.scientificamerican.com/article/the-six-moons-most-likely-to-host-life-in-our-solar-system/

Article Summaries

Six moral dilemmas facing space exploration

1. Should we try to communicate with aliens?
Our first attempt to contact aliens was in 1974 when scientists sent out a signal called the Arecibo Message. Today, however, some scientists compare contacting aliens to Christopher Columbus's landing in America, which was a disaster for the people already living there. Extraterrestrial life might do damage to us, or we to it. We must be cautious with how we interact with life beyond Earth.

2. Do we need laws?
The Outer Space Treaty is the most solid legal system we have for space, but it was written when only two countries—the US and the Soviet Union—were participating in the space race. Today, many more nations and private companies are traveling off our planet. We must develop our legal framework because space is dangerous and has few life-support resources.

3. Space junk
Things sent into orbit stay there even after they die or stop being useful. We currently have over 25,000 pieces of space junk orbiting Earth. Some get in the way of current and future missions, and some crash back down to Earth and could land anywhere. We need guidelines on managing space junk moving forward because the problem will only get worse with so many more people investing in space travel.

4. Should we take human remains to the Moon?
The Moon is a significant part of many religions. In 2024, the Native American Navajo tribe objected to the company Celestis, which planned to take the cremated remains of 70 people and a dog to the Moon as a final resting place. The mission went ahead despite protests, but a fault with the spacecraft kept it from reaching its destination. The issue remains about how much we should consider different religious and cultural beliefs regarding space exploration.

Article Summaries

Six moral dilemmas facing space exploration, *continued*

5. Should we inhabit a home away from Earth?
Other planets might give us new resources, materials, and scientific discoveries. Space pioneers urge us to discover more and try to expand our reach. They may even keep humanity alive if something destroys Earth. But there is also the question of whether we will neglect Earth if we believe we have the option of a 'backup' planet.

6. Do we need to go to space to appreciate Earth?
Many astronauts experience the overview effect. Looking at Earth from space, they can understand how everything is interconnected from a new perspective. Astronauts often become more protective of Earth after returning from space and are more concerned about climate change and extinction. Going to space helps us become more cooperative and determined to better our planet.

Syed. M. (2024, July). A New Frontier - Six moral dilemmas facing space exploration. BBC Radio 4; BBC. https://www.bbc.co.uk/programmes/articles/4WWrBRfrWlzGbdNdhyMH2cS/six-moral-dilemmas-facing-space-exploration

Article Summaries

Space debris will block space exploration unless we start acting sustainably

Our ecosystems are all linked together, and that includes space. As of 2023, over 30,000 pieces of space debris were orbiting Earth. All these disrupt satellites, which must adjust their orbits to avoid being hit by space junk. We cannot continue accumulating space debris; we need to develop satellites and rocket bodies that do not contribute to this growing problem. Indigenous communities have managed land and ocean sustainably for many years, and we ought to continue this approach into space. Different orbits of Earth comprise various 'habitats,' each with a specific capacity to carry human-made objects. We have not yet determined what that capacity is, and in the meantime, we should focus on reusing satellites in orbit.

SpaceX's Falcon 9 rocket is an innovation here; unlike most rockets, it is reusable. The European Space Agency is also implementing its Zero Debris policy by 2030, committing to recycling, refurbishing, repurposing, and reusing its objects in space.

The US Federal Communications Commission also passed a policy that requires satellites to be disposed of within five years of their mission's end. Unfortunately, this policy still allows satellites to re-enter Earth's atmosphere. Reentry often burns satellites up, but some survive and cause damage and pollution when they crash back down to our land or oceans. If we continue exploring and sending technology into space, we need a framework that requires satellite producers to consider what will happen at the end of the technology's lifecycle.

Jah, M. (2023, August 1). Space debris will block space exploration unless we start acting sustainably. Scientific American. https://www.scientificamerican.com/article/space-debris-will-block-space-exploration-unless-we-start-acting-sustainably/

Article Summaries

Space exploration is not a luxury, it's a necessity

The space industry has many ongoing projects, including Artemis II, the first crewed mission to the Moon since the 1970s. We have been exploring all of human history, and exploring space has had many huge benefits in our daily lives. For one thing, the satellites we launch into space power many aspects of our technology, from GPS to Wi-Fi. They also collect data about the Earth's surface, providing information about weather conditions, forest fires, the effects of climate change, and more.

The methods we use to explore space also have parallels on Earth that help us understand more about ourselves. Astronauts in space are a small, remote population. By learning how to provide medical care to them, we also learn how to provide medical care to small, remote populations here on the planet's surface. Innovations in telehealth and portable medical devices result from some of NASA's work.

Finally, exploration is a bonding experience, personally and politically. Astronauts from Russia, the US, Japan, Canada, and Europe live together on the ISS. This kind of international cooperation is vital for our shared future.

Fillion, D. (2024, April 15). Space exploration is not a luxury, it's a necessity. The Conversation. https://theconversation.com/space-exploration-is-not-a-luxury-its-a-necessity-227140

Article Summaries

Space is deadly. NASA's Artemis mission will help us learn how to survive It.

Artemis I launched in November 2022. It was one of a series of missions that NASA hopes will put humans back on the Moon for the first time in decades. The mission, which aims to determine what space does to our bodies, has no humans on board.

One concern about space travel is how radiation and biology interact. On Earth's surface, we experience nothing close to the radiation dose we get in deep space. Earth's magnetic sphere protects us. We know radiation exposure causes cancer, but we also need to understand how it affects the heart and brain. To answer this, three mannequins called Helga, Zohar, and Commander Moonikin Campos are all aboard Artemis I. They are set with different sensors measuring acceleration, vibration, and radiation and are made of materials mimicking real bones and organs. Using multiple mannequins is vital because, in the past, most space missions were performed by white men, and we need to know how different bodies are impacted by radiation and other factors in space.

Artemis I also carried yeast cells into space. Yeast reacts to radiation very similarly to human cells; it has been used in biomedical studies for years. It can also survive in a dehydrated state almost indefinitely, so it can be transported for a long time and then rehydrated and studied. Artemis I is due to orbit the sun for a long time, sending data back to Earth, so this is a chance to study the long-term effects of different types of radiation.

Space poses many risks to humans, even before we land on other celestial bodies and deal with whatever challenges they might pose. But Artemis I aims to understand and mitigate those risks so we can go further than ever.

Dhanesha, N. (2022, November 16). Space is deadly. NASA's Artemis mission will help us learn how to survive It. Vox. https://www.vox.com/science-and-health/2022/11/15/23460642/nasa-artemis-sls-moon-deep-space-radiation-yeast-helga-zohar

Article Summaries

They went to space for eight days - and could be stuck until 2025

This situation was still ongoing at the time this chapter was published. We encourage educators to investigate the outcome of Wilmore and William's hopeful return to Earth before sharing resources.

On June 5, 2024, Barry Wilmore and Sunita Williams were launched in a Boeing Starliner spacecraft on a test mission to the ISS. They expected to spend eight days on the mission, but the Starliner started to experience issues as it approached the ISS. The astronauts made it safely to the ISS, but NASA is unsure if the Starliner will get them safely home. They hope to be able to use the craft but are exploring other options. They could return with other astronauts on a planned SpaceX flight in February 2025. If they decide to do so, they will spend eight months on the ISS rather than the scheduled eight days. NASA has used a SpaceX rocket to deliver food and supplies to the ISS for Williams and Wilmore. They are working with other crew members at the ISS and report that they are in good spirits.

Wendling, M. (2024, August 7). They went to space for eight days - and could be stuck until 2025. BBC.
https://www.bbc.co.uk/news/articles/cg4yqepr469o

Article Summaries

Treaty on principles governing the activities of states in the exploration and use of outer space, including the Moon and other celestial bodies

In 1966, the United Kingdom, the United States, and the Russian Federation agreed upon and signed the Outer Space Treaty. It is a framework for international space law. It states that outer space exploration and use should benefit all countries, and all countries can explore it. No part of space can be claimed by one nation for their use or occupation; no one owns space. No one is permitted to put nuclear weapons or any weapon of mass destruction into space, including in orbit or on any celestial bodies. Celestial bodies, including the Moon, can only be used for peaceful purposes. Each state is responsible for damage caused by its space objects, and states are also responsible for activities carried out by non-governmental agencies. This means that each nation is responsible for their private companies' activities in space and their government's activities. Finally, states must avoid contaminating space and celestial bodies.

United Nations Office for Outer Space Affairs. (n.d.). Treaty on principles governing the activities of states in the exploration and use of outer space, Including the Moon and other celestial bodies. UNOOSA. https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introouterspacetreaty.html

Article Summaries

What breakthroughs in medicine came from NASA?

Space agencies must innovate to send people to space; the technologies they invent are used in many aspects of our daily lives. In the field of medicine, NASA has had some significant breakthroughs. Sometimes, they invent entirely new technologies. Often, however, they create technologies that lead to medical breakthroughs from other scientists. One example is Magnetic Resonance Imaging (MRI), which is used to make detailed images of the insides of our bodies which can be used to diagnose diseases. NASA developed image processing to enhance pictures of the Moon, which then led to improvements in MRIs, CTs, and CAT scans.

Another example is the artificial heart pump LVAD, which helps people waiting for heart transplants. It was based on the fuel pumps from space shuttles. Another example is light technology; NASA uses this in space plant experiments. It is also used to reduce chemotherapy side effects for cancer patients.

Many other medical innovations came partially from the technology used to develop our ability to explore space. These include imaging technologies, transmitters, and light-based technologies.

Brinson, L. (2024, March 7). What breakthroughs in medicine came from NASA? HowStuffWorks. https://science.howstuffworks.com/innovation/nasa-inventions/nasa-breakthroughs-in-medicine.htm

Article Summaries

What toll does spaceflight take on astronauts? Here's what we know

Over 700 humans have flown in space. Over the past sixty years, we have been studying how the stress of space travel impacts our bodies. Astronauts undergo rigorous physical exams before, during, and after spaceflight. One study was on two identical twins. Scott Kelly was on the ISS for a year, and his twin, Mark Kelly, remained on Earth. This enabled NASA to study the genetic effects of space, although only with a tiny sample size. Other studies by NASA and JAXA examined blood, urine, stool, saliva, sweat, and skin cells. They created a public database of samples. One surprising result was that even short spaceflights affected the body, including DNA. Astronauts' microbiomes (the bacteria and other organisms that live in and on us) changed in only a week. Working with an obstetrics and gynecology doctor, they found that genes associated with the hormone estrogen also changed, and the changes were more significant in female astronauts than in males. Other results showed that spaceflight might impair our metabolism, reproductive, and immune systems.

Kruesi, L. (2024, July 9). What toll does spaceflight take on astronauts? Here's what we know. National Geographic. https://www.nationalgeographic.com/science/article/space-human-body-astronaut-health

Article Summaries

What will space exploration look like in 2050?

In a new podcast, the first Briton in space (Helen Sharman) and the first Swedish astronaut (Christer Fuglesang) discussed their predictions of the future of space exploration. First, they predicted we would establish a permanent Moon base and a research base on Mars. Fuglesang claims that the main issue we need to solve is how to live outside Earth. He predicts that massive solar shades might protect us from global warming and protect life on Earth. Still, we might need to expand to another planet for our long-term future. Landing humans on the Moon again will be a stepping stone to exploring Mars and even establishing a permanent human population there.

Fuglesang and Sharman agree that space regulations, from exploration guidelines to managing space debris, will be necessary. More and more debris surround Earth; even tiny pieces of space junk can damage astronauts' suits and equipment. Moving forward, healthy competition between countries might encourage everyone to explore the limits of space, but we will need to manage risks carefully and cooperate when needed.

What will space exploration look like in 2050? (2021, May 22). Saab. https://www.saab.com/newsroom/stories/2021/may/what-will-space-exploration-look-like-in-2050

Article Summaries

Why Europe's astronauts are learning Chinese

China is joining Europe, the US, and Russia as a superpower in space exploration, and European astronauts set out on training exercises with their Chinese colleagues in 2017 near Yantai. German astronaut Matthias Maurer said the atmosphere in the Chinese training camp was completely different from training exercises in Texas. He said he would see his colleagues only during sessions in the Texas training and rented his own apartment. On the other hand, the Chinese astronauts were much closer to each other, treating one another like family and even vacationing together.

China launched the Shenzhou spacecraft into orbit in 2003. It is based on the design of the Russian Soyuz spacecraft, but it is much roomier and more advanced. Maurer said training with the Shenzhou was much more comfortable than with Soyuz. He has also been learning Mandarin to better communicate with his colleagues.

While the US was not cooperating with China regarding space missions at the time of this publication, the ESA was more open to a partnership. Europe already collaborates with member-states that speak different languages, so the ESA is well-positioned to join other nations' space agencies. China also signed an agreement with the United Nations to open its space station to international research. In the future, more nations might need to work together instead of pursuing rivalries to get humans back to the Moon and Mars. More cooperation means more opportunities for all.

Hollingham, R. (2018, June 27). Why Europe's astronauts are learning Chinese. BBC. https://www.bbc.com/future/article/20180626-why-europes-astronauts-are-learning-chinese

Article Summaries

Why should we explore space? What are the benefits for us?

The mysteries of the universe have fascinated humans for centuries; however, space exploration offers much more to humanity than simply satisfying our curiosity. Listed below are several reasons we should continue to explore what the universe provides.

1. Technological breakthroughs: Cell phones, cameras, solar panels, and emergency beacons initially used for space exploration are now commonly used by most of Earth's population. Global Positioning Systems (GPS), satellite navigation tools created for space missions, are now used in various industries, such as transportation and agriculture.
2. Economic opportunities: Exploring space has created jobs in government and private industries, providing new opportunities for economic growth worldwide.
3. Human survival needs: Learning how to survive in space environments, such as the ISS and other spacecraft, provides solutions for humans' long-term survival.
4. Improving international cooperation and trust: Countries working together on space exploration projects, as done on the ISS, promote collaboration and a peaceful way to work together regardless of political or cultural differences.

Continued space exploration provides opportunities for all individuals to overcome challenges, increase creativity, enhance critical thinking, and improve problem-solving skills. These attributes are crucial for furthering humanity's social, economic, and national security problems.

Deel, G. L. (2024, March 15). Why should we explore space? What are the benefits for us? American Public University. https://www.apu.apus.edu/area-of-study/math-and-science/resources/why-should-we-explore-space/

Article Summaries

Why we explore Mars - and what decades of missions have revealed

Telescopes first revealed the surface of Mars in the 1800s, and the landscapes made scientists think it might have had civilizations building on its surface. We know it is a dry planet, but it may once have been habitable. We have learned much about Mars in the past few decades, and NASA aims to land the first humans there by 2030.

Mars is about half the size of Earth, but it has a thin atmosphere of carbon dioxide that Earth's life forms cannot survive in. Water exists in the Martian polar ice caps and possibly underneath the planet's surface. However, scientists can see features almost certainly made by flowing liquids, showing that Mars might have once been covered in a vast ocean. Exploring the planet can help us understand more about how considerable shifts in climate can change a whole planet.

Missions to Mars started with flybys in the 1960s, then advanced to probes, landers, and rovers. The US, Russia, Europe, and India have all successfully put spacecraft into Martian orbit. Still, only NASA has managed to operate a craft on the planet's surface, starting with the Viking 1 and 2 missions in 1976. Exploring Mars has shown us the largest volcanoes in the solar system, one of the largest canyons ever discovered, and many dust storms. NASA's rovers, Spirit and Opportunity, sent more than 100,000 images back to Earth, staying in operation for many years longer than expected. As of 2020, two NASA spacecraft were active on Mars, InSight and Curiosity. There are three more NASA spacecraft in orbit around Mars, along with two ESA and one Indian spacecraft. These missions have shown that Mars is active and has the ingredients for life that we are familiar with, such as carbon, water, and energy. But we still need to find out if life ever evolved on Mars or if it is there now.

Because Mars and Earth orbit around the sun at different speeds, we are closest together once every 26 months. During this close period, most Mars missions take off. The summer of 2020 was one of those times, and three countries—the United Arab Emirates, China, and the US—aimed to send spacecraft. NASA launched the Perseverance rover in July 2020. NASA claims this is the groundwork for sending the first humans to Mars by 2030.

Drake, N. (n.d.). Why we explore Mars - and what decades of missions have revealed. National Geographic. https://www.nationalgeographic.com/science/article/mars-exploration-article

Article Summaries

Why we search

One of humanity's biggest questions is whether there is life beyond Earth. Answering this question will tell us about our place in the universe and what kind of universe we live in. At the moment, NASA's Exoplanet Program is looking for life. The focus is searching for a world like ours- small, rocky, with oceans and an atmosphere containing a mix of gases. To do this, they use spectroscopy, which analyzes light that passes through the atmosphere of distant planets to determine what ingredients are in the atmosphere. A planet would have to have liquid water for life as we know it. It would also need to be in its star's habitable zone. We might find life on Mars or moons like Europa or Enceladus. By studying early Earth life and extremophiles (organisms that can survive in extreme environments like outer space), we might better understand what to look for when it comes to life on other worlds.

Why we search. (2024, April). NASA.
https://science.nasa.gov/exoplanets/why-we-search/

Article Summaries

Why we'll never live in space

Some private companies are designing technology to let humans live on the Moon. But these plans are only sometimes realistic. Humans evolved on Earth, and we are not physically or mentally well adapted to living off-planet. It is also a substantial economic risk, with little public support for spending. At the 2023 Analog Astronaut Conference, these problems seemed manageable to overcome, but there were many challenges.

The 1991 Biosphere 2 project showed some potential issues facing human space exploration. Eight people entered a three-acre space to study how humans might live in enclosed environments off-planet. But besides producing too little oxygen, water, and food, the residents also suffered psychologically. Further Biosphere projects continue to test more of these 'analog astronauts,' who reproduce aspects of space travel while staying on Earth.

However, analog astronauts cannot reproduce the effect of microgravity on humans or other space conditions. Microgravity causes blood vessels that lead to the brain to get stiffer. Spaceflight also seems to damage our immune systems, making fighting diseases harder and impacting our vision and bone density. Astronauts in space exercise for hours daily to maintain healthy muscles and bones. Most worryingly, radiation damage to our DNA is much higher in space. In space, we might be able to use water shields to reduce radiation damage. However, galactic cosmic rays are not blocked by water, and during long-term space travel, they could increase cancer risk massively. Finally, even if the body can be protected, people in space experience higher anxiety, depression, and sleep problems and lower resilience, cognitive function, and ability to communicate.

Article Summaries

Why we'll never live in space, *continued*

The biggest issue is the cost of going to space. While some billionaires might say they want to build space colonies, there is no realistic business case for making it happen because a business has to make money. Traveling to space costs money. It needs an end-goal product to make a company money. There is some demand for private space tourism, but the risk of accidents is very high, and most people who like to visit space want a short joyride, not to spend the rest of their lives on Mars. Most taxpayers agree that sending humans to Mars should be a low priority for the government. NASA, a governmental agency, relies on US taxpayers for funding. Even a few NASA consultants think space exploration is not worth it for the average taxpayer. While many essential innovations have come out of the field, just as much good could come from the government directly investing in improving lives on Earth.

No clear-cut answer exists as to whether sending humans to space is worth the cost. The financial cost is one thing; the psychological and physical costs are another. For many astronauts, the simplicity of being on a mission is part of the draw, and coming back to Earth and the stress of daily life is the struggle. But going to Mars or another planet could be a horrible experience; it certainly will be challenging even for astronauts who genuinely want to go. We also might contaminate the Moon or other planets with bacteria from Earth. Science-fiction scholar Gary Westfahl points out that travel and 'pushing boundaries' does not equal a virtuous, happy life.

Scoles, S. (2023, October 1). Why we'll never live in space. Scientific American. https://www.scientificamerican.com/article/why-well-never-live-in-space/

Additional Media Links

AN UPDATED LIST OF SPACE MISSIONS: CURRENT AND UPCOMING VOYAGES

Description: This is a list of current and scheduled space missions from various space agencies worldwide.
Astronomy. (2024). An updated list of space missions: Current and upcoming voyages. [List]
Retrieved from https://www.astronomy.com/space-exploration/space-missions-a-list-of-current-and-upcoming-voyages/

ESA - EUROPEAN SPACE AGENCY

Description: This is the official Instagram account for the European Space Agency (ESA).
ESA - European Space Agency. (n.d.). [Instagram Account]
Retrieved from https://www.instagram.com/europeanspaceagency/

EXOPLANET CATALOG

Description: This is NASA's exoplanet encyclopedia, containing details about the over 5,500 exoplanets cataloged so far, with artist renditions.
NASA Science. (2024). Exoplanet catalog. [Encyclopedia]
Retrieved from https://science.nasa.gov/exoplanets/exoplanet-catalog/

EXOPLANET TRAVEL BUREAU

Description: Travel along with audio guides and beautifully illustrated posters of exoplanets like Kepler-16b, and then explore the planets' surfaces with artist renditions based on the scientific information NASA has gathered.
NASA. (n.d.). Exoplanet travel bureau. [Interactive posters and landscapes]
Retrieved from https://exoplanets.nasa.gov/alien-worlds/exoplanet-travel-bureau/?intent=021

THE FERMI PARADOX - WHERE ARE ALL THE ALIENS? 1/2

Description: This video presents the most common theories for why, if life is ordinary in the universe, we have never found life beyond Earth.
Kurzgesagt- In a Nutshell. (2015). The Fermi Paradox- Where are all the aliens? 1/2. [Video]
Retrieved from https://www.youtube.com/watch?v=sNhhvQGsMEc

Additional Media Links

FOOTAGE OF PERSEVERANCE ROVER LANDING ON MARS RELEASED BY NASA

Description: Watch the original live NASA footage of the Perseverance rover landing on the surface of Mars.
Guardian News. (2021). Footage of Perseverance rover landing on Mars released by NASA. [Video]
Retrieved from https://www.youtube.com/watch?v=T4UKr7W-YC8

GUIDES TO THE NIGHT SKY

Description: This site allows you to search for a location and then lists the objects visible in the night sky from that location. The tabs at the top allow you to switch between viewing satellites and natural objects like stars, planets, and asteroids.
In-the-sky.org. (n.d.). Guides to the night sky. [Website]
Retrieved from https://in-the-sky.org/

HOW DOES A MARS ROVER WORK? (PERSEVERANCE)

Description: This video shows the mechanics of NASA's Perseverance rover, how it was built and launched, how it works, and how it communicates.
Owen, J. (2022). How does a Mars rover work? (Perseverance). [Video]
Retrieved from https://www.youtube.com/watch?v=0-oQRSViZQE

INTERNATIONAL SPACE STATION BATHROOM TOUR

Description: Watch how astronauts maintain hygiene in space, how plumbing works on the ISS, and how water behaves without gravity.
European Space Agency, ESA. (2015). International space station bathroom tour. [Video]
https://www.youtube.com/watch?v=nPUvzn3CTQc&list=PLbyvawxScNbtiUw3X0Qji8gGzAf1FZYvh

IS SPACE EXPLORATION WORTH THE MONEY?

Description: This video examines the actual cost of going to space and whether that cost is worthwhile.
The Planetary Society. (2022). Is space exploration worth the money? [Video]
Retrieved from https://www.youtube.com/watch?v=1Upxg0D-Eiw

Additional Media Links

JAMES WEBB SPACE TELESCOPE MISSION OVERVIEW

Description: This is a short overview of the James Webb mission, from construction to discoveries.
James Webb Space Telescope (JWST). (2023). James Webb Space Telescope mission overview (2023). [Video]
Retrieved from https://youtu.be/QNY6DPZNZII

JAXA DIGITAL ARCHIVES

Description: View the images from the Japanese Aerospace Exploration Agency, including their pictures from the SLIM Moon lander.
JAXA. (n.d.). JAXA Digital Archives. [Photo gallery]
Retrieved from https://jda.jaxa.jp/search.php?lang=e&page=1&category1=724&page_pics=20

JUNOCAM IMAGES

Description: This is an image gallery from NASA's Juno spacecraft, which has orbited Jupiter since 2016.
NASA Science. (n.d.). JunoCam images. [Photo gallery]
Retrieved from https://science.nasa.gov/gallery/junocam-images/

NASA

Description: This is the official Instagram for the US National Aeronautics and Space Administration (NASA).
NASA. (n.d.). [Instagram Account]
Retrieved from https://www.instagram.com/nasa/?hl=en

NAVAJO: STORY OF THE STARS

Description: This video introduces the basic Navajo story of the formation of stars, how constellations are viewed in Navajo tradition, and how scientists understand star formation.
NASA Astrobiology. (2019). Navajo: Story of the stars. [Video]
Retrieved from https://youtu.be/gYWyIISAMGs

SPACE JUNK WITH DR. ALICE GORMAN

Description: In this podcast, Dr. Alice Gorman discusses space debris and what it tells us about the history and future of space exploration.
Smologies with Alie Ward. (2024). Space junk with Dr. Alice Gorman. [Podcast]
Retrieved from https://www.alieward.com/smologies/spacejunk

Additional Media Links

THE STRANGEST PLANETS IN THE UNIVERSE | COMPILATION

Description: This compilation video introduces some of the most extreme planets we have discovered.
SciShow Space. (2021). The strangest planets in the universe | Compilation. [Video]
Retrieved from https://www.youtube.com/watch?v=FIJ8dOwPyC4

WEBB'S FIRST IMAGES GALLERY

Description: View and download high-resolution images sent from the James Webb Space Telescope.
Webb Space Telescope. (n.d.). Webb's first images gallery. [Photo gallery]
Retrieved from https://webbtelescope.org/news/first-images/gallery

WHAT'S IT LIKE TO LIVE IN SPACE? | COMPILATION

Description: This compilation video gives an overview of astronauts' lives in space, from the food they eat to the rules they must follow.
SciShow Space. (2020). What's it like to live in space? | Compilation. [Video]
Retrieved from https://www.youtube.com/watch?v=v-NBaUTm6Bk

WHY JUICE IS COMING BACK TO EARTH

Description: The ESA explains how their Jupiter Icy Moons Explorer (Juice) uses Earth's gravity to slingshot itself further into space and arrive in Jupiter's orbit.
European Space Agency, ESA. (2024). Why juice is coming back to Earth. [Video]
Retrieved from https://www.youtube.com/watch?v=I8jkXMompss

Discussion Topics

1. Does your area have a relationship with the space industry?
2. Have you ever watched a rocket launch?
3. Would you like to travel into space? Why or why not?
4. Why do we study outer space?
5. How have discoveries in outer space benefitted us here on Earth?
6. How do private companies perform space exploration?
7. Would you like to live in a space colony? Why or why not?
8. Do you believe there are life forms in space? What do you think that life looks like? Can we communicate with them?
9. What qualities would a planet contain that would make you want to live on it?
10. Have you used a satellite for a phone call, television, or internet?

Use these prompts to spark thinking before, during, and after engaging in the research activities. All of the prompts can be adapted to either discussion or writing.

Learning Prompts - Activating

1. What is a spacecraft?
2. What are space explorers called? Why are there different names for this profession?
3. What are planets? How are they different from moons? How are they different from exoplanets?
4. Are there natural satellites? What are they called?
5. What happens to satellites after they are no longer used?
6. How can satellites return to Earth? Do any of them cause harm?
7. What is the ethical conflict about space exploration? What are the reasons for each side?
8. Should communication satellites be public property, available to all countries?
9. Are there health risks involved with space travel? If so, what are they?
10. Is space travel safe for humans? If not, what safety measures can you think of that would reduce potential harm?
11. Why do astronauts float inside the ISS?

Learning Prompts - Open Response and Writing

1. What balance should we strive for between governmental and private company space exploration?
2. Should space tourism and private space exploration missions have safety regulations? What regulations should they have?
3. Are space colonies ethical to pursue? Explain your answer.
4. Should mining space bodies be allowed? If so, should private companies be allowed to mine for profit?
5. How should space junk be regulated to protect future space travelers and satellites?
6. Is space travel worth the financial costs to achieve it? Why or why not?
7. How long is a light year? Do you think we will be able to travel at that speed in the future?
8. What are some challenges for living in a space environment? Which is most important to successfully overcome, and how would you solve the issue?
9. How does space exploration impact politics on Earth? How does it impact relationships between countries?
10. Is the ISS a success story for space exploration? Why or why not.

Assessment - Multiple Choice

Name _____

1. Which of the following are dwarf planets?

a. Pluto
b. Ceres
c. Eris
d. All of the above

2. Exoplanets refer to...

a. an object that orbits a star, is big enough for its own gravity to make it into a sphere and big enough that it is the only object of similar size near its orbit
b.any planet outside our solar system.
c.a giant planet with a gaseous body around a solid core.
d.a natural satellite that orbits a planet, asteroid, or dwarf planet.

3. In 1966, the Outer Space Treaty was agreed to and signed by all but one of the below entities. Which entity did not sign the Outer Space Treaty?

a. The United States
b. The United Kingdom
c. The Russian Federation
d. The European Union

4. Which of the following do the Rovers do?

a. Land on the surface of a celestial body and move from where they land
b. Land on the surface of a celestial body and stay where they land
c. Land on the surface of a celestial body and bring astronauts
d. Orbit a celestial body

5. Orbital decay is...

a. when debris is caught in two or more orbit paths and is torn apart
b. when a celestial body used to orbit a star independently but now has lost some of its gravitational force and is affected by other similarly sized objects
c. when an object orbiting another object gets closer and closer until it eventually falls to the surface, or the two objects collide
d. when an object that orbits another object gets further and further until its shape becomes unrecognizable.

6. Why did NASA cancel the first all-female spacewalk?

a. risk of injury from a nearby asteroid
b. one of the women was ill
c. two female spacesuits were not available
d. communication channels were not working, and the spacewalk could not be captured on video

7. Which is considered NASA's greatest achievement?

a. the Hubble Space Telescope
b. Apollo 13
c. Explorer 1
d. Apollo 11

Assessment - Multiple Choice

8. China gathered soil samples from the South Pole-Atken basin which is located where?

a. in the South Pole
b. on an asteroid
c. on the far side of the moon
d. on Mars

9. Our Solar System contains all of the following types of planets EXCEPT which type?

a. terrestrial
b. rogue
c. gas giant
d. dwarf

10. Which of the following organizations was NOT involved in the development of the James Webb Space Telescope?

a. China National Space Administration (CNSA)
b. European Space Agency (ESA)
c. National Aeronautics and Space Administration (NASA)
d. Canadian Space Agency (CSA)

11. Several countries have successfully put spacecraft into Martian orbit. Which of the following has successfully operated a craft on the planet surface?

a. Russia
b. India
c. U.S.
d. Europe

12. NASA aims to land the first humans on Mars by what year?

a. 2045
b. 2040
c. 2035
d. 2030

13. The US Federal Communications Commission requires satellites to be disposed of within how many years of their mission's end?

a. 2 years
b. 5 years
c. 8 years
d. 10 years

14. Which system is not known to be impacted by spaceflight?

a. metabolic
b. digestive
c. reproduction
d. immune

15. Which of the following is not one of Jupiter's moons?

a. Triton
b. Ganymede
c. Callisto
d. Europa

Assessment - True/False

Name _____

_____ 1. The Earth is a satellite of the Sun.

_____ 2. Wheat grown in China was generated from seeds flown in space.

_____ 3. Increased space travel has generated positive public opinion.

_____ 4. Memory Foam was first developed for space travel.

_____ 5. The first human in space was Alan Shepard.

_____ 6. Space exploration has an impact on Earth's politics.

_____ 7. The Moon is a satellite of the Sun.

_____ 8. According to the 1966 Outer Space Treaty, countries are responsible for the activities of their private space exploration companies.

_____ 9. MRI scan technology can be attributed to NASA image processing technology.

_____ 10. It is easier to build institutions that practice gender equality than to reform old institutions with unequal practices.

_____ 11. Several countries have begun mining in space.

_____ 12. The ISS experiments on life support systems in space such as plant growth and water purification.

_____ 13. India has successfully conducted human space missions.

Assessment - True/False

Name _____

_____ 14. Eight moons are currently being evaluated for hosting life in our Solar System.

_____ 15. Spectroscopy determines what ingredients make up a distant planet's atmosphere.

_____ 16. Space junk does not pose a threat to working satellites.

_____ 17. Artemis I contains mannequins that gather data on how space impacts the human body.

_____ 18. Yeast reacts to radiation in a similar manner to human cells.

_____ 19. Over 1.000 humans have flown in space as of 2024.

_____ 20. China is joining Europe, the US, and Russia as a superpower in space exploration.

Assessment - Fill-in-the-Blank

Name _____

1. The Moon Agreement of _____ limits how resources on the moon can be exploited.
2. The Moon may hold a reserve of _____ used for energy production through nuclear fusion.
3. _____ developed to explore the Moon and Mars are used on Earth to explore disaster areas.
4. The _____ was the first reusable spacecraft.
5. The artificial heart pump, _____, was based on the design of the Space Shuttle fuel pump.
6. NASA and the _____ partnered to create a curriculum that combines Western science with the traditions of this culture.
7. The Arecibo Message was our first attempt to contact _____ in 1974.
8. Over 25,000 pieces of _____ currently orbit the Earth.
9. The first woman to command the ISS is _____.
10. As of 2023, over _____ exoplanets have been cataloged.

Assessment - Answer Key

Multiple Choice

1. D
2. B
3. D
4. A
5. C
6. C
7. D
8. C
9. B
10. A
11. C
12. D
13. B
14. B
15. A

True/False

1. T
2. T
3. F
4. T
5. F
6. T
7. F
8. T
9. T
10. T
11. F
12. T
13. F
14. F
15. T
16. F
17. T
18. T
19. F
20. T

Fill-in-the-Blank

1. 1979
2. helium-3
3. Robots
4. Space Shuttle
5. LVAD
6. Navajo Nation
7. aliens
8. space junk
9. Peggy Whitson
10. 5,500

Use these assessments as formative or summative assessments. Consider assessing learners at the beginning of the unit as a pre-assessment, and again at the end as a post-assessment to see their progress. Teachers can use these as graded assignments if needed.

FUTURE Problem Solving

Additional curricular resources

We hope you find this edition of our activity unit series to be a valuable resource as your students gather knowledge about Future Problem Solving topics of study.

Space Exploration Activity Unit

Our activity unit on this topic contains step-by-step lesson plans for research-based independent and collaborative work for use with students in a variety of settings, including out-of-school time. The publication includes 3 extra topic-related future scenes for practice, a variety of tools, research, and metacognition activities, and a variety of specific problem-solving step activities.

Global Issues Champions Series

This series showcases student written work for the 2024 Global Issues world champion team and individual competitors by division. Their full evaluations are included. To use this publication as a coaching tool, first review the Air Quality future scene with your students. Then ask students to complete a booklet using the future scene. You can do this as a mock competition or step by step as practice. For students looking to deepen their understanding of evaluations, we recommend that you give each team a copy of the student work, step by step. Ask students to identify strengths and weaknesses in the sample work based on their understanding of the scoring rubric. Review the evaluation concepts identified in each step and look at the scores and feedback from evaluators together.

Education Standards

Our Future Problem Solving process fulfills a wide variety of education standards. We take connecting with these standards into account when developing our program materials. Teachers can easily tailor Future Problem Solving content to meet their specific education system and local requirements as needed.

How our topics are selected

Our topics represent important challenges from business, civics, society, science, and technology and serve as the thematic basis for given problem solving situations. Each school year, students get 3-5 opportunities to solve important near-future global issues based on their progress in local and regional competitions. To be considered, a topic must be broad enough to appeal to participants living around the globe, offer a range of themes and issues to explore, and be considerate of a variety of views. Lastly, of course, every topic must be accessible for all, from ages 8 to adult.

We welcome submissions of topic ideas from anyone year round. Our topics committee reviews, refines, and categorizes submissions into our diverse strands. Then options are narrowed down and screened by our regional affiliate leaders. They pre-select top candidates for each of the category strands to present to our entire global community for a vote. The community's input, including students, heavily influences the final selection. We announce topics for the upcoming competition season March 1.

About Future Problem Solving

Future Problem Solving proudly celebrates over 50 years of placing more than a million young people at the core of a dynamic, purposeful learning experience. Each year K-12 students around the world participate in a variety of challenges designed to empower curious youth to become changemakers. Problem solvers learn how to think, not what to think, and gain skills they need to succeed in work and life. Our programs help young people develop their own voices and the confidence to use them.

To learn more about Future Problem Solving, to submit a topic idea, or contact us, visit fpspi.org.

FUTURE Problem Solving™

Video Games

Business & Economics

RESEARCH UNIT

- Research
- Readings
- Resources
- Problem-Solving Tools

Supports all these programs

GRADES 4-12

Qualifying Problem | 2025-2026

This publication is a compilation of the hard work of many people. Special thanks are extended to our curriculum author Kate Wolf.

Topic Contents

Video Games

How might evolving gaming technology, laws, and consumer expectations impact the business of video games in the future?

Research

Readings

Resources

Supplemental: Problem-Solving Tools

We strongly advise Future Problem Solving coaches and others using this content to review their educational organization's policies on appropriate content, and to screen any materials before making them available to students.

Cover Page: Freepix (Photo Credit)

Introduction

Background
Video games are a popular form of entertainment and interactive media that have evolved into a multi-billion-dollar industry. They encompass various digital experiences, from action-packed adventures and strategy games to immersive simulations and educational tools. Video games are typically played on computers, gaming consoles, or mobile devices and involve players engaging with digital worlds, characters, and challenges.

Context
Video games offer diverse experiences, from competitive eSports competitions to solo adventures and social experiences where players collaborate or compete with others online. Video games have become a significant cultural phenomenon, with a global fan base and dedicated communities. They are even recognized as art forms. These games continue to push the boundaries of technology, storytelling, and creativity, influencing not only entertainment but also fields like education, cognitive science, and virtual reality.

Questions to Explore
What makes video games of all kinds so popular?
How do video games influence societies? How will the rapidly expanding field of artificial intelligence shape video gaming of the future?
What will be the next frontier for video games look like?

Use this publication as a starting point for research as your students gather knowledge about the topic of study. By the time of distribution, some of the information may change or become out-of-date. Keep in mind, however, that observing and studying the changes that take place in a given subject area over a few months or years can be an incredible asset to problem solvers who work with scenarios set in the future.

Themes and Concepts

Themes and concepts assist in organizing a lot of information into manageable threads or ideas, providing a complete picture or understanding of the subject.

CENTRAL THEME #1

Healthy gaming

In the 1990s and 2000s, there was a massive backlash against video games, with fear from parents and educators that violent games would make gamers more violent in real life. As games have continued to grow in popularity, the actual effect of video games on mental health is a lot more complicated, and games can improve mental health and be a great mode of connection and joy.

MAJOR CONCEPTS:

No significant link has been found between playing violent video games and being more violent in real life. Although video games are more popular today than ever, violent crime in the US decreased between 1990 and 2022 by over 50%.

Gaming addiction can be a serious concern; when people use video games to escape real life and lose control of how much time they spend on games, it can take a toll on work, studies, and relationships.

Video games can improve mood and anxiety- they're fun! It is essential to have entertaining hobbies, and the many different types, styles, and storylines can appeal to many people.

As with all areas of the internet, harassment is still a significant problem in the gaming arena. While games are getting more inclusive, there is still work to be done to make this a safe space for more people.

There is still debate about how to set healthy limits around gaming. The Chinese government has taken more steps than others, setting strict limits on how much time minors can spend gaming and how gaming companies can target gamers' wallets with pay-to-win strategies.

Themes and Concepts

CENTRAL THEME #2

The economy of gaming

The video games industry is a massive entertainment sector, generating billions of dollars of revenue worldwide. It is also relatively new, and the technology involved is developing constantly, so the risks and rewards of breaking into the games industry are also changing. This sector includes many jobs, but protections for actors, developers, and workers are not always clear or sufficient.

MAJOR CONCEPTS

An individual game can cost millions of dollars to produce. Big game studios like EA, Nintendo, and Capcom can afford to make massive, detailed games, while smaller independent studios can struggle to get off the ground and may close if one game does not sell well.

The games industry employs various professionals: actors, artists, animators, coders, marketers, musicians, and more. Esports is becoming increasingly lucrative, with competitive gamers earning a lot of money and providing more jobs for event managers and others, making in-person competitions possible.

62% of game studios already use AI. AI can sometimes be beneficial, allowing more dynamic and detailed art choices in-game. However, studios seem to have a distinct lack of respect in training AI on data made by humans who are not compensated for their work being used to train the AI.

Themes and Concepts

CENTRAL THEME #3

Games and culture

Video games are a significant part of today's culture around the world. Many game characters are household names, from Pikachu to the Mario Brothers. Games are a large part of our entertainment landscape, from esports competitions to solo gaming.

MAJOR CONCEPTS

Video games are often ridiculed as a waste of time or a distraction from life. Still, more and more, they are recognized as a valuable art form with distinct cultural, aesthetic, and emotional value.

For young people primarily, video games act as a social space separate from work, home, or school, where friends can spend time together and catch up while playing. Online games offer a place to meet others, make friends, and expand social circles.

The video games industry has traditionally been seen as a space dominated by white men, while women and people of color have been excluded. Today, though, more and more gaming spaces are seen as a haven for marginalized communities.

Video games can be and often are used in classrooms and for education. Their engaging and dynamic nature makes them a great way to teach new concepts and encourage problem-solving and resilience.

Themes and Concepts

CENTRAL THEME #4

What's next in gaming?

As technology changes and improves, video games are on their way to a significant power-up. Innovations like GenAI and the metaverse could transform the future of the industry.

MAJOR CONCEPTS

The metaverse concept has existed since 1992 but hasn't yet been executed. In the coming decades, people could live as their avatars and interact virtually with other avatars in this virtual 3D world.

While AI has been used for decades to do things like power NPCs, recent innovations in AI (separate from GenAI) have vastly improved the processing power that games dedicate to making NPCs act like real people.

Virtual Reality (VR) has been around for decades with improving quality and complexity. More companies continue to enter the arena every year, and now even big names like Meta, PlayStation, Samsung, and Apple are investing more in VR advancement.

Rendering in games has steadily improved, with 3D models more life-like than ever. High-quality graphics cards have revolutionized high-fidelity graphics in games, and they are only getting better.

Overview

The first video game, Tennis for Two, was released in 1958 and could only be played in the creator's laboratory. By 1970, a similar game, Pong, was popular in arcades. Today, video games are a significant and vital part of the entertainment economy, with hundreds of games being released yearly by major companies and independent studios. Live streamers and esports players garner millions of fans, game characters are household names, and there are over three billion active players of video games worldwide.

Video games are a source of entertainment, a social space, a hobby, and, for some, a career. Despite early fears that they could decrease productivity or lead to a rise in violence, studies mostly show that video games are a positive force in the lives of people who play them. They often require resilience, creativity, and problem-solving, which can help develop these traits. They can also be a great place to meet people and deepen friendships. Many young people turn to video games as a social space; while playing with friends online, they can chat, discuss their lives, and let off steam. Like those surrounding esports, competitive communities can be a great place to meet like-minded friends. A passionate hobby and a close community are essential to mental health; video games can be vital to that balance. They are also becoming more inclusive. Technology is advancing in making games more accessible to people with disabilities, allowing more people to experience the joy, challenge, and frustration of gaming.

In an educational setting, video games can be a great way to teach multiple concepts simultaneously and get lessons to stick. Many people are calling for more use of video games in classrooms. Although these efforts can be controversial and too expensive for some schools, lessons incorporating video games are often more engaging and interactive than many traditional learning techniques. The hand-eye coordination required for video games is even helpful for doctors; those who play video games more than three times per month are shown to have more efficient surgeries, especially when using robotic tools.

Our topics, determined with input from our global community as well as subject matter experts, represent important challenges from business, civics, society, science, and technology. We welcome ideas for future competition topics from everyone including students and coaches. Share your topic ideas and feedback at https://fpspi.org/topic-submission/

Overview

Despite these many significant benefits, there is still an air of skepticism around video games. One big question is whether they are art (worthy of industry protection, critical acclaim, and attention). Critics argue that video games may contain art in the form of graphics and music, but they are not art themselves. Players, designers, and artists who create video games often vehemently disagree. One way to highlight this is by looking at the use of generative AI (GenAI) in the games industry. The backlash against GenAI in games is almost identical to that in the music and digital arts industries. Actors' unions were on strike for much of 2024 to get fair contracts regarding this issue. People are upset not only because jobs in the video games industry are declining and artists are not being compensated for their work but also because AI-generated games have no 'soul,' no details just for the fans, and no meaning behind each decision. The thought and care behind the character design, settings, voice acting, and story arcs are staggering in many games.

The use of GenAI also has implications for labor practices and economics in the games industry. Executives of games and AI companies claim that AI can be used to perform repetitive tasks that humans may not want to do. They say that background texture and architecture's 'boring' work could fall to AI instead of people. However, it should be noted that this is not a sentiment that has been widely echoed by many artists working on games, let alone the many actors, voice artists, musicians, and other creative professionals who create art for games. The push for GenAI use in games is mainly economic, and those most excited about it have the most to gain from hiring and paying fewer people.

Other technologies are also changing the games industry. Improving graphics, animation software, consoles, and motion detection all play a part in the race to create more and more advanced games. Virtual reality is also an emerging trend, though it is still a relatively small part of the industry. It is expensive to buy VR sets, especially compared to games that can be played on mobile phones, but it can be expected to grow in the future.

Overview

As the games industry grows, these issues must be addressed. Video games are essential in our entertainment landscape, economies, and social spaces. Other technologies, including VR, improved graphics and controls, and more, will change how video games are played. The space they take up in our culture will also change. As we continue to play, we must consider how games are made, who is welcomed into gaming communities, and their role in our lives.

The future of gaming presents many opportunities for increased economic growth, technological developments, and opportunities for social interaction. Cloud gaming allows users to stream games that may be unavailable through common sales channels. Using non-fungible tokens (NFTs) and blockchain technology offers gamers a forum to earn real-world money. Collaboration across businesses to create the metaverse provides unique gaming and social interaction opportunities in a multiverse platform. As technologies such as AI and VR improve the gaming experience, more users will be enticed to enter the gaming world.

Vocabulary

accessible: designed to be usable by a range of people, including those with disabilities. Accessibility features include captions and subtitles, color adjustment modes, simplified controls, pause functions, screen readers, and more

artificial intelligence (AI): a system that uses data and algorithms to perform a task or tasks normally done by humans, including reasoning, automation of workflow, data analysis, and pattern recognition

augmented reality (AR): technology that overlays a user's view of the real world with a computer-generated image

autonomy: the ability to independently make choices without outside intervention

avatar: an image that represents a player in a game world

battle arena: a place where players compete against one another

blockchain: a system where a log of anonymous transactions is kept on a network and is accessible to all users

cloud gaming: gaming that is hosted on servers that are not in the gamer's home, like streaming television; gamers do not own their games and instead subscribe

console: a video game hardware unit that connects to a screen, controllers, and other hardware to play games; many video games are designed to be played on one specific type of console, but some work across multiple consoles

controller: any input device that allows a player to interact with the game, including a gamepad, mouse, joystick, touchscreen, and more

co-op: a multiplayer game in which players work together to overcome a challenge or beat an enemy

display: a device, usually a computer monitor, television screen, or projector, that outputs graphics for a video game

esports: electronic sports; professional, organized competitions between players and teams watched by spectators

Vocabulary

first-person shooter (FPS): a type of game in which the player views the action as though through the eyes of their player character, and when the gameplay involves shooting enemies and targets

game animator: a person who designs and animates visual elements of a video game

game designer: a person who makes the core features of a game, including the gameplay rules, plot, concept, and structure

game developer: a person who takes the game design and creates a playable product, including the mechanics and code

gameplay: the mechanics of a game, including its plot and how it is played, how to win or advance, what a player can and cannot do, and the challenges that must be overcome

game programmer: a software engineer who creates code for video games and software, ensuring the game works correctly

game studio: a company that specializes in designing and developing video games

gaming addiction: also known as internet gaming disorder; when a person loses control over their gaming habits and gaming has a negative impact on their daily life, job or school performance, physical or mental health, etc.

generative AI (GenAI): a type of AI that focuses on creating new content. GenAI uses training data to learn patterns and creates new content with similar characteristics, such as video, images, and text.

gesture control: technology that allows users to interact with devices by making physical movements rather than using input methods like keyboards

indie game: a game created by a small team or one person, without the support of a major game studio; indie games are often more experimental and considered more unique and artistic compared to major games

Massive Multiplayer Online Role-Playing Game (MMORPG): an online RPG in which many players play at once

Vocabulary

metaverse: a proposed network of immersive online worlds where users interact with each other as avatars; experienced through VR or AR

multiclass: when a character can have multiple player classes at once, gaining the abilities and attributes of each of them

multiplayer: a game where more than one player can play at once in the same environment and interact with one another

non-fungible token: a unique digital identifier that cannot be copied, substituted, or subdivided, that is recorded in a blockchain

non-player character (NPC): a character in a game that the player does not control

player character (PC): the character in a game under the control of the player

player class: the background of a character, such a role, ability, and career (e.g. wizard, soldier, bounty hunter); players usually choose a class when creating a character in an RPG

real-time strategy (RTS): games in which players act simultaneously in real-time, instead of taking turns

role-playing game (RPG): a game in which players take the role of a character in a fictional world, often science fiction or fantasy

simulation (SIM): a game that imitates real-life activities and lets players explore and develop skills without defined goals

sound designer: a person who creates the sound for a game, including integrating music, character voices, and sound effects

stream: in video games, a live broadcast of a player's gameplay over the internet; streams often allow watchers to comment and interact with the player in real-time

third place/space: a space that is separate from work, school, or home, which mainly functions as a social gathering place

Vocabulary

turn-based strategy (TBS): when players take turns performing actions during gameplay, giving more time to think and strategize than real-time games

virtual reality (VR): a simulated three-dimensional environment that users can interact with using equipment like a screen and gloves with sensors

Interactivity:
A Quizlet containing all the topic vocabulary may be found here.

Use password: FPSPI
https://quizlet.com/994697216/gaming-flash-cards/?i=4351sf&x=1jqt

List of Articles - By Theme

A concerted effort was made to find recent articles from as many different perspectives as possible. While Future Problem Solving attempts to present a balance in the range of opinions, some sides of an issue are often more represented than others. This does not mean that Future Problem Solving supports that position. Future Problem Solving supports no position.

Central theme #1: Healthy gaming

- 5 reasons video games should be more widely used in school
- China is escalating its war on kids' screen time
- Gaming does not appear harmful to mental health, unless the gamer can't stop - Oxford study
- How do video games provide effective learning?
- The link between ADHD and video games
- NHS treats hundreds with gaming disorders
- The psychology of MMORPGs
- Video games and mental health: A surprising ally
- Video games and mental health: The good and the bad

Central theme #2: The Economy of gaming

- AI is already taking jobs in the video game industry
- China to increase curbs on video gaming industry
- Finally, Australia sees video games are important - but it can't be only because they make money
- For a nation of gamers, why doesn't Singapore have more homegrown video games?
- Generative AI is coming for video games. Here's how it could change gaming
- How the computer games industry is embracing AI
- SAG-AFTRA calls 'huge win' as 80 games agree to the union's AI terms
- Singapore video game developers share the industry is more than just fun and games

Central theme #3: Video games and culture

- Are video games works of art?
- Building community in esports: Transferable skills built through online worlds
- Everything you've ever wanted to know about esports (but were too afraid to ask)
- The evolution of gaming culture in Japan: From arcades to mobile gaming
- Gender representation in video games
- How I found my 'third place' through video games
- How video games have changed the world
- The impact of esports on society and culture
- "We've always been here": Women in the video game community
- Why so many teens use video games to meet others
- Why videogames are art

Central theme #4: What's next in gaming

- The future of gaming: 2025 and beyond
- Two technology trends shaping the future of gaming
- What does the future of gaming look like?

List of Articles - Alphabetical Order

5 reasons video games should be more widely used in school
AI is already taking jobs in the video game industry
Are video games works of art?
Building community in esports: Transferable skills built through online worlds
China is escalating its war on kids' screen time
China to increase curbs on video gaming industry
Everything you've ever wanted to know about esports (but were too afraid to ask)
The evolution of gaming culture in Japan: From arcades to mobile gaming
Finally, Australia sees video games are important - but it can't be only because they make money
For a nation of gamers, why doesn't Singapore have more homegrown video games?
The future of gaming: 2025 and beyond
Gaming does not appear harmful to mental health, unless the gamer can't stop - Oxford study
Gender representation in video games
Generative AI is coming for video games. Here's how it could change gaming
How do video games provide effective learning?
How I found my 'third place' through video games
How the computer games industry is embracing AI
How video games have changed the world
The impact of esports on society and culture
The link between ADHD and video games
NHS treats hundreds with gaming disorders
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Two technology trends shaping the future of gaming
Video games and mental health: A surprising ally
Video games and mental health: The good and the bad
"We've always been here": Women in the video game community
What does the future of gaming look like?
Why so many teens use video games to meet others
Why videogames are art

Information is a summary of the original article. It is up to the reader to determine which facts and ideas to accept. Future Problem Solving encourages coaches and teachers to preview the article summaries and links to determine whether all information is appropriate for their students. Efforts were made to minimize the sensitivity of the summaries' contents; however, different standards of acceptability apply to each individual student, coach, and community. Please use your discretion with these materials. ***Information is listed in alphabetical order by article title.***

Article Summaries

5 reasons video games should be more widely used in school

In 2021, the Chinese government set limits for children playing video games, significantly restricting how long students could play games during the school week. However, some video game designers do not agree that gaming and education oppose each other. Designer and scholar Andre Thomas advocates expanding gaming and incorporating it into the school day. Games have been used in classrooms for decades and can improve learning in many ways.

Some games improve math skills, such as calculus, which can help students stay in STEM fields even past challenging introductory courses. Games can also teach soft skills like creativity and problem-solving. They can help students become more comfortable with failure and more likely to try again after setbacks. They are also often more engaging than other learning tools. Finally, games allow students to assemble information independently, leading to higher-level complex knowledge.

Thomas, A. (2021, September 6). 5 reasons video games should be more widely used in school. Texas A&M Today. https://today.tamu.edu/2021/09/06/5-reasons-video-games-should-be-more-widely-used-in-school/

Article Summaries

AI is already taking jobs in the video game industry

Note: The full article includes some strong language in the form of quotes that may only be suitable for more mature readers.

In 2023, over ten thousand video game industry employees lost their jobs. The number has increased since then, primarily due to the expansion of GenAI tools like OpenAI. Other industries are also feeling the effects, but gaming is especially vulnerable. Most game employees are not in trade unions, meaning their jobs are easier to eliminate. While AI does not necessarily replace employees, many managers use it to create shortcuts and increase productivity, degrading and replacing human jobs. Almost every artist is anxious about and highly critical of using AI-generated images in video games.

More than other entertainment industries (TV, film, and music), the gaming industry relies on GenAI to storyboard and design characters. The actual breakdown is difficult to grasp because the industry is so convoluted. This complexity also makes it hard to claim that copyright has been violated. Some studios and artists are wary of this unstable copyright law section. There are also concerns about cybersecurity with the use of GenAI. Others see AI as a way to cut costs.

There is a clear divide in the industry between workers (who are almost universally against AI) and CEOs, who more often see the use of AI for profit. One CEO compared it to the Industrial Revolution when automation of jobs meant many people lost work in the short term but increased opportunities in the long term. However, one worker noted that AI was part of a more significant problem. Art is undervalued in games; companies will use any means necessary to reduce costs. China and Japan are also seeing lower wages being paid to illustrators.

Article Summaries

Managers will need to contend with some problems moving forward. One thing is that workers are becoming more interested in unionizing to protect their jobs. Another is that AI might not be that good or reliable. Games often require complex graphics that are difficult for humans to produce and not much easier for AI. The pushback from artists, developers, designers, and programmers is vast and may determine how much of a foothold AI will gain in the industry.

Merchant, B. (2024, July 23). AI is already taking jobs in the video game industry. Wired.
https://www.wired.com/story/ai-is-already-taking-jobs-in-the-video-game-industry/

Article Summaries

Are video games works of art?

Since the simple games of the 1980s have evolved into imaginative, often moving games, the question has come up as to whether video games can count as art. The drawings are certainly art; even mobile games take much time and effort to become immersive. Candy Crush, for example, features bright, carefully chosen colors and high-quality graphics. If other media, like book covers and films, involve illustration but are considered their unique art form, why should video games be excluded? The lines between what is and is not art are becoming less clear, and many in the art industry are beginning to agree that video games could be considered a unique art form.

Pietroni, D. G. (2021, September 9). Are video games works of art? The Art Insider. https://www.art-insider.com/are-video-games-works-of-art/2780

Article Summaries

Building community in esports: Transferable skills built through online worlds

With the evolution of the internet, our communities are much more widespread than in the past. Esports show how communities form across the globe via the digital world. Communities form on Twitch's live stream platform, where viewers can interact with gamers in real-time. Fans of esports organizations and teams also have dedicated servers on Discord, where they can host watch parties and organize meetups at live events. These also come into the offline world when local esports tournaments give gamers and fans a chance to connect. Some are massive competitions with sponsors, but others are small local events at community centers and gaming cafes.

eSports communities can be a great social environment where people can bond over shared passions and belong to a close community. It can also offer support and encouragement while players learn new skills from one another. They can be a good place to develop leadership skills, become more confident, and face challenges offline.

Building community in esports: Transferrable skills built through online worlds. (2024, August 27). Leadership Skills Foundation. https://leadershipskillsfoundation.org/support-articles/building-community-in-esports-transferrable-skills-built-through-online-worlds/

Article Summaries

China is escalating its war on kids' screen time

In 2021, China established a limit on children's time playing video games. Users under 18 were prohibited from playing more than three hours per week, and social media platforms had to filter their content for young users to limit their screen time and in-app spending. In 2023, they planned to escalate the regulations to start managing how children use apps on phones, smart watches, speakers, and other devices. These new regulations rely on app developers, app store providers, and device manufacturers to coordinate to create a 'minors' mode' on their devices. Non-Chinese companies like Apple and Samsung are also expected to coordinate their devices with this plan.

Under the new regulations, children under the age of eight can only use smart devices for 40 minutes each day and only access educational and hobby-related content. Older kids can access entertainment content and use devices for up to an hour daily. These hyper-specific rules are designed to keep companies from finding loopholes. In the past few years, they have effectively reduced the time young people spend gaming. Still, many young people get around them using older relatives' or friends' accounts and devices, though some companies have implemented facial recognition software to prevent that. So far, many parents have had a favorable view of these restrictions, but it is unclear if people will continue to be comfortable with stricter rules.

More and more child-safety bills are being proposed in the US as well. However, balancing restrictions with data security can be difficult because these rules rely on people providing personal information to companies. The app cannot restrict minors if it does not know who is playing. However, providing legal identification to a company like Meta is not necessarily attractive. In China, however, the system is already in place to verify user identity, and the Chinese government is more involved in deciding what content is not appropriate for minors (including politics). Many other governments are much less comfortable or able to determine what their citizens should be allowed to read, watch, or play.

Yang, Z. (2023, August 9). China is escalating its war on kids' screen time. MIT Technology Review. https://www.technologyreview.com/2023/08/09/1077567/china-children-screen-time-regulation/

Article Summaries

China to increase curbs on video gaming industry

In 2023, the Chinese government planned to increase restrictions on video games. the idea is to limit spending on in-game purchases and to prevent gaming disorders. the regulations also ban content that the government believes could cause political unrest.

These restrictions come after a set of rules that were enforced in 2021. They do not allow games to offer incentives for playing for longer hours or logging in more often. It is expected to reduce the number of daily active users and reduce revenue for tech companies. China has the largest gaming market in the world. The government announcement caused shares in Tencent, their biggest tech company, to fall by 12.4%. Other companies also experienced losses. The recent restrictions affect their pay-to-win style games, which are free to play but incentivize players to spend money. Tencent is a big enough company likely to recover from the loss, but smaller game studios may struggle under the new rules.

McCallum, S., & McMahon, L. (2023, December 22). China to increase curbs on video gaming industry. BBC News. https://www.bbc.co.uk/news/technology-67801091

Article Summaries

Everything you've ever wanted to know about esports (but were too afraid to ask)

Esports, also known as competitive gaming, is a multibillion-dollar industry. Esports is shot for electronic sports. Competitions occur worldwide, and in 2023, the Olympic Esports Week took place for the first time in Singapore. There are several popular categories: multiplayer online battle arena (MOBA), shooter games, fighting games, and strategy games. Big competitions fill stadiums with fans, and the atmosphere is like traditional sports games. Teams are also identical to traditional sports teams. Each team is usually based in one country, although players may be from other countries. In multiplayer games, each player usually fills a specific position.

Unfortunately, the gender discrimination in esports is also similar to that of traditional sports, with reports of sexual harassment and women gamers being paid less than men. There are some efforts to address discrimination. In 2022, G2 Esports debuted its first all-female League of Legends team.

The top three markets for esports are China, North America, and Europe. Esports are predicted to generate $1.87 billion by 2025 in Europe. This growth is expected to continue. To watch competitions, tune in on Twitch and YouTube.

Ulea, A. (2023, June 22). Everything you've ever wanted to know about esports (but were too afraid to ask). Euronews. https://www.euronews.com/culture/2023/06/22/everything-youve-ever-wanted-to-know-about-esports-but-were-too-afraid-to-ask

Article Summaries

The evolution of gaming culture in Japan: From arcades to mobile gaming

Japan is arguably the birthplace of video games and still holds some of the biggest gaming companies in the world, including SEGA, Sony, and Nintendo. The industry began after World War II, when Japan was in a period of economic growth, and pinball machines were popular in arcades. By the 1960s, those were replaced with electronic machines. In 1978, Japan had a global hit with the game Space Invaders. It was so popular that it kickstarted the culture of using gaming as a social activity in Japan. In 1980, the Japanese company Namco launched Pac-Man, a household name more than 40 years later.

Companies raced to create the first home gaming console. Soon, Atari licensed Space Invaders in the US and sold more than a million copies. Then, an economic recession in the US slowed the games market there, and Japan had the chance to become the leader in the industry.

The 1980s saw a revival of arcade machines, including the hugely successful game Street Fighter, which is still one of the most successful games ever. In 1989, Nintendo released the Game Boy, which took over the handheld console market. Heavy competition ensued between SEGA and Nintendo, each advancing the industry in the race to develop more and more successful consoles.

Today, Japan's innovations and contributions to video game culture mean it is still central to the global industry. The influence goes both ways; gaming has made a significant impact on Japanese culture, as well. Video games are expected to contribute 28 billion USD to the Japanese economy in 2024. Besides huge destinations like Universal Studios Japan and the Capcom, Nintendo, and Pokémon centers, Japan has many esports parks and themed cafes that offer VR, AR, and mixed-reality games.

In 2024, Japan's most significant games market is in mobile gaming. These started with the hugely popular Snake game, preloaded on Nokia phones in the 1990s, and continue today. Esports tournaments are also a growing market. In the future, mobile games and esports are expected to continue to grow, and technology for VR and AR gaming will advance even further.

Carter JMRN. (n.d.). The evolution of gaming culture in Japan: From arcades to mobile gaming. Carter Japan Market Resource Network. https://carterjmrn.com/blog/the-evolution-of-gaming-culture-in-japan-from-arcades-to-mobile gaming/#:~:text=Gaming%20in%20Japan%20wields%20significant

Article Summaries

Finally, Australia sees video games are important - but it can't be only because they make money

In Australia, video games have value. Primarily, it is measured by the money they make and the jobs they create. Although an exhibit at the Australian Centre for the Moving Image (ACMI) is one example of how video game development has cultural value beyond money, that is not reflected in Australia's policies or how the public discusses video games. In 2008, the games industry was devastated by the global financial crisis. However, in the following years, Australia built up its games industry again, and now many Australian games are critically acclaimed. Australia's new national cultural policy, Revive, promises to support the arts, including video games.

Revive's wording clarifies that economics is a significant part of why video games are being supported. It also says that video games can bring audiences to more traditional art forms like classical music. It does not acknowledge the art of the games themselves. It ignores the experimentation and innovation of game development. Like any art form, developing games can be unpredictable and rarely linear; policies need to understand and support this unique work to support the video games industry.

Keogh, B. (2023, March 6). Finally, Australia sees video games are important – but it can't be only because they make money. The Guardian. https://www.theguardian.com/games/2023/mar/06/finally-australia-sees-video-games-are-important-but-it-cant-be-only-because-they-make-money

Article Summaries

For a nation of gamers, why doesn't Singapore have more homegrown video games?

Market research has suggested that around 75% of Singapore's population plays video or mobile games, and over 41% spend more than 15 hours per week playing. And yet, although there are some big and small game developers, Singapore has not developed many games.

For one thing, Singapore's population is much smaller than that of nearby countries like South Korea and China, so its market is also much smaller. It can be challenging for Singaporean game developers to scale up games for an international audience. There is also a digital talent gap; games need skilled coding and digital design. Singapore is increasing its digital talent, but one survey says that 82% of organizations in Singapore need help filling their tech roles. Once companies have the talent to create games, they also need much data to make playable games. Developers must analyze player data to ensure their games are not too easy or complicated and keep players in a flow. As Singapore's gaming industry develops its talent, technology, and data, it is set to thrive.

Chan, C. Y. (2023, May 19). For a nation of gamers, why doesn't Singapore have more homegrown video games? CNA. https://www.channelnewsasia.com/commentary/gaming-video-mobile-e-sports-sea-talent-developer-studio-3497161

Article Summaries

The future of gaming: 2025 and beyond

At the start of 2025, the gaming industry is growing and changing faster than ever. Virtual reality via headsets like Oculus Quest 3 and the PlayStation VR2 provides experiences beyond gaming, including learning, traveling, and connecting with others. Increased use of Artificial Intelligence (AI) will make games more adaptable to players' strategies and preferences. Cloud gaming, or streaming games directly to a user's device, is still in the early days but is expected to increase immensely. Indie gaming has shown that large budgets and corporation backing are unnecessary to create a successful game. Community support and crowdfunding have generated more diverse and innovative games.

In the future, blockchain technology may become significant in the gaming arena. Blockchain technology would allow users to own in-game items and freely trade or sell them to other gamers, earning real-world value from gaming achievements. While this technology is still being developed, it offers some exciting additions to gaming.

The metaverse is another exciting opportunity for the future of gaming. With their online virtual concerts and events, games like Fortnite and Roblox give glimpses of what the metaverse could offer. Building the metaverse will require many companies to collaborate to connect games and platforms into an interconnected virtual world. There are some challenges to all the changes coming to the gaming industry. Many developers work incredibly long hours to meet unrealistic deadlines, resulting in a mental and physical crunch. Game funding needs to be universal, through subscription services or crowdfunding. Accessibility must be improved, and games must be made accessible to players with disabilities and welcoming to groups.

The future of gaming: 2025 and beyond. (2025, January 9). TOXIGON Infinite. https://toxigon.com/the-future-of-gaming-2025-and-beyond

Article Summaries

Gaming does not appear harmful to mental health, unless the gamer can't stop - Oxford study

Oxford University's Internet Institute surveyed nearly 40,000 gamers and their habits. The survey found that there was no cause-and-effect link between gaming and poor mental health, no matter what games were being played.

However, there was a difference between casual gamers and compulsive gamers. Gamers who play because they enjoy it do not suffer ill mental health. Studies included basic games like Animal Crossing and more competitive and sports-based games. People who felt they had to play did suffer adverse effects, though. The researchers also noted that they only surveyed seven games, which is a limited sample size when thousands of games are on the market. Getting the data for just seven games was still complicated, though. Game developers, distributors, and companies all have to agree to release data, and it can be hard to get everyone on board. The researchers noted that big gaming platforms like Nintendo should empower players and scientists to learn how their products influence our lives.

Gaming does not appear harmful to mental health, unless the gamer can't stop - Oxford study. University of Oxford. https://www.ox.ac.uk/news/2022-07-27-gaming-does-not-appear-harmful-mental-health-unless-gamer-cant-stop-oxford-study

Article Summaries

Gender representation in video games

Note: This article contains discussion of hyper sexualization of characters and may be suitable only for more mature readers.

Video games are a massive form of entertainment, but they have struggled with having diverse gender representation for a long time. They often rely on stereotypes of gender. There is also a severe underrepresentation of female characters in lead roles. The female characters are usually side characters, hypersexualized, and less capable and less critical than male characters. The online publishing platform Medium posted an analysis of how gender representation has changed over time within video games. With better awareness, developers, players, and the gaming community can work to change the culture and have better representation in games. Better character representation can help gaming be more inclusive, leading to better, more diverse player experiences.

Male characters have consistently been more common than female characters in the twelve years of the study. No genre of game has been studied with more female than male characters. The gap is widest in action-type games and narrowest in adventure games. RPGs also have more balanced gender representation, possibly partly because players can customize their characters. Within the industry, every publisher also has more male characters than female.

One of the most important publishers is Nintendo. Nintendo has shown a clear bias towards male characters in their top-selling games. Just because they have female characters does not mean the representation is good; characters from Super Mario, like Princess Peach and Princess Daisy, are ‘damsels in distress’ and have less agency and importance than most male characters. One of Nintendo’s most prominent female characters, Bayonetta, is also the most sexualized in the Nintendo world.

Article Summaries

In 2021, representation between male and female characters was at its closest, but the gap grew the following year. The data shows that the issue of representation is not improving. More attention should also be paid to intersectionality in video games, meaning that gender is considered alongside other factors like race, ethnicity, and sexual orientation.

Liang, M., Mendoza, J., Pang, Y. T., & Takeuchi, T. D. (2023, June 2). Gender representation in video games. Medium. https://medium.com/@yinting_76935/gender-representation-in-video-games-355ed9480431

Article Summaries

Generative AI is coming for video games. Here's how it could change gaming

The 2024 Game Developers Conference featured a lot of talk about artificial intelligence. However, the conference did not clarify how much of a role AI will play in the industry moving forward. Big companies showed off dynamic NPCs but did not announce that they would be included in upcoming games. Attendees noted that people are nervous about using AI in the games industry. Companies might make promises, but they may not work out because of the additional work required to make them functional. Still, behind the scenes, AI bots could be doing much work. In quality assurance, they might replace human workers who test for glitches and bugs. Some talks at the conference were about how GenAI can help production, generate maps, and improve faces on digital characters. It could also automate tasks and speed up production and workflow. One company experimented with using a series of AI tools for a game. In the end, every step of game development still required some human intervention. GenAI was also not very good at fixing bugs or creating user interfaces with menus. The company concluded that AI was not ready to replace human workers.

They also noted legal and ethical concerns about using GenAI to make games. One judge upheld a ruling that AI-created art is not entitled to copyright protection, so studios might risk not owning the content they put out if AI generates it. The company's developers might also be against using AI tools. GenAI can and often does also reproduce bias. For example, Dall-E 3 and Midjourney image generation created an image of an all-male crowd, even though there was no reason to exclude other genders from the image. There is also concern about the ethics of how AI is trained; they use publicly available data, which was produced in large part by the people who may now lose their jobs to AI.

Article Summaries

One lecturer suggested that AI will most likely be used in more mundane ways than making art. They compared it to introducing the PC to offices, which increased efficiency and reduced the need for personal assistants and secretaries. Some students trying to get into the gaming industry are using AI from the start, leading to concerns that these students and new workers may not understand the fundamentals of coding if they are using AI rather than creating code from scratch. However, there is some general enthusiasm for using AI to generate code.

Lumb, D. (2024, May 4). Generative AI is coming for video games. Here's how it could change gaming. CNET. https://www.cnet.com/tech/gaming/generative-ai-is-coming-for-video-games-heres-how-it-could-change-gaming/

Article Summaries

How do video games provide effective learning?

People learn best when motivated and free to make mistakes, when there is an authentic, meaningful context for learning, and when learners have autonomy. Video games can provide each of those things, making them an excellent place for people to learn.

Context is how we connect new information to what we already know. Video games put learners into a story, providing context that helps learners remember new things. Games also authentically give motivation; for example, it is more compelling to remember a sentence in a foreign language when it helps advance the story to act on a character's words rather than memorize it because it will be on the next test. Practice is also essential, and part of practice is failing. Learners must be free to fail, and video games often let players try again or change the input when something is not working. The final building block of learning is autonomy. Learners learn more successfully when in charge of their success and acting in their self-interest. Video games let learners engage in the learning process in diverse ways, encouraging decision-making, curiosity, and perseverance.

Kozlova, M. (2021, May 19). How do video games provide effective learning? Cambridge English. https://www.cambridgeenglish.org/blog/how-do-video-games-provide-effective-learning/

Article Summaries

How I found my ‘third place’ through video games

The author, a student in Miami, reports that he plays video games daily. He plays with friends on Discord and uses the time to catch up with them. In the past, this kind of discussion was often held around the dinner table, and for many families, that is still the case. However, for the author, this new routine helped him settle into college life with comfort and friends. He uses video games as a ‘third place,’ a separate space from work or home. Other examples of third spaces are coffee shops, community centers, and bookstores. However, many brick-and-mortar third spaces are not accessible or comfortable for everyone, so the author has created a digital third space to spend time with friends. These spaces are accessible worldwide, making playing video games much more accessible than going out. For some people, video games can be the perfect place to spend time with friends.

Macy, L. (2024, March 5). How I found my ‘third place’ through video games. The Miami Student.
https://www.miamistudent.net/article/2024/03/third-places

Article Summaries

How the computer games industry is embracing AI

Computer games are hugely expensive to develop. One PlayStation game can cost hundreds of millions of dollars to build, which is not sustainable for most companies. Using AI can cut those costs significantly. One AI company is working on a system that can learn from artists. Using the system, humans will still work together with AI. Other software firms also use AI to add realism and detail to games. They believe AI can make games interact with players more compellingly, personalizing the gaming experience and creating adaptive worlds. AI can allow players to explore parts of a game world that no one else has spent much time in, giving them a truly unique experience. It can provide players with more options instead of being restricted to the paths that video game developers programmed into the game.

However, using AI has a profound effect on the human workforce. The AI executives claim that AI is not replacing workers, though, just allowing them more 'creative dignity,' claiming that AI can take the repetitive tasks that artists might not want to spend time on.

Wakefield, J. (2024, May 2). How the computer games industry is embracing AI. BBC News. https://www.bbc.co.uk/news/business-68844761

Article Summaries

How video games have changed the world

The video games industry has grown hugely in the last few decades. They have had impacts on technology, culture, community building, and education around the world. For one thing, gaming has become more immersive and realistic, meaning manufacturers have pushed to have faster, more advanced systems to run games. Computer graphics, storage, and processors have all improved alongside virtual reality, augmented reality, and motion control. The games industry has also enhanced algorithms and AI systems, and these improvements have been seen in many other fields, including healthcare and engineering.

Culturally, video games have become a significant worldwide phenomenon. They have changed how we tell stories and many video game characters are mainstream in pop culture. Esports makes enormous profits and has millions of fans, often more than professional sports and traditional athletics. They also voice diverse experiences; many games center around complex social issues and take representation very seriously. Diversity of gender, ethnicity, and background allows players to develop empathy and inhabit many different experiences.

This empathy can extend to real people, especially in multiplayer games. Online, players can collaborate and even form strong communities and friendships. These communities are sometimes back fundraisers for charitable causes and can be a force behind social movements. Video games can also be a powerful educational tool, helping develop problem-solving skills. As they develop further, we can expect to see even more of their impact on our lives and society.

How video games have changed the world. (2023, June 23). Mastery Coding. https://www.masterycoding.com/blog/how-video-games-have-changed-the-world

Article Summaries

The impact of esports on society and culture

Esports have had a significant impact on society. One of the primary ways is that they expand our ideas about what sports are. They have also challenged our ideas about gaming. While gaming was previously seen as a solo hobby, esports has transformed video games into a social activity with teams and audiences. They have also allowed young people to pursue a new type of career. Besides just competitors, the world of esports requires broadcasters, marketers, and event managers. Finally, esports have impacted our entertainment consumption. Live streaming on Twitch and YouTube brings competitions worldwide and allows audiences and gamers to interact. They have brought sports to an entirely new audience who might have little interest in traditional sports.

The impact of esports on society and culture. (2023, April 5). Game Influencer. https://gameinfluencer.com/the-impact-of-esports-on-society-and-culture/

Article Summaries

The link between ADHD and video games

An estimate from Frontiers in Pediatrics says that 91% of children between ages two and seventeen play video games. Adults also play a lot of games. A study in 2021 showed that gaming disorders are linked to ADHD. People with ADHD tend to spend more time gaming and are more likely to develop an addiction to video games. However, researchers do not believe that video games cause ADHD.

A 'gaming disorder,' according to the World Health Organization, is a change in a person's behavior that negatively impacts personal, family, or social interactions, educational or job success, or other important areas of functioning, and must continue for at least 12 months. Very few children are at risk for a real gaming disorder. Video games can even improve some skills such as math, reading, social and language skills, and spatial visualization. They are also shown to decrease stress, anxiety, and loneliness symptoms and increase self-esteem and confidence. For kids with ADHD, playing video games can also help with switching between tasks. Some researchers say that video games can even help to manage ADHD. They can also be helpful research tools and allow researchers to test a variety of tasks and metrics, all while being fun and encouraging curiosity and challenge. Many games are popular with people with ADHD, and multiplayer or co-op games can be a great way to build personal connections.

Hovde, M. (2022, July 15). The link between ADHD and video games. PsychCentral. https://psychcentral.com/adhd/adhd-video-games

Article Summaries

NHS treats hundreds with gaming disorders

As of 2023, the English National Health Service (NHS) has treated over 700 gamers at the National Centre for Gaming Disorders. According to the NHS, a gaming disorder is when a person cannot control how much time they spend on video games, resulting in adverse effects like avoiding school and work, issues with family, and withdrawal from society. The number of people treated has gone up since 2021. The clinic works with psychiatrists, psychologists, and family therapists to help people with gaming disorders, as well as their family members. They offer individual and group therapy, workshops, support groups, and consultations. On average, the clinic's patients are between 13 and 17 years old. The average treatment time is around three months, though some are one-off sessions and others last over a year.

Gaming disorders are like other addictive and mental health disorders. They can affect the person suffering and those around them, but they can also be treated. England's Minister for Primary Care and Public Health notes that technology can be invaluable and positive, improving socialization, relaxation, and problem-solving skills. But it can go too far, so it is essential to recognize the warning signs. The support offered can be beneficial to people who feel their habits have gotten out of control, as well as benefiting their families.

NHS treats hundreds with gaming disorders. (2023, March 28). NHS England. https://www.england.nhs.uk/2023/03/nhs-treats-hundreds-with-gaming-disorders/

Article Summaries

The psychology of MMORPGs

Massive Multiplayer Online Role-Playing Games (MMORPGs) have a surprising appeal. They fit into a 2006 psychological theory called Self-Determination Theory, which argues that three needs influence human behavior. First is autonomy, which MMORGPs provide because people can play them differently. The second is competence; MMORPGs give players a sense of accomplishment by leveling up, beating raids, and completing achievement logs. Finally, there is relatedness, meaning the person playing feels connected to the task. MMORPGs often have strong world-building, and on top of that, players are playing with others. They give the chance to make new friends and connect with them in-game. MMORPGs capitalize on these needs by having a paid subscription model. It can be challenging to level up to the highest player class in the initial subscription period (often one month), so players continue subscribing and paying for the game.

Because people play together with strangers in MMORPGs, they can be social hubs. People make real friends in these digital spaces by saying hello and playing together. A 2007 study showed that around 75% of players surveyed had made good friends by playing MMORPGs, and nearly half met those new friends offline. The same survey showed players discussed personal issues and mental health with MMORPG friends. The game structure itself encourages this. Players work together to accomplish complex, shared tasks and deal with conflict. Group problem-solving skills are essential in this context, allowing one to become closer and improve self-esteem.

The role-playing aspect of MMORPGs is also valuable. Playing as an avatar is different from their everyday selves; players can exhibit characteristics they may not know how to embody daily, like confidence and assertiveness. Some player classes allow players to act as leaders, going out of their comfort zone and taking charge of challenging situations safely.

The psychology of MMORPGs. (2020, June 4). PlatinumParagon. https://platinumparagon.info/psychology-of-mmorpgs/

Article Summaries

SAG-AFTRA calls ‘huge win’ as 80 games agree to the union’s AI terms

The US-based actor’s union SAG-AFTRA is celebrating a win in contract negotiations regarding using GenAI in the games industry. Union workers have been on strike since July of 2024, and 80 games have signed an interim agreement to employ union talent during the strike, allowing voice actors to work for the games that have signed the deal while negotiations continue. This indicates that many companies are willing to agree to fair compensation terms for AI use. Actors are worried developers can use their recorded performances without the performers’ consent and without providing any compensation. The strikes are intended to protect actors from this unfair labor practice. The current strike follows similar strikes in 2017, but the unions have learned from those negotiations and can now provide work for employees under this interim contract.

Riendeau, D., & Francis, B. (2024). SAG-AFTRA calls “huge win” as 80 games agree to the union’s AI terms. Game Developer. https://www.gamedeveloper.com/production/sag-aftra-calls-huge-win-as-80-games-agree-to-the-union-s-ai-terms

Article Summaries

Singapore video game developers share the industry is more than just fun and games

People think that making video games for a living would be a fun job, but the truth is much more complicated. People often start in the games industry as eager creatives. Game developers work long hours before deadlines and face negative comments from friends and family who believe they are not doing 'serious' work. One games developer shared that he puts so much time into his work that he has almost no time for anything else. And while he feels judged by his peers and family, his game Ghostlore was a top-seller on Steam during its early-access release week.

Being an entrepreneur in Singapore's games industry is a challenging path. The CEO of The Gentlebros studio shared that developing one game can take two or more years. If the game does not sell well, that is two years wasted, and a small studio might have to close due to the failure. However, he and other up-and-coming game studios are pushing the idea that it is essential to have a good work-life balance. Working for big game companies can also be frustrating, even though it might offer more job security than trying to start up an independent company. Game designers say big companies can stifle creativity and make the job much less fun.

Most people in the industry agree that people are the most crucial part of the business. In Singapore, the games industry is relatively small, and people work very closely together. Many also have to do multiple jobs in their companies to keep things running. Even though this can limit what a studio can accomplish, keeping studios small can also be attractive. It allows people to have more creative freedom and work more closely together. Singapore's market is growing, though. Game developers there believe it can compete in the global market if people have the support they need to succeed.

Leong, C. (2022, September 1). Singapore video game developers share that the industry is more than just fun and games. The Peak Magazine. https://www.thepeakmagazine.com.sg/lifestyle/video-games-developers-gaming-industry-singapore/

Article Summaries

Two technology trends shaping the future of gaming

This situation was still ongoing at the time this chapter was published. We encourage educators to investigate the outcome of Wilmore and William's hopeful return to Earth before sharing resources.

Gaming has always been a leader in technological advancement, and as the metaverse develops, gaming will become a large part of that ecosystem. In the metaverse, players must move seamlessly between games and experiences and bring their digital identities, assets, and achievements. For this to be possible, game developers must create shared universes and platform experiences across different games.

Web3 technology that uses blockchain and decentralized protocols allows users to own their digital, in-game assets. Future technology will create in-game assets as non-fungible tokens (NFTs) that users can trade or sell across different platforms. As Web3 technology advances, players can redeem NFTs for real-world value.

The metaverse and web3 technologies will provide players and developers with a more diverse and inclusive industry and significant opportunities.

Marr, B. (2023, July 11). Two technology trends shaping the future of gaming. Forbes. https://www.forbes.com/sites/bernardmarr/2023/07/11/two-technology-trends-shaping-the-future-of-gaming/

Article Summaries

Video games and mental health: A surprising ally

For World Mental Health Day 2023, the UN acknowledged video games' positive role in helping people cope, communicate, and connect. The number one reason people play games is to have fun, and 71% of people surveyed by the Power of Play report also agreed that they can help relieve stress. They are also valuable tools for overcoming isolation and everyday challenges and boosting creativity and cognitive functions.

During the COVID-19 pandemic, many people turned to video games. The crisis highlighted how essential games can be for mental health and connection and was a turning point in public perception of video games. The World Health Organization offered guidelines in popular games in 2020 to promote physical distancing and hygiene. The UN has other initiatives that bring social issues to gaming. Some games teach about the refugee crisis, while others focus on tackling climate change. As the gaming industry expands, the UN hopes to continue to leverage this tool for global good.

Video games and mental health: A surprising ally. (2023, October 31). United Nations Western Europe.
https://unric.org/en/video-games-and-mental-health-a-surprising-ally/

Article Summaries

Video games and mental health: The good and the bad

A 2023 study showed that 85% of middle and high school students played video games. At the same time, 86% of parents thought their kids spent too much time on games. Video games do affect mental health in both positive and negative ways.

There are some harmful effects associated with video games. For one thing, some studies show that violent video games can increase players' aggressive behavior. In addition, depending on when people play, games can interrupt sleep patterns. Many gamers prefer to play late at night, which can lead to sleep deprivation. Too much gaming time can lead to an unhealthy dependence on games to escape reality. This and other problematic gaming behaviors can lead to depression, isolation, and social anxiety. These impacts are more likely to occur when a person spends several hours per day gaming rather than for casual gamers who spend less time playing. There is a risk of developing internet gaming disorder, also known as video game addiction, a type of behavioral addiction that a mental health professional should treat. Some studies show a link between neurodivergence and internet gaming disorder.

While there are many concerns about video games' effect on mental health, many positive impacts should be recognized. Video games often involve complex cognitive tasks like problem-solving and strategy, which can improve these skills. They are also usually a healthy, accessible way to socialize and relieve stress. Online multiplayer games are a great way to connect with friends, reduce loneliness, and give gamers an outlet and distraction from anxious thoughts. They are fun, which is an essential factor in dealing with depression.

Overall, it is vital to find a balance with gaming. In moderation, it can be a fantastic mood booster and hobby.

Laderer, A. (2023, July 5). Video games and mental health: The good and the bad. Charlie Health.
https://www.charliehealth.com/post/video-games-and-mental-health

Article Summaries

“We’ve always been here”: Women in the video game community

Video games can be a lifeline in lonely, frightening, or isolating situations. One woman recalls her experience of an extended hospital stay when she played during the day and talked to her friends on Discord at night. She says that games helped improve her socialization skills and gave her a community during a difficult time. While the typical view of a ‘gamer’ is often a young man, people of many different genders, races, and ages participate in video games. According to Forbes Magazine, 41% of gamers in the US were women in 2020. Asia had a similar demographic. But at the same time, many women feel underrepresented. A professor at the University of Kentucky wrote that women should advocate for themselves to be visible in video game communities. Women have always been part of gaming but have often been ignored.

Female characters in video games are often sexualized even when they are present, perhaps hurting real women’s self-esteem. When female characters are objectified in games, this can also promote sexist views in men and boys. However, the gaming industry often neglects women in storylines. Most video game protagonists are male. Conversations about inclusion can be productive, but sometimes there is severe backlash.

Representation is not as simple as gender, either. Racial representation and intersectional representation are just as important. The bodies that we depict in games and art show what bodies we care about, who have agency, and who are devalued in our culture. When only white men are shown, it sends an unmistakable message that only white men matter. It can also be complicated for marginalized people to play games online when interacting with others, but others cannot see them. Many people assume that everyone else playing with them is white. Black women who stream their games face racism as well as misogyny.

Article Summaries

Despite the negativity, women are still in the gaming community. They love games, the escape and creativity they provide, and make the community more welcoming and diverse for everyone.

Pilger, D. (2023, March 29). “We’ve always been here”: Women in the video game community. Smithsonian Center for Folklife and Cultural Heritage. https://folklife.si.edu/magazine/women-video-games-experiences-representation

Article Summaries

What does the future of gaming look like?

As an industry, video gaming has increased in popularity over the years, surpassing movies and sports combined. In 2023, global gaming revenue exceeded $189.9 billion, with the average gamer aged 36 years old. The gaming culture will only become more mainstream in the coming years, especially with the following tech innovations:

- Virtual Reality (VR). Initial VR headsets were considered bulky, pricy, and uncomfortable for gaming. Historically, VR has been a solitary experience. New VR games such as Rec Room and VRChat allow gamers to interact and socialize with each other in real-time. With more companies investing in the VR industry, the industry is projected to grow 30.5 percent by 2028.
- Augmented Reality (AR). AR is a gaming technology using hardware such as smartphones or specialized glasses to impose digital images onto the physical world. Pokémon Go, a vastly popular game using AR, has generated more than $8 billion in player spending since its release. Tech company Magic Leap has released a lightweight, glasses-type headset using AR technology in the healthcare, design, and manufacturing industries.
- Artificial Intelligence (AI). AI has been in gaming for decades, mostly in non-player characters (NPCs) such as the ghosts in Pac-Man. Changes to NPCs using AI have begun in the gaming industry, but future changes must overcome challenges such as costs and programming that mimic complex human thinking.
- Cloud Gaming. Cloud gaming, or game streaming, is a form of online gaming that uses games from faraway servers, like Netflix, to stream movies. This type of gaming uses subscriptions for play rather than the use of hardware such as game CDs. Cloud gaming is expected to exceed $143 billion by 2032 and possibly more as the number of users with internet access increases.

Article Summaries

- High-Fidelity Graphics. High-fidelity graphics cards that greatly enhance 3D imagery have greatly improved the gaming experience. Chip shortages have hindered users from using this technology, but that may change soon.
- Free-to-play games. In 2024, free-to-play games earned over $83.2 billion from advertising and in-game purchases. Gaming companies will continue to offer these free-to-play games due to their high revenue stream.
- Metaverse. The metaverse is an online cyberspace or parallel virtual space where users can live out a 'second life.' More companies are working to make the metaverse a reality, and once built, it will be used for more than just gaming.

Urwin, M. (2024, June 25). What does the future of gaming look like? builtin. https://builtin.com/articles/future-of-gaming

Article Summaries

Why so many teens use video games to meet others

Free or low-cost social spaces and activities are not very common today. These spots are called ‘third places,’ safe social spaces away from school, home, or work. In many towns and cities, public parks or cafes are the only available places for teens. Community centers, libraries, and bookstores are just not as common as in the past, and many people have no public places to go unless they are willing to pay for a meal or to shop. Instead, the only ‘place’ many young people can afford and enjoy is online. Games like World of Warcraft, where players can chat with others, are becoming new third places.

Psychologists do warn that virtual communication is limited. Online friendships are often less meaningful than in-person friendships. It is vital to have third places to spend time. When none are available in person, it is only natural to turn to online spaces. The suggestion is not to limit teens’ online activity but to try to help them find additional communities in person.

Fishman, A. (2023, April 3). Why so many teens use video games to meet others. Psychology Today. https://www.psychologytoday.com/intl/blog/video-game-health/202303/why-so-many-teens-use-video-games-to-meet-others

Article Summaries

Why videogames are art

Video games share a lot of elements with film and television. In terms of style, cinema and video games are very similar. They both rely on technological advancement and commercial success to keep going. Many games even implement actors' voices and even film them as part of the game. The Museum of Modern Art in New York has a set of video games in its permanent collection. But many critics still say that even though there can be art in video games, the games themselves are not art. Some argue that because video games do not 'contemplate truth' and can be addictive, they do not 'count' as art. Other criticisms include that games do not have an 'owner' or single creator, although it can be noted that neither do films or plays. Another is that video games are created by people who must put profit and popularity over 'artistic truth.'

A video game designer and producer responded that all art develops from early stages to more advanced forms and is accepted as art today. When they were first created, photography and cinema were not considered art forms. But there are many arguments for video games being art now and not just at some unknown, accepted point in the future.

The modern improvement of graphics and visuals has also created genuinely beautiful games. New 3D modelers and animators can portray humans, creatures, and other features in incredible detail and beauty. It is not 'non-art' just because it is also interactive; the architecture of cathedrals is considered art and can be interacted with.

Creating a game is collaborating with different artists and combining their artistic visions into one work. As more artists join in and the industry gains more cultural influence, the industry will undoubtedly put out even more works of art in the future.

Gimate-Welsh, A. (2022, June 24). Why videogames are art. Game Developer. https://www.gamedeveloper.com/game-platforms/why-videogames-are-art

Additional Media Links

AFTER 34 YEARS, SOMEONE FINALLY BEAT TETRIS

Description: This video explains the history of Tetris, what made it nearly impossible to get to the True Killscreen, and how a teenager beat the game.
AGameScout. (2023). After 34 Years, someone finally beat Tetris. [Video].
Retrieved from: https://www.youtube.com/watch?v=GuJ5UuknsHU

AUSTRALIAN CENTRE FOR THE MOVING IMAGE

Description: The official Instagram account for ACMI, a cultural center for motion and art. ACMI. (n.d.). @acmionline. [Instagram account].
Retrieved from https://www.instagram.com/acmionline/?hl=en

BLACK GIRL GAMERS

Description: The official Instagram account for Black Girl Gamers, an organization dedicated to heightening the voices of Black women in the gaming industry.
Black Girl Gamers. (n.d.). @theblackgirlgamers. [Instagram account].
Retrieved from https://www.instagram.com/theblackgirlgamers

CHINA RESTRICTS ONLINE GAMING BY MINORS

Description: This deep-dive news story covers the time limits set by the Chinese government on gaming, as well as the controversy and benefits of the legislation, and how this strategy contrasts with the attitude of the US government.
CGTN. (2021). China restricts online gaming by minors. [Video].
Retrieved from https://www.youtube.com/watch?v=vSEympbwMu8

ESPORTS: COULD IT BECOME MORE POPULAR THAN THE REAL THING?

Description: From the eSports stadium in Doha, reporters tune in with competitors and explain what makes eSports so popular.
Euronews. (2022). Esports: Could it become more popular than the real thing? [Video]. Retrieved from https://www.euronews.com/2022/06/23/esports-could-it-become-more-popular-than-the-real-thing

GAMING WITH DR. JANE MCGONIGAL

Description: A game designer and gaming scientist discusses games and how they factor into our social, mental, and emotional health, as well as the future of video games.
Ali Ward. (2024). GAMING with Dr. Jane McGonigal. [Podcast].
Retrieved from https://www.alieward.com/smologies/gaming

Additional Media Links

HOW I CONQUERED MY VIDEO GAME ADDICTION

Description: A doctor explains the mechanisms that lead to productivity, boredom, creativity, and behaviors that we might want to change and improve.
HealthyGamerGG. (2023). How I conquered my video game addiction. [Video].
Retrieved from https://www.youtube.com/watch?v=8PYhEWK2wVA&t=785s

HOW STRAY SUBVERTS VIOLENCE IN VIDEO GAMES | VIDEO ESSAY ON MY GAME OF THE YEAR

Description: This video essay explores how the game Stray deals with violence without a combat system, and how creative gameplay can make us reflect on our own society.
Filmotter (2022). How stray subverts violence in video games | Video essay on my game of the year 2022. [Video].
Retrieved from https://www.youtube.com/watch?v=9uVEibRp0bQ

HOW VIDEO GAMES CAN HELP KIDS LEARN AND GROW

Description: The chief scientist at iThrive Games talks about the psychology of games, how to keep gamers engaged in healthy gameplay, and how games can be part of the school curriculum to help build skills.
Rivers, S. (2024). How video games can help kids learn and grow. American Psychological Association. [Podcast].
Retrieved from https://www.apa.org/news/podcasts/speaking-of-psychology/video-games-kids-learn

HOW VIDEO GAMES CAN LEVEL UP THE WAY YOU LEARN

Description: This talk goes into the psychology of learning and how digital technology and games can improve higher education.
Alexander, K. (2023). How video games can level up the way you learn. TED. [Video].
Retrieved from https://www.youtube.com/watch?v=CkFnqGHZ5tA&t=306s

HOW VIRTUAL REALITY TRICKS YOUR BRAIN

Description: This explains how VR is different from a flat image on a screen and how it can create real reactions even without hyper realistic images.
Vox. (2020). How virtual reality tricks your brain. [Video].
Retrieved from https://www.youtube.com/watch?v=ybyib5pAq7Y

Additional Media Links

THE FUTURE OF GAME DEVELOPMENT

Description: A game designer walks through how open-source software like Blender helps produce games, and why it is different from paid subscription technology like Autodesk.
Brackeys. (2024). *The future of game development.* [Video].
Retrieved from https://www.youtube.com/watch?v=EYt6uDr-PHQ

I ASKED SAG TO EXPLAIN THE VIDEO GAME STRIKES

Description: In this interview, a video game performer and union leader explains why the Screen Actors Guild is striking regarding contracts with major video game studios and how fair contracts surrounding the use of GenAI can make the industry more sustainable.
Play, Watch, Listen+ with Alanah Pearce. (2024). I asked SAG to explain the video game strikes. [Video].
Retrieved from https://www.youtube.com/watch?v=AIR7S1sMgK0&t=619s

I'D RATHER BE GAMING | ACCESSIBLE VIDEO GAME PLAYING FOR DISABLED PLAYERS WITH HELP FROM ABLEGAMERS

Description: This introductory video shows how AbleGamers helps players with disabilities play video games.
AbleGamers. (2024). I'd rather be gaming | Accessible video game playing for disabled players with help from AbleGamers. [Video].
Retrieved from https://www.youtube.com/watch?v=7YyQZKI4KQs

THE OPPORTUNITIES AND CHALLENGES OF CHINA'S GAMING INDUSTRY

Description: This podcast goes into how the gaming industry is operating in China, in discussion with hosts in China, the US, and the UK.
Round Table China. (2024). The opportunities and challenges of China's gaming industry. *CGTN.* [Podcast].
Retrieved from https://radio.cgtn.com/podcast/news/1/The-opportunities-and-challenges-of-Chinas-gaming-industry/458634

STATISTICS SAY SCREENS AREN'T DESTROYING TODAY'S TEENS

Description: This video goes into how statistics determine if two things are correlated and how that maps to what we know about mental health and screen time in young people.
SciShow. (2019). Statistics say screens aren't destroying today's teens. [Video].
Retrieved from https://www.youtube.com/watch?v=SYLySBpGGM8

Additional Media Links

THIS STRIKE COULD DETERMINE THE FUTURE OF VIDEO GAMES

Description: Video game designers behind games like Call of Duty and Fortnight strike the unethical use of AI by studios, explaining what fair pay for AI use should look like.
More Perfect Union. (2024). This strike could determine the future of video games. [Video]. Retrieved from https://www.youtube.com/watch?v=W1ZO8GjRaVA

VIDEO GAMES CAN MAKE US BETTER... IF YOU USE THEM RIGHT

Description: This video explores the social benefits of video games and whether violent video games increase aggression in players.
SciShow. (2023). Video games can make us better... If you use them right. [Video]. Retrieved from https://www.youtube.com/watch?v=oofNHP94mXA

VIDEO GAMES HACK YOUR BRAIN (IN A FUN WAY)

Description: This video explains how video games can put you in a state of flow, and what that can tell us about concentration and enjoyment.
SciShow Psych. (2021). Video games hack your brain (in a fun way). [Video]. Retrieved from https://www.youtube.com/watch?v=lQoqYth4oWY

Discussion Topics

1. Do you or your family spend time gaming?
2. How much time is appropriate to spend gaming daily?
3. Are games useful for learning at school?
4. In your opinion, are violent games more likely to encourage violence outside of the gaming environment?
5. Would you enjoy a career developing games? Why or why not?
6. Which type of games do you prefer? Adventure? combat? building? exploring?
7. Have you ever participated in online, multiplayer gaming? How was the experience?
8. What is the preferred gaming platform for you and your friends? PC? Console? Phone?
9. Do you purchase in-game items to enhance your gaming experience?
10. Have you used a VR headset for gaming? What did you enjoy or dislike about the experience?

Use these prompts to spark thinking before, during, and after engaging in the research activities. All of the prompts can be adapted to either discussion or writing.

Learning Prompts - Activating

1. How has gaming changed over the past ten years?
2. Is gaming inclusive for all genders? For all ethnicities? Why or why not?
3. In what ways has technology improved the gaming experience?
4. Are there health risks with gaming?
5. Can gaming technology be used in other industries?
6. Is gaming an effective way to teach language skills? Math skills? Keyboarding skills?
7. Given the popularity of gaming worldwide, what is the environmental impact?
8. What are the benefits of competing in esports?
9. Where are most games designed and developed?
10. What are some of the different job opportunities available within the gaming industry?

Learning Prompts - Open Response and Writing

1. Should gaming content be regulated by the government? Should the government regulate gaming time spent? Why or why not?
2. What are the differences between learning how to fly or drive via a gaming situation as opposed to the actual experience? What are the pros and cons of each?
3. How can virtual gaming environments be used to teach job skills without potential real-world hazards?
4. Have you considered competing in esports? If so, explain where you envision yourself competing and how you would prepare.
5. In the future, gaming may incorporate blockchain technology to enable users to 'own' prizes earned in games and then sell or trade these items for money. Is this a technology you would utilize? How might that change how you participate in games?
6. Are social skills gained via online interactions more, less, or like those earned via in-person interactions? Do you find yourself acting differently with online friends than with in-person friends?
7. Cloud gaming is increasing in popularity. Have you purchased games using this platform? What are some advantages and disadvantages of this method for purchasing games?
8. Have you spent time playing the video games of your parent's generation? How do those games compare with the games your generation is playing?
9. Many games have branched into movies and television shows. Have you watched any of these game-based movies/shows? Does that increase your enjoyment of playing the game? Did you find greater than average enjoyment from watching the movie/show since you already had character knowledge?
10. Have you spent time gaming with friends in an arcade? In a home console setting? How do the experiences compare? What are some differences and some similarities with gaming in these different environments?

Assessment - Multiple Choice

Name _____

1. Which of the following is NOT a building block to learning using games?

a. context
b. motivation
c. memorization
d. autonomy

2. Negative effects from gaming disorder, according to the English National Health Service include all the following EXCEPT which one?

a. withdrawal from society
b. avoiding school and work
c. issues with family
d. headaches

3. Video games have been shown to improve skills in which of the following areas:

a. math
b. reading
c. language skills
d. all the above

4. Which of the following is not a benefit of playing a massive multiplayer online role-playing game (MMORGP)?

a. the ability to earn money
b. making friends
c. increase problem-solving skills
d. increase confidence

5. Which of the following is NOT an esports category?

a. fighting games
b. word games
c. strategy games
d. shooter games

6. What are the top three markets for esports?

a. China, Australia, and Europe
b. Singapore, China, and North America
c. China, North America, and Europe
d. Singapore, Australia, and Sweden

7. Which of the following is NOT a gaming company from Japan?

a. Atari
b. SEGA
c. Nintendo
d. Sony

8. Which of the following is the most important factor contributing to the increasing popularity of the gaming industry?

a. high cost of video game consoles
b. advances in mobile gaming
c. rise of traditional board games
d. decline in online games

9. What approximate revenue did the global video game industry generate in 2023?

a. $50 billion
b. $120 billion
c. $190 billion
d. $220 billion

10. Which of the following was most important in increasing mobile gaming's popularity?

a. availability of specialized hardware for mobile gaming
b. free-to-play games
c. high-end graphics
d. multiplayer-only game modes

Assessment - Multiple Choice

11. Which demographics will most likely engage in “casual gaming” through mobile phones and social platforms?

a. children under 10
b. teens and young adults
c. middle-aged adults and older adults
d. only professional gamers

12. Which of the following is NOT considered a “third place,” a safe social space away from school, home, or work?

a. public park
b. café
c. shopping center
d. online

13. Which of the following is considered a non-player character, or NPC, in gaming?

a. Mario
b. Pac-man ghost
c. Sonic the Hedgehog
d. Luigi

14. What is a key factor in the success of esports within the gaming industry?

a. rise of mobile gaming
b. online streaming platforms like Twitch and YouTube
c. popularity of casual games
d. declining interest in competitive gaming

15. That trend has contributed to the expansion of cloud gaming services, such as Xbox Cloud Gaming and Google Stadia?

a. declining internet speeds
b. increased demand for high-end PC hardware
c. enhanced cloud infrastructure and streaming technology
d. reduced interest in mobile games

Assessment - True/False

Name _____

_____ 1. The average age of a gamer in 2024 is 36.

_____ 2. China currently limits the amount of time children can use smart devices.

_____ 3. Compulsive gamers do not suffer from negative health effects.

_____ 4. The average age of people seen in the clinic to treat gaming disorders is between 13 and 17 years.

_____ 5. There is no connection between addiction to video gaming and ADHD.

_____ 6. Video games have been shown to reduce feelings of isolation.

_____ 7. The COVID-19 pandemic provided a turning point in public perception of video gaming.

_____ 8. Video games are a large part of the culture of Singapore, making Singapore a large developer of games.

_____ 9. The first Olympic Esports Week was held in 2023.

_____ 10. Gender discrimination is not common in gaming.

_____ 11. Across the gaming industry, there are more male characters than female characters.

_____ 12. The gaming industry makes more revenue than the film and music industries combined.

_____ 13. Esports is now considered a professional sport in many countries.

Assessment - True/False

Name _____

_____14. Virtual reality (VR) gaming has been a major success in the mainstream gaming market.

_____15. The metaverse is an online space only used by gamers.

_____16. The first video game ever created was Pong.

_____17.Game Boy took over the handheld console market in 1989.

_____18. Mobile gaming accounts for a larger share of the gaming market than console gaming.

_____19. Cloud gaming is a technology that allows players to play games directly from the cloud without needing a physical console or high-performance PC.

_____20. The gaming industry has a higher percentage of female players than male players worldwide.

Assessment - Fill-in-the-Blank

Name _____

1. Being able to make personal choices, or _____ has been shown to increase learning using games.
2. Game _____ allow people to express themselves in ways they may feel uncomfortable with in real life.
3. A Power of Play report stated that the number one reason people play games is ____.
4. The _____ _____pushed many people into gaming as a method to improve mental health and connection.
5. _____ tools have led to loss of jobs in the video games industry.
6. _____ has developed a new cultural policy called Revive that includes video games as an art form.
7. Many gamers consider games to be a _____ _____, a space that is separate from work or home.
8. Successful _____ gaming companies have shown that game development is not limited to large corporations.
9. The _____, while not yet fully functioning, is an exciting future world where many universes and games will be combined into one arena.
10. _____ _____ is a streaming method for gaming, much like Netflix is for movies.

Assessment - Answer Key

Multiple Choice

1. C
2. D
3. D
4. A
5. B
6. C
7. A
8. B
9. C
10. B
11. C
12. C
13. B
14. B
15. C

True/False

1. T
2. T
3. F
4. T
5. F
6. T
7. T
8. F
9. T
10. F
11. T
12. T
13. T
14. F
15. F
16. F
17. T
18. T
19. T
20. F

Fill-in-the-Blank

1. autonomy
2. avatars
3. fun
4. COVID-19 pandemic
5. GenAI
6. Australia
7. third space
8. indie
9. metaverse
10. Cloud gaming

Use these assessments as formative or summative assessments. Consider assessing learners at the beginning of the unit as a pre-assessment, and again at the end as a post-assessment to see their progress. Teachers can use these as graded assignments if needed.

FUTURE Problem Solving

Additional curricular resources

We hope you find this edition of our activity unit series to be a valuable resource as your students gather knowledge about Future Problem Solving topics of study.

Video Games Activity Unit

Our activity unit on this topic contains step-by-step lesson plans for research-based independent and collaborative work for use with students in a variety of settings, including out-of-school time. The publication includes 2 extra topic-related future scenes for practice, a variety of tools, research, and metacognition activities, and a variety of specific problem-solving step activities.

Global Issues Champions Series

This series showcases student written work for the 2024 Global Issues world champion team and individual competitors by division. Their full evaluations are included. To use this publication as a coaching tool, first review the Air Quality future scene with your students. Then ask students to complete a booklet using the future scene. You can do this as a mock competition or step by step as practice. For students looking to deepen their understanding of evaluations, we recommend that you give each team a copy of the student work, step by step. Ask students to identify strengths and weaknesses in the sample work based on their understanding of the scoring rubric. Review the evaluation concepts identified in each step and look at the scores and feedback from evaluators together.

Education Standards

Our Future Problem Solving process fulfills a wide variety of education standards. We take connecting with these standards into account when developing our program materials. Teachers can easily tailor Future Problem Solving content to meet their specific education system and local requirements as needed.

How our topics are selected

Our topics represent important challenges from business, civics, society, science, and technology and serve as the thematic basis for given problem solving situations. Each school year, students get 3-5 opportunities to solve important near-future global issues based on their progress in local and regional competitions. To be considered, a topic must be broad enough to appeal to participants living around the globe, offer a range of themes and issues to explore, and be considerate of a variety of views. Lastly, of course, every topic must be accessible for all, from ages 8 to adult.

We welcome submissions of topic ideas from anyone year round. Our topics committee reviews, refines, and categorizes submissions into our diverse strands. Then options are narrowed down and screened by our regional affiliate leaders. They pre-select top candidates for each of the category strands to present to our entire global community for a vote. The community's input, including students, heavily influences the final selection. We announce topics for the upcoming competition season March 1.

About Future Problem Solving

Future Problem Solving proudly celebrates over 50 years of placing more than a million young people at the core of a dynamic, purposeful learning experience. Each year K-12 students around the world participate in a variety of challenges designed to empower curious youth to become changemakers. Problem solvers learn how to think, not what to think, and gain skills they need to succeed in work and life. Our programs help young people develop their own voices and the confidence to use them.

To learn more about Future Problem Solving, to submit a topic idea, or contact us, visit fpspi.org.

FUTURE Problem Solving™

Surveillance

Civics & Society

RESEARCH UNIT

- Research
- Readings
- Resources
- Problem-Solving Tools

Supports all these programs

GRADES 4-12

Affiliate Finals Problem | 2025-2026

This publication is a compilation of the hard work of many people. Special thanks are extended to our curriculum author Kate Wolf.

Topic Contents

Surveillance

How might surveillance be used responsibly to balance public safety with privacy and ethical considerations in the future?

Research

Readings

Resources

Supplemental: Problem-Solving Tools

We strongly advise Future Problem Solving coaches and others using this content to review their educational organization's policies on appropriate content, and to screen any materials before making them available to students.

Cover Page: Freepix (Photo Credit)

Introduction

Background
Surveillance is the systematic and continuous monitoring, observation, or tracking of individuals, groups, or activities, often conducted by governments, businesses, organizations, or individuals. Surveillance uses various methods, including electronic surveillance, video monitoring, data collection, and even physical surveillance by law enforcement or intelligence agencies.

Context
Surveillance can serve legitimate purposes such as public safety, national security, and crime prevention, but it also raises significant privacy and civil liberty concerns. In the digital age, issues surrounding surveillance have become increasingly complex, as personal data and online behaviors are subject to investigation by both public and private entities. The struggle to balance between security and privacy is an ongoing debate, with discussions focused on defining the limits, legality, and ethical implications of surveillance practices, especially in the context of technology and the digital landscape.

Questions to Explore
What are the implications of surveillance for individuals and society?
After surveillance data is gathered, how should it be stored and distributed?
Beyond criminal investigation, what other applications does surveillance have?
How does surveillance vary from country to country?
How should surveillance be governed at an international level?

Use this publication as a starting point for research as your students gather knowledge about the topic of study. By the time of distribution, some of the information may change or become out-of-date. Keep in mind, however, that observing and studying the changes that take place in a given subject area over a few months or years can be an incredible asset to problem solvers who work with scenarios set in the future.

Themes and Concepts

Themes and concepts assist in organizing a lot of information into manageable threads or ideas, providing a complete picture or understanding of the subject.

CENTRAL THEME #1

Crime and control

Many governments, law enforcement agencies, security services, and other organizations use different types of surveillance. This technology is often used to deter crime or catch criminals, as well as to monitor extremist organizations that might threaten the safety of a nation. However, more and more, governments are using mass surveillance and collecting data on all people, not just those suspected of wrongdoing.

MAJOR CONCEPTS

At recent significant public events, including the Paris Olympics and Beyonce concerts in the UK, AI surveillance of crowds via live video feeds has been part of the security strategy.

Law enforcement claims to need surveillance to keep up with the demands of modern policing. However, facial recognition programs perform considerably worse for women and people of color than for white men, meaning that people of color are more likely to be misidentified and falsely accused of crimes.

Facial recognition has been used at political protests to round people up for minor offenses like parking tickets; this is a way of harassing leaders of political movements and generally intimidating people into being silent and compliant.

Social media is monitored explicitly by several governments, including China and Iran, which crack down on people expressing dissenting opinions online. This practice is becoming more commonplace in governments worldwide.

Themes and Concepts

CENTRAL THEME #2

Surveillance capitalism

Surveillance capitalism refers to an economic state that relies on collecting and selling personal information— the world we live in today. Social media companies, advertising agencies, technology companies, and data brokers work hard to harvest personal information from users online.

MAJOR CONCEPTS

Social media companies like Meta, TikTok, and Twitter/X collect a vast amount of personal information, from name and address to face scans to marital status. It is almost impossible to opt out of some data collection and use these services. These companies' business model relies on selling that information, and users do not choose where their data goes.

Social media is designed to use what it knows about you to manipulate you into feeling like you need to buy something and then serve you advertisements for that exact thing.

Even when a user does not explicitly give personal data, websites can still track their behavior and make accurate guesses about them using keylogging, mouse movements, and third-party cookies.

With so much information available about people online, hackers have a vast amount of data to try to collect; data breaches can lead to identity theft, financial fraud, and ransom of vital information like healthcare records.

Surveillance at schools and workplaces leads to less autonomy, worse learning outcomes, and lower employee satisfaction. Being constantly watched breaks trust; students who feel their schools don't trust them, in turn, do not trust their teachers and administrators. Workers have lower job satisfaction and may focus more on looking busy than doing their job.

Themes and Concepts

CENTRAL THEME #3

When surveillance gets it right

Despite its many drawbacks and serious concerns, surveillance can be essential for public health and safety. It is not likely that surveillance is going away any time soon. Information is vital to any crime investigation, and surveillance technologies are instrumental. Besides people, surveillance can also apply to animals and even diseases, helping protect our health and environment.

MAJOR CONCEPTS

Law enforcement often uses CCTV footage to track crime suspects and victims, which has been used to solve major crimes. Police claim that it is also an asset in fighting drug trade and human trafficking. However, how many cases are solved using CCTV or invasive social media surveillance is unclear.

Some studies show that, on average, the presence of obvious security cameras can reduce crimes such as vehicle vandalism and theft in the area by around 13%. It is unclear if those crimes are then displaced to other locations and violent crime is not significantly reduced.

Public health surveillance is used to track diseases, their spread, and the effectiveness of treatment and to make significant public health decisions that can prevent epidemics and pandemics. Accurate data is vital, and many of the same methods used to track people can help track outbreaks.

In areas where poaching is threatening wild animals, cameras set up with video feeds broadcast online for anyone to see are an effective means of catching poachers.

Themes and Concepts

CENTRAL THEME #4

Protecting data

Protecting your personal information as much as possible, primarily online, is vital. Governments and businesses are often unclear about how personal data is used and sold, and data breaches can expose your financial, personal, health, and other information to anyone. While it may not be possible to avoid tracking by facial recognition systems in the outside world, gaining control of the data we can protect is necessary.

MAJOR CONCEPTS

When using computers, it is recommended to safeguard privacy by avoiding cookies, regularly clearing your internet history and cache, and using browsers that avoid or delete third-party cookies.

If you install home security devices such as cameras and smart doorbells, ensure they are password protected.

Laws and regulations surrounding how governments and businesses use personal data are often unclear and outdated. Human rights organizations are pushing for more precise, robust regulations protecting privacy and personal data. In some places, this has led to better privacy laws, including banning live facial recognition in the EU.

Overview

Governments and other groups have historically used various methods to track, monitor, and understand populations and individuals. However, with modern technology and modern lives documented in detail online, surveillance is more common and invasive than ever. Security cameras, smart devices, phones, microphones, dash-cams, ID photos, websites, AI, and more all monitor society differently. In England, there may be as many as one security camera per fourteen people, though it is almost impossible to determine an accurate number. What is clear is that no matter where we go or what we do, someone may be watching.

Surveillance is often seen as a public good, and it does indeed have valuable applications. CCTV footage can help solve crimes that happen in public, and some studies show that it may also deter robbery and vandalism. It can help security and law enforcement respond to crimes quickly; for example, the Black Mamba Anti-Poaching Unit in South Africa has used publicly accessible livestreams to become alert of poachers in national parks. Public health organizations can also use similar technologies to track diseases and respond to epidemics and pandemics. Monitoring social media pages can help track and respond to extremist organizations. Police also use surveillance to track possible terrorists or criminal organizations. But this can get, and has gotten, out of hand.

Government and police misuse and overreach of surveillance are widespread. Governments of countries like Russia and China are famous for mass surveillance, primarily via social media. The Chinese government is widely criticized for using AI facial recognition and monitoring and censoring social media. They have been accused of genocide against Uhygur Muslims, a minority ethnic group, and areas with high Uhygur Muslim populations are under constant camera surveillance. Technology companies work with the government to develop more and more sophisticated tools for labeling and tracking people.

Our topics, determined with input from our global community as well as subject matter experts, represent important challenges from business, civics, society, science, and technology. We welcome ideas for future competition topics from everyone including students and coaches. Share your topic ideas and feedback at https://fpspi.org/topic-submission/

Overview

However, it is essential to remember that these methods are actively used by many other governments and law enforcement agencies worldwide, often with little oversight and no clear rules. The UK and US governments keep massive amounts of personal data on people who are not suspected of any wrongdoing and actively create databases of biometric data such as fingerprints, face scans, and more. MI5, England's domestic security agency, has been accused of grossly mishandling such data. We can see how surveillance technology entrenches biases in law enforcement. In India, police use of technology is making it easier to track and harass people of lower castes. Instead of creating more equitable policing, the technology makes it easier for police to target people who are already assumed to be suspicious, just based on their place in the social order.

A hot topic of surveillance debate is the use of facial recognition technology. Facial ID is used to match passports to their carriers at border crossings and to match camera footage of crimes to suspects. However, facial recognition algorithms are significantly less accurate in identifying Asian and Black faces than white ones, leading to false positives, more false arrests, imprisonment, and sentencing of innocents, which disproportionately affect minorities. Even when it works, the technology is contentious. In the US, police have used live facial recognition during mass political actions like Black Lives Matter protests to pick up protesters for unrelated, minor offenses like unpaid traffic tickets. These actions limit activism; when the government is watching, people are less likely to attend political protests in person, and journalists and activists are more likely to self-censor and avoid publishing dissenting views. Police use of facial recognition and other types of mass surveillance often enables and encourages violence against minorities and those protesting government actions.

Overview

Of course, law enforcement is only the tip of the iceberg regarding surveillance. The business model of online companies is to track customers and compile and sell their data. Online shops and sites often use keylogging and tracking mouse and scrolling movements to determine what customers are interested in. They can then analyze that data to determine things about customers they might not tell the company explicitly, such as age, marital status, number of children, where they live, and political views. According to the Federal Trade Commission, Facebook (Meta), WhatsApp, YouTube (Google), Twitter/X, and other social media companies surveil users. Their business model relies on collecting and selling user data to advertisers, who serve targeted advertisements on the same social media platforms. There is very little user control over personal data, who keeps it, or how it is used. We have also seen a rise in 'smart products,' such as speakers, thermostats, doorbells, and even air fryers. Companies that sell such products may make more money from selling the data they get when customers interact with the product than from product sales.

Human rights groups have been pushing against increasing surveillance worldwide for many years. But today, very few places have up-to-date laws regarding surveillance, especially for modern and developing tools like live facial recognition. Laws are patchwork and evolving much slower than technology.

Advocates of heavy mass surveillance may turn to the adage, 'If you have nothing to fear, you have nothing to hide.' But this ignores the reality of entrenched bias and the extreme lack of privacy that mass surveillance creates. Nearly anything can be construed as 'suspicious' if a person is part of a minority group or expresses a measure of dissent against a government. People should expect a reasonable degree of privacy and obscurity in their daily lives. As technology grows increasingly powerful and we sign away more of our data in agreements with tech companies, we must look carefully at what everyone loses when no life is private life.

Vocabulary

artificial intelligence (AI): a system that uses data and algorithms to perform a task or tasks normally done by humans, including reasoning, automation of workflow, data analysis, and pattern recognition

biometric data: data related to your physical body, such as an ID photo, fingerprint, iris scan, voice print, or DNA sample

census: a count of all people and households in a nation; many nations take a census every ten years and may include questions about personal information

closed-circuit television (CCTV): a system of video cameras that sends signals to a limited number of monitors

cookie: small files with data such as username and password that allow websites to identify a computer; one use of cookies is session management, and without them, users would have to log in to a site every time they visit, even while using the same computer

dash-cam: dashboard camera, a camera mounted inside a car to film traffic, often used to prove a driver's innocence in the case of a traffic accident

database: a collection of information or data

data breach: a security incident when unauthorized users gain access to private or confidential information such as personal data

data broker: an individual or company that collects personal data from public or private sources and sells or licenses that information, often to advertising companies

defendant: a person, company, or institution who is accused of a crime in a court of law

emotion recognition: facial recognition technology that attempts to assign emotions or motivations to different facial expressions

encryption: the process of converting information or data into a scrambled code that can only be unscrambled with a key

face surveillance: sometimes called live face surveillance or live facial recognition; facial recognition technology that identifies faces in videos and moving images

Vocabulary

facial recognition: technology that compares an image of a person's face to a database of faces in order to identify that person

hacker: a program or person who can get into a computer system without permission, often to gather data

intelligence: the ability to gather and apply information and skills

intelligence agency: a government agency that gathers information or intelligence for the purposes of national security and defense, e.g. MI5 and MI6 (UK), CIA and NSA (USA)

internet history: also called browser history, a list of web pages that a user has visited, including metadata, like page title and time of visit, which is usually stored by web browsers; users can usually go back to previously visited pages

internet of things (IoT): the connection between computing devices in different objects that send and receive data, such as GPS devices, cars, and appliances that are connected to the Internet

investigation: in law, the process of gathering data about a situation or person, usually to present in a court case

IP address: a unique string of characters that identifies each computer, allowing them to communicate over a network

keylogging: when a website monitors what a user types into a page before hitting the 'enter' or 'submit' button

law enforcement: various government agencies that are involved in preventing crimes and dealing with criminals, such as police force, courts, prisons, and security agencies

livestream: a video broadcast which shows what a camera is capturing in real time

mass surveillance: collecting and monitoring a large amount of information about a population, often without the knowledge or consent of the population

obscurity: the idea that personal data is safer when it is difficult to find or interpret

Vocabulary

personal data: sometimes called personal information; details about a person, possibly including their name, address, race, ethnicity, age, political affiliation, religion, financial information, and other details unique to that person

police brutality: when police officers use excessive, unnecessary force against a person or group, often leading to physical harm

smart device: an electronic device that is wirelessly connected to other devices or networks, which can interact with the user or other devices

surveillance: close observation of a person or their actions, including tracking their movements, purchases, internet history, or communications

surveillance capitalism: the economic system that relies on harvesting personal data from consumers and then monetizing that data by selling it to brands to target customers more efficiently

third-party cookie: a cookie that belongs to a domain different from the one displayed in the browser, usually used for tracking purposes

tracking device: an electronic device that allows someone to monitor the location of a person or object

virtual private network (VPN): a network that protects users by encrypting their data and masking their IP addresses

Interactivity:
A Quizlet containing all the topic vocabulary may be found here.

Use password: FPSPI
https://quizlet.com/1012800853/surveillance-flash-cards/?i=4351sf&x=1qqt

List of Articles - By Theme

A concerted effort was made to find recent articles from as many different perspectives as possible. While Future Problem Solving attempts to present a balance in the range of opinions, some sides of an issue are often more represented than others. This does not mean that Future Problem Solving supports that position. Future Problem Solving supports no position.

Central theme #1: Crime and control

- Australia's surveillance laws: Let's hear from those at the pointy end before the spies
- Cardiff Beyonce concert: Face recognition use criticized
- CCTV cameras in Singapore set to more than double by 2030 following use in crime solving successes
- Face recognition technology follows a long analog history of surveillance and control based on identifying physical features
- How many CCTV cameras are in London?
- MI5 breached surveillance laws for more than a decade, Tribunal told
- Reform of Australia's electronic surveillance framework
- Settled habits, new tricks: Casteist policing meets big tech in India
- Social media surveillance
- 'There's cameras everywhere': Testimonies detail far-reaching surveillance of Uyghurs in China

Central theme #2: Surveillance capitalism

- 'High-surveillance' schools lead to more suspensions, lower achievement
- How facial recognition technology works
- Internet surveillance in the workplace: 43% report having their online activity monitored in 2025
- Is your air fryer spying on you? Concerns over "excessive" surveillance in smart devices
- The rise of facial recognition in retail: What shoppers should know
- The slow death of surveillance capitalism has begun
- Social media and online video firms are conducting 'vast surveillance' on users, FTC finds
- Student privacy laws: Protecting confidentiality and rights
- Surveillance Education tracks the rise of spying technology in schools
- Surveillance is pervasive: Yes, you are being watched, even if no one is looking for you
- What is surveillance capitalism?

Central theme #3: When surveillance gets it right

- 6 types of surveillance for investigations explained
- How CCTV played a vital role in tracking Sarah Everard — and her killer
- Surveillance safari: Crowdsourcing an anti-poaching movement in South Africa
- Video doorbells: Police champion them but do they cut crime?
- WHO launches global network to detect and prevent infectious disease threats

Central theme #4: Protecting data

- AI facial recognition: Campaigners and MPs call for ban
- Internet surveillance: Why privacy matters and how you can secure yours
- Limiting face recognition surveillance: Progress and paths forward
- The movement to limit face recognition tech might finally get a win
- Time to ban facial recognition from public spaces and borders

List of Articles - Alphabetical Order

6 types of surveillance for investigations explained
AI facial recognition: Campaigners and MPs call for ban
Australia's surveillance laws: Let's hear from those at the pointy end before the spies
Cardiff Beyonce concert: Face recognition use criticized
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How CCTV played a vital role in tracking Sarah Everard — and her killer
How facial recognition technology works
How many CCTV cameras are in London?
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'There's cameras everywhere': Testimonies detail far-reaching surveillance of Uyghurs in China
Time to ban facial recognition from public spaces and borders
Video doorbells: Police champion them but do they cut crime?
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WHO launches global network to detect and prevent infectious disease threats

Information is a summary of the original article. It is up to the reader to determine which facts and ideas to accept. Future Problem Solving encourages coaches and teachers to preview the article summaries and links to determine whether all information is appropriate for their students. Efforts were made to minimize the sensitivity of the summaries' contents; however, different standards of acceptability apply to each individual student, coach, and community. Please use your discretion with these materials. ***Information is listed in alphabetical order by article title.***

Article Summaries

6 types of surveillance for investigations explained

Investigating criminals and suspicious activity can sometimes require surveillance, and investigators use different tools and methods. Investigators use surveillance to get more information about people, groups, and environments. These tools can help uncover evidence that is needed to convict a criminal.

- Physical surveillance observes people and places in person, such as when an investigator follows a subject around
- Electronic surveillance relies on devices like cameras, microphones, and GPS trackers
- Computer surveillance monitors internet history and online activities like emails.
- Social media surveillance gathers information about a subject through social media accounts that are not protected by expectations of privacy.
- Financial surveillance consists of checking transactions and is used in cases of money laundering and other financial crimes.
- Biometric surveillance involves identifying people using physical characteristics like fingerprints and facial recognition; CCTV is one type of biometric surveillance.

Investigators can use various tools to conduct all these types of surveillance. Often, they will have a car to follow subjects. They might also use a GPS tracker, which can be planted on a subject's vehicle, binoculars, audio recorders, and cameras. They might also use a computer to log information, possibly with a VPN, to protect their privacy while investigating.

Not all these tools are legal in all circumstances. Investigators must have a legitimate reason to place a GPS tracker, which can only ever be on a vehicle, not on a person themselves. Investigators can only use audio recorders and cameras in certain situations, often only in public places where the subject would not reasonably expect privacy. Different states have different laws about what evidence is allowed. Social media posts are permissible evidence in most areas because they are considered public information.

6 types of surveillance for investigations explained. (2023, April 25). NITA. https://investigativeacademy.com/6-types-of-surveillance-for-investigations-explained/

Article Summaries

AI facial recognition: Campaigners and MPs call for ban

A group of politicians and campaigners in the UK are calling for an immediate ban on facial recognition surveillance. However, the UK government recently announced that they plan to allow police access to passport photo databases. The Home Office says that facial recognition has led to criminals being caught, and a government spokesperson said it can help search for missing people. Facial recognition cameras can scan faces in public and compare those faces to databases of 'watch lists.' Police claim they inform citizens about camera use by displaying physical notices that alert people they are entering areas where cameras are being used.

Policing Minister Chris Philip also wants police to access a broader range of databases. Campaigners are vehemently opposed to this move. There is serious concern that this technology is a tool of authoritarian governments, and campaigners say that it amounts to putting everyone in a permanent police line-up. UK law enforcement agencies are already under criticism for their use of live facial recognition at significant public events. They claim that the data of people not on a watch list is 'immediately deleted.' Some large companies have defended using live facial recognition in stores, saying it helps cut crime. In Europe, live facial recognition using AI is banned.

Rahman-Jones, I., & McMahon, L. (2023, October 5). AI facial recognition: Campaigners and MPs call for ban. BBC News. https://www.bbc.co.uk/news/technology-67022005

Article Summaries

Australia's surveillance laws: Let's hear from those at the pointy end before the spies

Australia has a new independent monitor for national security legislation, Jake Blight. Blight says he focuses on meeting non-government groups, not intelligence agencies, at the start of his new position. His role covers laws around espionage, foreign interference, sabotage, and secrecy offenses. Many non-governmental groups, like the media, are affected by those laws. Blight says security agencies will need ways to get around end-to-end communications encryptions.

Taylor, J. (2023, December 2). Australia's surveillance laws: Let's hear from those at the pointy end before the spies. The Guardian. https://www.theguardian.com/australia-news/2023/dec/03/australias-surveillance-laws-lets-hear-from-those-at-the-pointy-end-before-the-spies

Article Summaries

Cardiff Beyonce concert: Face recognition use criticized

The South Wales Police are set to use live facial recognition cameras at a Beyoncé concert in Cardiff to identify people wanted for 'priority offenses.' There will be around 60,000 people at the concert. The system uses AI to compare faces in the crowd to a database of people on a 'watch list.' The police say that for those not on the watch list, all biometric data will be immediately deleted, though the original footage will be kept for one month. They add that officers, not AI, decide to stop someone based on the alert.

This technology is not available or used everywhere. In Europe, live facial recognition technology is banned in public spaces. Police Scotland says that it does not use live facial recognition. The Metropolitan Police in London used this technology at King Charles's coronation; however, they published that advance notice would be given before its use.

Human rights campaigners call for a halt to using live facial recognition, saying that not enough has been done to prevent bias in this technology. The Policing Minister for the UK and the home office are working to embed facial recognition in policing. In 2023, the National Physical Laboratory (NPL) stated that the technology had improved significantly. They claim this technology could be used without bias against race and gender.

Despite this, human rights groups are still pushing back. A lawyer for the human rights group Liberty says that facial recognition does not improve safety; it entrenches discrimination and violates people's privacy for the sake of very few arrests. Bias is still a concern, and there is low public confidence in the technology. Scotland's Biometrics and Surveillance Camera Commissioner has also expressed concerns about the technology. There are insufficient regulations on how the government and law enforcement use facial recognition.

Vallance, C., & Gillibrand, P. (2023, May 17). Cardiff Beyoncé concert: Face recognition use criticized. BBC News. https://www.bbc.co.uk/news/uk-wales-65622404

Article Summaries

CCTV cameras in Singapore set to more than double by 2030 following use in crime solving successes

Police surveillance cameras were introduced to Singapore in 2012. In the decade since they were introduced, the Singapore Police Force (SPF) says that they have helped to solve over 5,000 crimes. By 2030, the government plans to double the number of cameras in Singapore. The SPF says that physical crimes like harassment, burglary, and property damage have decreased by over 50% since 2015. The surveillance system also helps officers respond to incidents more effectively. Video analytics technology is improving, making the network more sophisticated.

CCTV cameras in Singapore set to more than double by 2030 following use in crime solving successes. (2021, November 26). IFSEC Global. https://www.ifsecglobal.com/video-surveillance/cctv-cameras-in-singapore-set-to-more-than-double-by-2030-following-use-in-crime-solving-successes/

Article Summaries

Face recognition technology follows a long analog history of surveillance and control based on identifying physical features

The US police do not always have to reveal that they have used facial recognition technology to identify criminal suspects. However, technology can fail, leading to wrongful convictions in multiple cases. Facial recognition is a type of biometric surveillance. Along with things like fingerprints and passport photos, it is a way to decide who has the right to move freely. It turns photos or videos of faces into data points compared to other face data already in the system.

This may be helpful technology in some cases, but overall, the people targeted by this technology are already disproportionately marginalized. In 2019, facial recognition misidentified Asian and Black people at a rate 100 times higher than it misidentified white faces. With more images in databases and the use of AI, error rates are decreasing, but the bias is still there. The entire idea of surveillance assumes that some people need to be tracked and that less privacy means more security. Early systems, like fingerprinting, passport photographs, and body measurements, required the person being tracked to participate. Facial recognition changed that; the tracked person might not know they are being surveilled. The CIA did early research and funded face recognition software for border surveillance. Recently, private companies have gotten into facial recognition for data harvesting to be used to leverage personal data for profit. The systems that use and design facial recognition are now watching everyone and paying greater attention to those that might be deemed a risk to the structures in power.

Pearl, S. (2024, January 19). Face recognition technology follows a long analog history of surveillance and control based on identifying physical features. The Conversation. https://theconversation.com/face-recognition-technology-follows-a-long-analog-history-of-surveillance-and-control-based-on-identifying-physical-features-217226

Article Summaries

‘High-surveillance’ schools lead to more suspensions, lower achievement

In the US, where school shootings have become commonplace, school campuses might wish to increase security and surveillance measures. However, research shows that these methods are harmful to academic progress, especially for Black students.

‘Surveillance’ can mean many things in schools, such as metal detectors, random drug tests, dog sniffs, keeping students on campus during lunch and free periods, strict dress codes, and ID badges for students and staff. However, these methods tend to address general fears rather than specific problems. The American Education Research Association found that schools with tight security and high surveillance have higher suspension rates and lower math performance than other schools. Students in high-security schools were also less likely to enroll in or graduate from college. Students feel less safe in schools with conspicuous surveillance like metal detectors. These adverse effects are also more likely to be experienced by Black students, who are more than four times more likely than white students to attend high-surveillance schools.

Surveillance in schools increased significantly after high-profile school shootings like Sandy Hook and Columbine High School. These shootings took place at primarily white, suburban schools. But security measures increased most at schools with predominantly students of color— not suburban, white schools. Black students are also more likely to be suspended and even arrested than peers of other races.

While it is logical that schools with worse misbehavior problems might need tighter security, studies show that high-surveillance schools suspended more students even when overall misbehavior rates were the same. Surveillance systems can make it even more challenging to implement restorative justice systems. They do not drive reconciliation or improve overall disorderliness in schools.

Sparks, S. (2021, April 21). ‘High-surveillance’ schools lead to more suspensions, lower achievement. Education Week. https://www.edweek.org/leadership/high-surveillance-schools-lead-to-more-suspensions-lower-achievement/2021/04

Article Summaries

How CCTV played a vital role in tracking Sarah Everard — and her killer

Sarah Everard was a young woman who was kidnapped and murdered in London in 2021. Later, CCTV helped police find her body and her killer. CCTV from a passing bus showed her standing next to a rental car, which was traced back to her killer, Wayne Couzens.

The role that CCTV played in finding Everard's killer also highlights the prevalence of surveillance in the UK. There may be as many as five million surveillance cameras in the UK as of 2021, with residents filmed as many as 300 times daily. Doorbell cameras, dash-cams, cameras inside stores, and petrol stations all captured images of Everard and Couzens.

CCTV helps to solve around 16% of crimes. In Everard's case, it was well-suited to solving the crime, but it has a lot of limitations. It is most helpful in solving crimes in public, not private spaces. It is also unclear if CCTV is effective at preventing crime in the first place, and many UK councils have cut camera usage because they are expensive. There are rising concerns about the number of CCTV cameras in the UK and the lack of regulations surrounding them.

Townsend, M. (2021, October 2). How CCTV played a vital role in tracking Sarah Everard – and her killer. The Guardian. https://www.theguardian.com/uk-news/2021/oct/02/how-cctv-played-a-vital-role-in-tracking-sarah-everard-and-her-killer

Article Summaries

How facial recognition technology works

Facial recognition might look easy and accurate in crime shows, but it is not a straightforward technology. The first step is differentiating between the photo's face and background. Then, technology must measure features of the face, such as the distance between the eyes, the nose's width, and the jawline's length. These features are called nodal points. In early versions of technology, facial recognition systems compared a 2D image with another 2D image from a database, trying to determine if they were the same person. That meant the face needed to look directly at the camera, and the two photos needed similar lighting conditions. However, facial recognition is not used in controlled environments. Actual images from security cameras are often low quality, in low light, and at strange angles.

These days, facial recognition uses a 3D model for more accuracy. It focuses on areas of bone and rigid tissue (like eye sockets, nose, and chin), which change less over time than softer parts of the face. Because the 3D model uses depth, it is less affected by lighting and can recognize faces at different angles.

Skin biometrics can help verify matches as part of this system. Surface texture analysis (STA) can make facial recognition more precise by looking at the uniqueness of skin texture. A 'skinprint' (a picture of a skin patch) is measured and converted to code like the nodal points of facial recognition. Combined with other aspects of facial recognition, this can help the system ignore changes in facial expression, growth of facial hair, and eyeglasses. Poor lighting, insufficient resolution, and covering parts of the face (with sunglasses or hair) could still affect the system's accuracy. Different products have features that might correct lighting conditions or adjust for other changes.

Article Summaries

While facial recognition was mainly used by law enforcement in the past, it is now more widely used in government agencies. It is used in immigration to identify known criminals and suspected terrorists; anyone entering the United States will be checked against these databases, as well as against their visa data. Some companies are using it to track employees' time and attendance. It is used as security for ATMs and banks, potentially helping reduce fraud. However, there is always the risk of false matches, which can lock users out of their accounts. There are also serious privacy concerns, mainly when facial recognition is used without the knowledge or consent of those being imaged. Its benefits may not be worth the risks to liberty.

Bonsor, K., Johnson, R., & Taras, Z. (2024, April 17). How facial recognition technology works. HowStuffWorks. https://electronics.howstuffworks.com/gadgets/high-tech-gadgets/facial-recognition.htm

Article Summaries

How many CCTV cameras are in London?

Clarion Security Systems (Clarion UK) submitted freedom of information requests to understand the number of CCTV systems operating in London. As of 2022, nearly 9.5 million people live in London. In the same space, there are almost 21,000 public-operated CCTV cameras. Over 15,000 are in the London underground, and 3,000 are attached to police buildings. The Metropolitan Police also operates around 24,000 body cameras. Most street cameras are owned and operated by local councils. Clarion UK estimates that, on average, a person in London will be caught on camera around seventy times daily. Since 2012, there has been an over 200% increase in the number of CCTV cameras in operation.

Finding out the number of public-operated cameras is simple. However, it is difficult to determine the number of cameras used by private businesses and households because they do not need to register surveillance systems with the government. However, Clarion UK estimates that there might be as many as seventy private CCTV cameras for every public-operated camera. In total, that means that there could be as many as 4.4 million CCTV cameras in London. However, that estimate is most likely higher than the actual number. A more likely estimate would be around 940,000 CCTV cameras, or around one camera per ten people.

There are a few reasons why surveillance may have gone up in recent years. People installed more CCTV cameras in their homes across the UK during the COVID-19 pandemic. People are more concerned about security, and CCTV can also help detect and deter crime if appropriately used.

Billinge, S. (2022). How many CCTV cameras are in London? Clarion Security Systems.
https://clarionuk.com/resources/how-many-cctv-cameras-are-in-london/

Article Summaries

Internet surveillance: Why privacy matters and how you can secure yours

Recently, more and more countries have introduced different forms of surveillance, from CCTV to internet monitoring. Many groups, from the government to cybercriminals, can track online data. Organizations also harvest data to improve business. It is essential to understand your digital footprint to ensure the privacy and safety of your data.

Different organizations want different information, but many have similarities. First, organizations and cybercriminals wish to harvest your personally identifiable information (PII), like your name, address, date of birth, and phone number. Cybercriminals can use PII for identity theft and other offenses. Second, your internet activity can be valuable information to government agencies (who might be looking for 'suspicious' activity like looking for extremist details online) and many businesses that can advertise to you based on your tastes. Third, emails can be a weakness. Businesses might collect legitimate surveys, but cybercriminals can use phishing emails to collect your data, including passwords. Fourth, financial transactions can show information like your credit card details and shopping habits, leaving you at risk of malware and other cybercrime. Finally, medical data is often stored electronically and can be very sensitive if leaked to the public.

All these areas might contain vulnerable information. Legally, there are regulations on how organizations can collect and use personal data, and the biggest threat to privacy is significant data breaches from things like cyberattacks. Neither internet surveillance nor cybercrime is going to go away any time soon. Cybersecurity is critical, and there are a few steps you can take to safeguard your information.

Article Summaries

First, it is essential to choose a secure browser. The Tor project browser is a safe choice that helps prevent hackers from tracking you through your IP address. If using other browsers, accept as few cookies as possible and clear your cookie cache and browser history regularly so that there is less data to harvest. If you purchase or submit sensitive information to a website, check the address bar. You should only use HTTPS URLs; HTTP sites are less secure. When choosing a search engine, Google might be the most popular, but it is hardly the most secure choice. Google conducts a lot of internet surveillance, and more private search engines will monitor and advertise to you less. You can also use a VPN that hides your IP address, offering better data protection.

Bunnell, J. (2023, January 2). Internet surveillance: Why privacy matters and how you can secure yours. PECB Insights. https://insights.pecb.com/internet-surveillance-why-privacy-matters-and-how-you-can-secure-yours/

Article Summaries

Internet surveillance in the workplace: 43% report having their online activity monitored in 2025

Nearly half of all employees in the US report that their employers monitor their online activity. Hybrid workers who split their time between working from home and working from the office report higher monitoring levels. Fully remote workers report less surveillance overall. There is also a lack of communication about surveillance policies; only 32% of employees reported having clear guidelines about how online activities were monitored in the workplace.

Employers measure different types of activities. The main thing tracked is time, with employers keeping track of employees' active work hours. The second most common thing is websites visited. Partly, this is done to maintain security and ensure employees use work devices appropriately. 32% reported that chats and messaging logs are monitored, and the same number reported that employers monitored their real-time screens. Employers also check incoming and outgoing emails, as well as what apps employees are using and when.

There is a lot of variety in employee responses to being monitored at work. While many of these checks can be necessary to ensure data is being kept secure, employers need to balance their business needs with their workers' rights.

Haan, K. (2024, March 25). Internet surveillance in the workplace: 43% Report having their online activity monitored in 2025. Forbes Advisor. https://www.forbes.com/advisor/business/software/internet-surveillance-workplace/

Article Summaries

Is your air fryer spying on you? Concerns over "excessive" surveillance in smart devices

The consumer group Which? tested smart devices to see how their audio recording systems connected to other networks. They found that a smart air fryer provided by the company Xiaomi had an app that connected with trackers for Facebook and TikTok ad networks. It and another air fryer from Aigostar sent personal data to servers in China. They also looked at smartwatches and digital speakers, highlighting location trackers, audio recording access, and access to stored files given through phone permissions. These tests show that products do not meet standards for data protection.

The UK Information Commissioner's Office (ICO) is creating new guidelines for manufacturers of smart products. Which? also called for enforcement of these policies for UK and foreign companies. More and more consumers are buying smart devices, like camera-enabled doorbells and smart TVs. The ICO encourages buyers to check to make sure such devices have a physical off-switch to prevent them from audio recording. They also point out that sometimes products will request unnecessary specific permissions during setup, and it is safer to keep them turned off.

Booth, R. (2024, November 4). Is your air fryer spying on you? Concerns over "excessive" surveillance in smart devices. The Guardian. https://www.theguardian.com/technology/2024/nov/05/air-fryer-excessive-surveillance-smart-devices-which-watches-speakers-trackers

Article Summaries

Limiting face recognition surveillance: Progress and paths forward

Half of the federal law enforcement agencies in the United States used face recognition technology as of 2022. The spread of this invasive technology threatens the human right to privacy.

Some states have limited the use of this type of technology. In 2017, only Oregon had laws regarding face recognition, but more than twelve other states have now limited face recognition surveillance to some degree. In places, it can only be used to investigate specific crimes, and it is required to tell the defendant if facial recognition technology was used. Vermont has almost totally banned facial recognition except in very extreme circumstances.

Congress must work to enact further limits. The FBI, Immigration and Customs Enforcement (ICE), and Customs and Border Protection are not governed by state law; they are only federal. State laws do not entirely safeguard citizens' rights either. The Center for Democracy and Technology recommends pausing face recognition surveillance for now, analyzing risks, and deciding on rules for how it is used. They have a set of six measures that they recommend.

Article Summaries

1. A warrant should be required to use face recognition technology as it is for searches, wiretaps, and monitoring private correspondence.
2. This technology should be limited to investigating serious offenses as it is for wiretaps.
3. Law enforcement must be transparent about their use of this technology.
4. Facial recognition should never be the only reason a person is arrested.
5. Untargeted scans should be prohibited. An untargeted scan is when investigators are not looking for a single target but instead identifying everyone in a video or image.
6. This technology must be tested, and its accuracy must be improved. There must be higher standards to ensure accuracy for everyone regardless of gender, race, ethnicity, or age.

Laperruque, J. (2022, August 23). Limiting face recognition surveillance: Progress and paths forward. Center for Democracy and Technology. https://cdt.org/insights/limiting-face-recognition-surveillance-progress-and-paths-forward/

Article Summaries

MI5 breached surveillance laws for more than a decade, Tribunal told

The human rights organizations Liberty and Privacy International have told the Investigatory Powers Tribunal that MI5 (the UK's domestic counterintelligence and security agency) has breached surveillance laws, and the Home Secretary has issued unlawful bulk surveillance warrants for years. Liberty and Privacy International said that MI5 had retained data longer than allowed and breached safeguards around who had access to this data. MI5 admitted during the tribunal that it stored the public's data when it had no legal right to do so and did not disclose this information to the Home Office.

This information came to light in a separate legal challenge to the Investigatory Powers Act 2016 (IPA, aka the Snoopers' Charter). During that case, the government admitted that MI5 had unlawfully retained and mishandled data. At that time, documents showed that MI5 referred to its data stores as 'ungoverned spaces.' Since then, further documents have revealed more of the scale of this mishandling. As far back as 2010, MI5 has been aware of these failings, but it took many years for them to fix the issues.

It is not clear whose data has been mishandled, but because MI5 has such broad surveillance, it likely includes the personal data of people not suspected of any crimes. Home Secretaries, who must approve surveillance warrants by MI5, have also been overlooking MI5's safeguarding breaches. They ignored the unlawful way MI5 mishandled data and continued signing off warrants.

Liberty and Privacy International are calling for unlawful surveillance warrants to be halted and for data that was retained unlawfully to be destroyed. They also wish for the IPA to be declared illegal because it does not work. A lawyer for Liberty points out that these safeguarding failures show that the IPA and other surveillance laws are unfit for purpose and that mass surveillance breaches privacy without making us safer. The legal director of Privacy International agreed, calling for an overhaul of the laws.

Liberty. (2022, July 25). MI5 breached surveillance laws for more than a decade, Tribunal told. The National Council for Civil Liberties. https://www.libertyhumanrights.org.uk/issue/mi5-breached-surveillance-laws-for-more-than-a-decade-tribunal-told/

Article Summaries

The movement to limit face recognition tech might finally get a win

In 2020, 18 cities in the US enacted laws that forbid police from using facial recognition. Since then, the movement to ban facial recognition has slowed down. It is unlikely that the technology will be banned at a federal level. The use of surveillance technology is growing and becoming more and more ingrained in our lives.

Many groups have been concerned about the use of facial recognition for years. It is a risk to privacy and can track people in real-time. The company Clearview AI changed policing in the US in 2018 when it gave free trials of its facial recognition software to law enforcement agencies nationwide. Evidence was growing that the technology was worse at identifying women and people of color than white men. In 2019, San Francisco banned police use of facial recognition. By 2020, seven cities in Massachusetts had followed suit. Even major tech companies like Amazon, Microsoft, and IBM supported the bans and pulled the technology from shelves.

Since 2020, we have become more comfortable using facial recognition daily. At the same time, law enforcement has become more vocal about the value of facial recognition in modern policing.

Ryan-Mosley, T. (2023, July 20). The movement to limit face recognition tech might finally get a win. MIT Technology Review. https://www.technologyreview.com/2023/07/20/1076539/face-recognition-massachusetts-test-police/

Article Summaries

Reform of Australia's electronic surveillance framework

In 2022, Australia's laws around electronic surveillance went under reform. The government wanted to create more precise laws around how law enforcement and intelligence agencies access information and respond to national security threats. The Attorney General's Department has a task force for this project to protect privacy and promote transparency.

With the significant changes brought on by internet communications, laws need to keep pace. Law enforcement can conduct electronic surveillance, but regulations around this practice are outdated and too complex. Criminals and extremist organizations adapt to new technology quickly; the law must also keep Australian communities safe and ensure that electronic surveillance is used appropriately.

The recommendation is to repeal the current law and parts of several acts and replace them with one single act. The act will better protect information and data and be clear and transparent for agencies that must comply. It will be as modern and technology-neutral as possible. It will have appropriate controls and safeguards and ensure that law enforcement and security agencies have adequate powers to disrupt and investigate serious crimes and security threats.

Reform of Australia's electronic surveillance framework. (n.d.). Australian Government, Attorney-General's Department. https://www.ag.gov.au/crime/telecommunications-interception-and-surveillance/reform-australias-electronic-surveillance-framework

Article Summaries

The rise of facial recognition in retail: What shoppers should know

Facial recognition is being used more and more in shopping and travel. Everywhere you shop, you are likely to be on CCTV. Now, CCTV also uses facial recognition. The CEO of a facial recognition and AI security software company notes that this increase comes after a spike in thefts. Business owners told researchers that they are concerned about theft. This technology is considered more precise than eyewitness accounts.

Customers use facial recognition daily, from face verification to unlock their phones to checking in at the airport. Retailers can add known shoplifters to facial recognition software databases, which can then be used to detect and notify appropriate personnel. Violence in stores affects everyone present, and facial recognition can help retailers spot potential threats and deter theft.

It is important to note that facial recognition technology should not replace human judgment. Retailers must stay up to date with privacy policies and laws and ensure users receive training for the use of the technology. They should also communicate with customers about how facial recognition is used in stores.

Riordan, D. (2024, October 21). The rise of facial recognition in retail: What shoppers should know. Forbes. https://www.forbes.com/councils/forbestechcouncil/2024/10/21/the-rise-of-facial-recognition-in-retail-what-shoppers-should-know/

Article Summaries

Settled habits, new tricks: Casteist policing meets big tech in India

Note: The full article includes descriptions of police violence that may only be suitable for more mature readers.

In India, police records are becoming digitized. However, the new databases and more advanced surveillance systems are created with rigged, biased data. People of some castes are assumed to be criminals already and are tracked. There is a total absence of regulations on this technology, so India's caste system is now troubled with a digital caste system.

India's constitution protects citizens' equality and freedom from discrimination based on caste, race, or religion. However, it has been challenging to move past the caste system, which is part of life in India and has made equality almost impossible for some communities. In the 1800s, the British colonial government categorized some people as 'hereditary criminals' (criminals from birth). When policing control was released to India's police force, the same communities remained targeted. Those at the bottom of the caste system experience police violence daily. Records of 'habitual offenders' (HOs) are now digitized into the Crime and Criminal Tracking Network and Systems (CCTNS). Instead of starting an objective, error-free algorithm, the vast amount of data collected on the lower castes has created a biased system. The CCTNS is just a more efficient way of carrying out the same biased policing that has happened since the British colonial government implemented the police force. And the police operate without a clear legal framework for their surveillance technology.

Article Summaries

Another advance in technology is the use of CCTV. Most large cities in India have CCTV on busy streets, intersections, and markets to replace in-person surveillance by police. Theoretically, it is used to improve security and protect women's safety. In reality, it is used to surveil marginalized communities, such as the surveillance of Muslim neighborhoods during the COVID-19 pandemic. Police use violence against women to justify heavy surveillance, but criminal law does not address violence against women, so perpetrators are rarely convicted. Women from marginalized communities are the most vulnerable, receive no support from the criminal justice system, and are harassed and beaten by police.

People often think of technology as neutral, but these digital systems target specific communities because they are fed by data that targets those communities. Better technology means the police are better at doing what they have always done, deepening biases and reinforcing hierarchies. Even the police do not have a good grasp on how many digital systems are being used, how data is uploaded, or what the aim is to collect so much data on citizens. However, because these systems are so easily accessible and interlinked, they can be used to justify discrimination in housing, education, employment, and more. We must work against these systems and challenge these forms of inequality.

Bokil, A., Khare, A., Sonavane, N., Bej, S., & Janarthanan, V. (2021, May). Settled habits, new tricks: Casteist policing meets big tech in India. TNI Longreads. https://longreads.tni.org/stateofpower/settled-habits-new-tricks-casteist-policing-meets-big-tech-in-india

Article Summaries

The slow death of surveillance capitalism has begun

In 2023, the European Union required that Meta (the company behind Facebook and Instagram) change its approach to personalized advertising. This requirement comes after the 2018 introduction of Europe's privacy law, the General Data Protection Regulation (GDPR), and is a significant ruling that comes with major fines for Meta.

As of 2023, Meta users had to agree to personalized advertising as part of the terms of service; without accepting, the products cannot be used. However, Ireland's data watchdog ruled that it violates GDPR to bundle personalized ads with terms of service. While Meta will likely appeal the decision, privacy activists celebrate the ruling. Many believe Meta's only choice is to use the system Apple switched to in 2021. Apple now asks users explicitly if they want to be tracked, and research shows that at least half, and maybe as many as 90%, declined to be tracked. However, Meta declared that instead of changing its policies, it would simply have to find a new way to justify its existing operations. If Meta follows Apple's lead, advertisers' profits will decrease.

Google is also trying to change how advertising cookies work. However, Google also claims that it cannot move away from personalized advertising because it would mean that publishers would not have enough funding.

In the future, tracking and personalized advertising could become opt-in. That would allow customers to choose what businesses could use their data. Other organizations are pushing for tracker-free advertising, which shows ads based on the context of where they are placed (e.g., an article about cars might feature car ads). However, it is still unclear what this EU ruling means for the future of online advertising.

Meaker, M. (2023, January 5). The slow death of surveillance capitalism has begun. Wired.
https://www.wired.com/story/meta-surveillance-capitalism/

Article Summaries

Social media and online video firms are conducting 'vast surveillance' on users, FTC finds

The Federal Trade Commission has reported on nine tech companies: Facebook, WhatsApp, YouTube, Discord, Reddit, Amazon, Snap, TikTok, and Twitter/X. They found that they track user engagement, collect personal data, and use it to target user advertisements. The FTC called out the companies for 'vast surveillance of users and called on lawmakers to regulate and protect user data. The companies' business models rely on collecting and selling this information, so they are not likely to regulate themselves. However, data collection needs to be limited, and lawmakers should make sure that it is not worth it to violate user privacy. The FTC also asked the companies to limit their data retention, restrict targeted advertising, and strengthen teenage protections.

The report clarifies that users do not have control over how companies use their personal details. Even when data is not collected from users, companies analyze user behavior to infer details like parental status, marital status, etc. They might look at user searches or categories for things like 'baby, kids' or 'divorce support' to infer this information, even if they do not ask users explicitly. They often use that information to tailor the content users see and sometimes share it with third parties to target advertisements. The FTC found that none of the companies offered a way for users to control or opt out of data use by algorithms, data analytics, or AI. Companies could not even list everyone with whom they share user data. They also claimed that because their platforms are not 'aimed' at children under the age of thirteen, they do not need different data-sharing practices for information collected from minors. The FTC further found that the companies do not permanently delete data even when explicitly requested by users.

Article Summaries

Some of the firms took issue with the report. Discord pointed out that they are a real-time communications platform with no feeds or formal digital advertising. Google claims they have strict privacy policies and do not use sensitive information to inform ads. The other firms did not comment. The Electronic Privacy Information Center calls on these companies to prove they are doing enough to comply with privacy requirements. Clearly, self-regulation is not working, and companies' priorities are always profit over consumer protection.

Bhuiyan, J. (2024, September 19). Social media and online video firms are conducting 'vast surveillance' on users, FTC finds. The Guardian. https://www.theguardian.com/technology/2024/sep/19/social-media-companies-surveillance-ftc

Article Summaries

Social media surveillance

Governments are increasingly using technology to monitor citizens' social media use. In many cases, people are arrested even for legitimate online activities, and this increasing online surveillance limits digital activism. Billions of people use social media to connect with others and to express religious, social, and political beliefs. Users' personal data is valuable for advertisers, law enforcement, and intelligence agencies. Many places, including Iran and China, use volunteers and workers to monitor online speech. Advances in AI have increased this capability. AI can spot (and sometimes manufacture) patterns that people might miss, and the conclusions made by this technology can draw attention and punishment to specific users.

Other nations also use social media surveillance. The Vietnamese Communist Party has punished nonviolent activists for their social media posts. In Pakistan, journalists and activists were targeted for expressing support for a murdered Saudi journalist on their social media accounts. Other Asian countries, including the Philippines and Bangladesh, are ramping up social media surveillance with help from the US government. In theory, these are 'anti-terrorist' measures. In reality, both governments have enacted widespread monitoring and sometimes violent crackdowns against journalists and dissidents. The market is also growing in the Middle East and Africa. Russia is also famous for surveillance methods, and more and more arrests and internet shutdowns related to protests.

Article Summaries

These surveillance tools often began as tools of war and counterterrorism. The Central Intelligence Agency (CIA) initially funded many data-mining companies in the US. They may have begun as tools to combat serious crimes like human trafficking and terrorism, but now they are also used to screen travelers for political views, track students and activists, and more. Department of Homeland Security agencies have claimed the power to search, collect, and analyze personal information without a warrant—including social media content. Searches for devices at US borders have nearly quadrupled between 2015 and 2018, though inbound travel to the US remained steady.

This surveillance technology is not more effective for ensuring national security than other, less invasive methods. Speech on social media is often misinterpreted and misunderstood, especially when users use slang. Data that trains AI is also biased, leading to further racial or religious discrimination. The use of social media surveillance must be overseen more thoroughly and must be more transparent to the communities it affects. It should not be used to monitor plans for peaceful protests or nonviolent political groups. People should have a reasonable expectation of privacy in public areas, even if they have 'nothing to hide.'

Shahbaz, A., & Funk, A. (2019). Social media surveillance. Freedom House. https://freedomhouse.org/report/freedom-on-the-net/2019/the-crisis-of-social-media/social-media-surveillance

This situation was still ongoing at the time this chapter was published. We encourage educators to investigate the outcome of Wilmore and William's hopeful return to Earth before sharing resources.

Article Summaries

Student privacy laws: Protecting confidentiality and rights

Maintaining student privacy has changed dramatically over the years. Securing student information is no longer as easy as locking documents in a file cabinet. As early as kindergarten, students learn, submit homework, and collaborate with other students and teachers in an online forum. All the data collected to make this environment workable in a classroom setting is at risk of misuse.

Three laws have been enacted in the United States to uphold student privacy and data security.

1. Family Educational Rights and Privacy Act (FERPA) is a federal law that applies to all educational institutions, requiring written consent from the student or custodial parent to release student records such as report cards and class schedules.
2. The Children's Online Privacy Protection Act (COPPA) is a federal law with strict rules on collecting personal information for children under 13 through websites and online services.
3. Children's Internet Protection Act (CIPA) is a federal law protecting students from exposure to inappropriate online content to ensure safe internet access in educational settings.

These laws act to monitor students and protect their data in schools and the commercial marketplace.

Poggi, N. (2024, June 27). Student privacy laws: Protecting confidentiality and rights. Prey Project. https://preyproject.com/blog/three-laws-that-protect-students-online-data-and-privacy

Article Summaries

Surveillance Education tracks the rise of spying technology in schools

Surveillance Education is a new book documenting the history of surveillance tools in education and the issues they cause. Surveillance tools in schools across the US promise to improve safety and academic outcomes, but their actual impact is much less favorable.

Effective education requires trust, autonomy, open discussion, and the freedom to make mistakes. Surveillance directly undermines trust and makes students less likely to take risks that would help them learn and improve their critical thinking skills. Under strict surveillance, students have less autonomy and more fear of making mistakes, making them less likely to participate.

For one teacher of young children, Kate, trust with her students and their families is the most important thing. Her students live in areas of high poverty and high crime. Kate must document all behavioral issues with her students but has refused. Many children misbehave because of more significant problems like being unhoused. She sees it as a violation of her trust with her students. Other teachers and educators are also ignoring offers from surveillance technology companies. They focus on the relationship between teachers and students and on fostering connections to get resources for vulnerable students.

The use of digital tools in education has other costs as well. Students with more digital education have shorter attention spans, weaker memory, and weaker critical thinking skills. Some argue that the tools feed students' egos without increasing their skills, meaning they are unaware of their shortcomings and unwilling to accept feedback or criticism. Teachers report feeling uncomfortable monitoring students' online behaviors or accessing their screens to ensure they are on task. Edtech surveillance can force students to give up their privacy and personal data to participate in education.

Higdon, N., & Butler, A. (2024, September 2). Surveillance Education tracks the rise of spying technology in schools. Teen Vogue. https://www.teenvogue.com/story/surveillance-education-spying-technology-schools

Article Summaries

Surveillance is pervasive: Yes, you are being watched, even if no one is looking for you

The US has more surveillance cameras per person than any other nation, and most Americans are aware of video surveillance and online tracking. However, it is essential to understand how physical and digital monitoring work together to understand how widespread surveillance is.

Law enforcement can track people using phone location data, private cameras, license plate readers on police vehicles and toll roads, and facial recognition technology. With a warrant, they can also extract and analyze cell phone data. Private data companies can also use all this information without needing a warrant. They compile and sell personal data to federal, state, and local law enforcement.

Online websites use ad trackers and cookies stored in users' browsers whenever they visit a site, and they check the other sites a user visits so advertisers can show them ads in multiple locations. Ad trackers and data brokers use personal information like internet address, religion, ethnicity, personal politics, and income to advertise more effectively to you. Some also use keylogging or monitor mouse and scrolling movements.

As of 2022, only five states had privacy laws, and there were no privacy laws at a federal level. It is often impossible to turn off phone location tracking, and 'anonymized' information can easily be traced back to individuals due to the massive amount of stored data. Data breaches from apps, hotels, government agencies, banks, or data brokers can reveal vast amounts of personal information, including vital private details like passport numbers, health insurance, and credit cards.

Krapp, P. (2022, July 22). Surveillance is pervasive: Yes, you are being watched, even if no one is looking for you. The Conversation. https://theconversation.com/surveillance-is-pervasive-yes-you-are-being-watched-even-if-no-one-is-looking-for-you-187139

Article Summaries

Surveillance safari: Crowdsourcing an anti-poaching movement in South Africa

Technology company Samsung is working with conservationists in South Africa to protect wild animals that are under threat from poaching. The Kruger National Park is one of Africa's largest game reserves, and around one million people come every year to see elephants, lions, leopards, rhinoceros, and buffaloes.

In 2020, COVID-19 lockdowns halted visitors from coming to the park. Africam, a wildlife media company, approached conservationists with a possible solution. Working together with Samsung, Africam could provide livestreams to people who could not visit the park the way they could before lockdowns. This livestream partnership resulted in the Wildlife Watch program in 2021 in the Balule Nature Reserve within Kruger National Park.

Samsung provided smartphones to the Black Mambas, an anti-poaching unit. With the Wildlife Watch's real-time tracking technology, they could respond more quickly to the presence of animals and poachers. Besides being a more effective strategy for surveilling a large area, the publicity has helped get the word out that Kruger is not a good place for poaching. In 2024, the Black Mambas announced that the program was expanding. With more advanced cameras that work at night, they are implementing a tagging system that helps provide location markers for camera traps, signs that poachers may be in the park, and evidence of animal behaviors.

Sub-Saharan Africa has lost around half of its large mammals in the last few decades. Tools like Africam and work by ranger units like the Black Mambas are vital to protect these spaces and species, allow audiences to learn about these ecosystems, and play their part in conserving them.

Langenheim, J. (2024, May 20). Surveillance safari: Crowdsourcing an anti-poaching movement in South Africa. National Geographic. https://www.nationalgeographic.com/animals/article/paid-content-surveillance-safari-crowdsourcing-an-anti-poaching-movement-in-south-africa

Article Summaries

There's cameras everywhere': Testimonies detail far-reaching surveillance of Uyghurs in China

China is accused of genocide and crimes against humanity for their mass detention and repression against Uyghurs and Muslim ethnic minorities. Police regularly track Muslims living in Xinjiang Uyghur autonomous region. One man, Abdusalam Muhammad, spoke about Chinese detention and re-education camps at a tribunal in London. He said he has been monitored by police since 1995. Muhammad reported that in 2014, he came home from a year in detention to find cameras and gates everywhere. Baqitali Nur also testified at the tribunal. He endured torture in a detention camp and said that the camp was covered in cameras; there was no privacy anywhere. When he was released in 2018, he was put under house arrest with a camera installed in his home.

Chinese authorities have gotten much more targeted with the use of technology in recent years. Huawei and Hikvision are two massive technology companies that have developed and tested technology that tracks and leads to the detention of Uyghurs. Both have developed technology designed to determine if someone is Han (China's majority population) or Uyghur using facial recognition. Hikvision has government contracts to implement facial recognition systems in re-education camps and at the entrances of nearly one thousand mosques in China. In the tribunal, an expert witness testified that facial detection to monitor Uyghurs resulted directly from government policy.

Article Summaries

Eleven companies were reported to play a role in China's surveillance state, and six were placed on the US entity list for complicity in human rights violations. US firms are not allowed to export technology to these companies. As of 2021, there were further bans on US investments in 59 Chinese companies, including Huawei and Hikvision. However, these companies and many others are not experiencing many negative impacts from these prohibitions. Local and state entities, including some US school districts, continue to buy equipment from these companies. The director of the Uyghur Human Rights Project calls on governments to impose stricter sanctions on these companies and prohibit them from profiting from genocide.

Bhuiyan, J. (2021, September 30). 'There's cameras everywhere': Testimonies detail far-reaching surveillance of Uyghurs in China. The Guardian. https://www.theguardian.com/world/2021/sep/30/uyghur-tribunal-testimony-surveillance-china

Article Summaries

Time to ban facial recognition from public spaces and borders

Some nations, like the UK and Israel, are increasing their use of biometric surveillance. Others, including the EU, are drafting plans to ban biometric surveillance in public places. Human Rights Watch calls for governments and companies to stop using facial recognition surveillance technology in public spaces and within the context of migration and asylum. It is a form of mass surveillance that does not comply with international human rights law. It threatens our rights to equality, non-discrimination, freedom of expression, freedom of assembly, and privacy. It is not enough to expect tech companies to regulate themselves in response to human rights concerns.

Governments use facial recognition technology to surveil protests and curb political dissent, as well as target people based on ethnicity. There is no safe way to use this technology, as it worsens inequalities and is worse for people with marginalized identities. It must be banned in public places and country borders, and companies must stop creating this tool.

Bacciarelli, A. (2023, September 29). Time to ban facial recognition from public spaces and borders. Human Rights Watch. https://www.hrw.org/news/2023/09/29/time-ban-facial-recognition-public-spaces-and-borders

Article Summaries

Video doorbells: Police champion them but do they cut crime?

Video doorbells are growing increasingly popular. There are even popular YouTube channels that publish footage caught from them. The owner of one such channel has seen a burglar walk up to her house and then leave her house through her video doorbell. She says that the device makes her feel safer in her home. The doorbell connects through Wi-Fi to an app on the user's phone, sending a notification and video when someone approaches the door.

In 2021, around 11.7 million smart doorbells were sold. Two of the most popular brands are Amazon Ring and Google Nest. Because they do not require a professional to install or operate, they can be considered a democratic way of operating home security systems.

A spokesperson for the London Metropolitan Police says that smart doorbells are a helpful way to solve crimes, as is all CCTV footage. In May of 2023, a doorbell video helped convict a man who had murdered two of his neighbors. In Manchester, UK, police often request doorbell footage to help investigate and identify suspects or witnesses. However, this has sometimes caused controversy. For example, when Amazon and Nest handed over footage from their doorbell surveillance to police without getting the homeowners' consent, Others argue that video doorbells compromise the privacy of neighbors, who might be recorded because the cameras are motion-activated and they are nearby.

While footage can be helpful in criminal investigations, it is not clear whether the presence of smart doorbells reduces crime in the first place. Some trials have indicated that they reduce crime in a neighborhood, but others show that they might not make much difference. One study found that a house with a smart doorbell might be more vulnerable because it might indicate that the homeowners are wealthy and, therefore, have more to steal. Hacking is also a concern.

Schutz, E. (2023, August 13). Video doorbells: Police champion them but do they cut crime? BBC News.
https://www.bbc.co.uk/news/business-66360030

Article Summaries

What is surveillance capitalism?

Professor Shoshana Zuboff coined the term ‘surveillance capitalism’ when the economic system is centered on selling personal data. In theory, it is a way for businesses to create better products and serve customers more efficiently by accurately predicting supply and demand. However, it also makes a system where a person’s value equals how much profit they can gain for a business.

Surveillance capitalism relies on a few key features. First, it needs to gather highly detailed data. These days, this is an easy step. Technology from online banking to smartwatches allows data brokers to gather information about us. Data collected by institutions, like medical and criminal records, are now much more accessible online. This amount of available details can make stealing identities or committing fraud much more straightforward.

Second, surveillance capitalism encourages businesses to exploit customers’ emotions. If people are afraid of missing out or have poor self-esteem, they are more likely to spend more money on products that promise to fix those problems. Therefore, social media platforms deliberately promote content that makes people feel bad about themselves and then use that negative emotion to drive sales.

Finally, social media and surveillance capitalism rely on making personal experiences into commodities. Life events like marriage and moving become data points that drive targeted ads. And we have embraced and encouraged this commodification with the rise of influencer culture and the desire to go viral.

It is increasingly difficult to opt out of surveillance capitalism. In the early days of the internet, people could delete their online accounts. Today, our data is spread so far that it is nearly impossible to pull away. We must take care to resist the cycle of overconsumption.

Baterna, Q. (2021, October 12). What is surveillance capitalism? Make Use Of. https://www.makeuseof.com/what-is-surveillance-capitalism/

Article Summaries

WHO launches global network to detect and prevent infectious disease threats

In 2023, the World Health Organization (WHO) launched the International Pathogen Surveillance Network (IPSN). It is a global network working to connect different regions, improve sample analysis, and use data to make decisions about and share information about public health.

IPSN uses pathogen genomics, which analyzes the genes of organisms to determine how they spread and how deadly and infectious they are. It can help scientists track diseases and respond to outbreaks. The WHO's main goal with this disease surveillance system is to detect and respond to diseases before they become epidemics and pandemics.

The WHO wants every country to have access to pathogen genomic sequencing. During the COVID-19 pandemic, it was very clear that this tool was critical in developing vaccines and identifying new virus variants. Genomics helps surveil many other diseases, including influenza, tuberculosis, HIV, and foodborne illness. Since COVID-19, many countries have scaled up their genomics operations. However, many still do not have adequate systems for collecting and analyzing samples. Countries (including wealthy countries) have also recently slashed public health budgets. More data, innovations, practices, and public health decisions must be shared globally. Diseases do not stop at human-determined borders. As the Director of the National Genomics and Bioinformatics Center in Argentina says, "...a disease threat in one country is also a threat to others."

WHO launches global network to detect and prevent infectious disease threats. (2023, May 20). World Health Organization. https://www.who.int/news/item/20-05-2023-who-launches-global-network-to--detect-and-prevent-infectious-disease-threats

Additional Media Links

AFRICAM LIVE STREAMS

Description: Watch live streams from Kruger National Park in South Africa. These streams are set up to allow 'virtual rangers' to monitor the park for poachers and other threats to wildlife while Africam works with the anti-poaching unit, the Black Mambas, to respond to threats.
Africam. (n.d.). Africam Story. [Videos].
Retrieved from https://www.africam.com/africam-story/

DISPLACEMENT, AI SURVEILLANCE - ARE THE PARIS 2024 OLYMPICS WORTH IT? | PEOPLE & POWER DOCUMENTARY

Description: People and Power document the widespread effects of the Paris 2024 Olympic games, from the shoehorning of mass surveillance technologies into law to the displacement and criminalization of migrants in France.
Al Jazeera English. (2024). Displacement, AI surveillance - Are the Paris 2024 Olympics worth it? | People & Power Documentary. [Video].
Retrieved from https://www.youtube.com/watch?v=g8ostfpSKyY

EXPOSING THE NSA'S MASS SURVEILLANCE OF AMERICANS | CYBERWAR

Description: VICE News interviewed an ex-employee of the National Security Agency and others, revealing the mass surveillance the intelligence agency conducts on its citizens.
VICE News. (2024). Exposing the NSA's mass surveillance of Americans | Cyberwar. [Video]. Retrieved from https://www.youtube.com/watch?v=tYVm62oEyWA

FRANCE PASSES CONTROVERSIAL AI SURVEILLANCE BILL AHEAD OF 2024 OLYMPICS

Description: This news segment reports on a bill allowing AI-powered surveillance in public spaces in France before the 2024 Olympics.
FRANCE 24 English. (2023). France passes controversial AI surveillance bill ahead of 2024 Olympics. [Video].
Retrieved from https://www.youtube.com/watch?v=tAQhuozo7To

HACKED CAMERA

Description: This is a live map of open-access cameras, likely because the user has not set up a password to access the feed. These cameras' feeds can be viewed by nearly anyone (not on this website).
Hacked.Camera. (n.d.). Hacked camera map. [Live map].
Retrieved from https://hacked.camera/map/

Additional Media Links

HOW AI FACIAL RECOGNITION WORKS

Description: The hosts discuss the use of AI in facial recognition, how the public plays along in our surveillance, and the dangers of its use in police systems, governments, and daily life.
Stuff You Should Know. (2020). How AI facial recognition works. [Podcast].
Retrieved from https://podcastaddict.com/stuff-you-should-know/episode/136834348

HOW CHINA'S SURVEILLANCE IS GROWING MORE INVASIVE | VISUAL INVESTIGATIONS

Description: This video uses information from hundreds of thousands of bidding documents to analyze and describe the technologies used by Chinese law enforcement, from cameras to Wi-Fi sniffers.
The New York Times. (2022). How China's surveillance is growing more invasive | Visual Investigations. [Video].
Retrieved from https://www.youtube.com/watch?v=Oo_FM3mjBCY

HOW DOES CHINA'S SOCIAL CREDIT SYSTEM WORK?

Description: This podcast details China's social credit system, how it is used to regulate the financial market and keep the economic system functioning, and the misconceptions that Western nations have about the system.
History of Everything Podcast. (2024). How does China's social credit system work? [Video]. Retrieved from https://www.youtube.com/watch?v=Z-BLXThBg6s

HOW POLICE CAMERAS RECOGNIZE AND TRACK YOU

Description: This video explains how police surveillance systems work alongside repositories of face data, including from social media.
Wired. (2022). *H*ow police cameras recognize and track you. [Video].
Retrieved from https://www.youtube.com/watch?v=9Xg-7FfLIVw

HOW WORRIED SHOULD YOU BE ABOUT SMART HOME SECURITY?

Description: This video explores how the Internet of Things can be hacked and the consequences of security breaches on smart devices.
SciShow. (2018). How worried should you be about smart home security? [Video].
Retrieved from https://www.youtube.com/watch?v=0CvLz55cjoc

Additional Media Links

IN A NUTSHELL: SHOSHANA ZUBOFF: SURVEILLANCE CAPITALISM AND DEMOCRACY

Description: Shoshana Zuboff, author of *The Age of Surveillance Capitalism*, discusses how a collection of personal data online is changing how economies work and how our privacy is being eroded for profit.

Alexander von Humboldt Institut for Internet and Society. (2021). In a nutshell: Shoshana Zuboff: Surveillance capitalism and democracy. [Video].
Retrieved from https://www.youtube.com/watch?v=5AvtUrHxg8A

SAFE AND SORRY - TERRORISM & MASS SURVEILLANCE

Description: This video looks at the history of the rise of anti-terrorism surveillance in the US and examines whether these measures effectively fight terrorism.

Kurzgesagt - In a Nutshell (2016). Safe and sorry - Terrorism & mass surveillance. [Video]. Retrieved from https://www.youtube.com/watch?app=desktop&v=V9_PjdU3Mpo

SIGHT AND POWER

Description: The host and guest, a law professor, explore how we are tracked and monitored, as well as the social costs of giving away so much information.

Thinking Allowed from BBC Radio 4. (2024). Sight and power. [Podcast].
Retrieved from https://www.bbc.co.uk/sounds/play/m00237q4

STATES FACE A DIVISIVE DEBATE OVER FACIAL RECOGNITION TECHNOLOGY IN SCHOOL HALLWAYS

Description: This news story goes into the use of surveillance in high schools and the competing privacy and safety concerns.

Sterman, J., Brauer, A. & Nejman, A. (2021). States face a divisive debate over facial recognition technology in school hallways. NBC 15 News. [Video].
Retrieved from https://mynbc15.com/news/spotlight-on-america/facial-recognition-technology-in-school-hallways-states-face-a-divisive-debate

THE TOWER OF SURVEILLANCE - SOCIAL MEDIA SURVEILLANCE

Description: This episode explores how social media and tech companies use data mining and advertisement to surveil and profit from their users.

ATEC CMS LAB. (2021). The tower of surveillance - Social media surveillance [Ep. 1/2]. [Video].
Retrieved from https://www.youtube.com/watch?v=7ogp33LSecA

Additional Media Links

WHAT FACIAL RECOGNITION STEALS FROM US

Description: This video explores how technology can turn faces into nametags without the consent of the person in the picture and the potential dangers and shortfalls of this technology.
Vox. (2019). What facial recognition steals from us. [Video].
Retrieved from https://www.youtube.com/watch?v=cc0dqW2HCRc

WHAT IS SURVEILLANCE CAPITALISM?

Description: This video introduces how industrial capitalism has evolved in a digital age into surveillance capitalism and how tiny changes in user behavior influence online ads, behaviors, and experiences.
Poiesis. (2020). What is surveillance capitalism? [Video].
Retrieved from https://www.youtube.com/watch?v=FcADchWhwUk

WHAT IS SURVEILLANCE CAPITALISM? AN EASY EXPLANATION IN 60 SECONDS

Description: This is a quick explanation of surveillance capitalism and the places we see it in our everyday lives.
Bernard Marr. (2024). What is surveillance capitalism? An easy explanation in 60 seconds. [Video].
Retrieved from https://www.youtube.com/watch?v=xBpLWa4CNog

WOMAN, LIFE, SURVEILLANCE

Description: BBC speaks with women in Iran who have been targeted by the Iranian government and morality police, discussing how they surveil women online and in person.
Note: this episode contains graphic descriptions of violence. Please check for suitability in your teams.
BBC Trending (2024). Woman, life, surveillance. [Podcast].
Retrieved from https://www.bbc.com/audio/play/p0jr863d

YOUR TECHNOLOGY IS TRACKING YOU. TAKE THESE STEPS FOR BETTER ONLINE PRIVACY

Description: This podcast advises regular people to get a handle on their digital lives and security.
Wamsley, L. (2020). Your technology is tracking you. Take these steps for better online privacy. NPR Life Kit. [Podcast].
Retrieved from https://www.npr.org/2020/10/09/922262686/your-technology-is-tracking-you-take-these-steps-for-better-online-privacy

Discussion Topics

1. Does your family use a doorbell or other camera system at your home? If so, does that make you feel safe?
2. Do you have smart devices like Alexa, smart phones, or laptops in your house?
3. Do you notice CCTV cameras when out in public, driving, or shopping in stores?
4. Is it acceptable for the government to use mass surveillance programs? If so, when?
5. Does your behavior change when you know you are under surveillance?
6. Do you think surveillance is used equitably across various communities?
7. What responsibilities do social media platforms have to protect users' private information?
8. Does surveillance violate personal privacy?
9. Do you notice any surveillance devices in your school? If so, do you feel safer because these devices are there?
10. How do you think surveillance will change in the future?

Use these prompts to spark thinking before, during, and after engaging in the research activities. All of the prompts can be adapted to either discussion or writing.

Learning Prompts - Activating

1. What is surveillance, and why is it used?
2. What are some standard methods of surveillance?
3. What are the benefits of surveillance?
4. How should surveillance be regulated to prevent abuse by law enforcement agencies?
5. How do different countries approach surveillance differently?
6. How does facial recognition technology work?
7. What role does surveillance play in social media?
8. How is technology changing the way we use surveillance?
9. What are the ethical concerns surrounding surveillance?
10. What is mass surveillance, and why is it controversial?

Learning Prompts - Open Response and Writing

1. How has the development of surveillance technologies (such as CCTV, drones, and facial recognition) changed over time?
2. What role does surveillance technology play in modern law enforcement and crime prevention?
3. What is mass surveillance, and how does it influence public behavior or perception of security?
4. How can individuals avoid being tracked, primarily online?
5. Can surveillance systems reinforce social inequalities? How?
6. What are the potential consequences of surveillance capitalism?
7. What are the potential social consequences of surveillance in schools and workplaces?
8. How does surveillance differ between countries (e.g., authoritarian vs. democratic states)?
9. How do public attitudes toward surveillance vary based on age, location, and socioeconomic factors?
10. How vital is surveillance transparency in increasing or decreasing public trust?

Assessment - Multiple Choice

Name _____

1. Which of the following is a type of surveillance technology commonly used for monitoring public areas?

a.Drones
b. CCTV cameras
c. Internet cookies
d. All of the above

2. Which of the following is a concern related to the increase in surveillance?

a. Better public safety
b. Privacy violations
c. Reduced crime rates
d. Enhanced communication

3. The term “mass surveillance” typically refers to:

a. Surveillance of specific individuals based on criminal suspicion
b. Surveillance that only collects information from public places
c. The use of surveillance to monitor government officials
d. Widespread monitoring of entire populations or regions

4. Which of the following best describes “biometric surveillance”?

a. Surveillance that tracks digital activities
b. Using drones to monitor remote areas
c. Monitoring physical traits such as fingerprints, facial recognition, or iris scans
d. Collecting personal data through social media platforms

5. What is the role of data encryption in surveillance systems?

a. To protect collected data from unauthorized access
b. To make surveillance devices more affordable
c. To increase the efficiency of surveillance
d. To track the movements of suspects in real-time

6. What is a key challenge regarding surveillance in democratic societies?

a. Lack of access to advanced technologies
b. Balancing national security and individual privacy
c. Lack of laws to regulate surveillance activities
d. Public support for widespread surveillance

7. How is facial recognition used in the retail setting?

a. To identify repeat customers
b. To apply coupons for store members
c. To identify past shoplifters
d. To print membership cards

8. Which of the following is not a type of surveillance used for investigations?

a. Financial Surveillance
b. Electronic Surveillance
c. Mail Scanning Surveillance
d. Biometric Surveillance

Assessment - Multiple Choice

9. Police surveillance cameras were introduced in Singapore is what year?

a. 2012
b. 2015
c. 2018
d. 2020

10. Which of the following is the main reason for monitoring online activity in the workplace?

a. To see if employees are playing online games
b. To track active work hours
c. To protect competitive secrets
d. To ensure workers are not gambling

11. Which of the following are uses for facial recognition software?

a. Security for ATMs and banks
b. Track employee time and attendance
c. Identify known criminals at immigration points
d. All of the above

12. Which of the following types of surveillance requires a warrant for law enforcement to use during an investigation?

a. Cell phone data
b. License plate readers
c. Phone location data
d. Private cameras

13. Which of the following is an example of surveillance used in the workplace?

a. Monitoring employee emails for productivity
b. Installing security cameras in public places
c. Tracking the movements of individuals in shopping malls
d. Recording phone conversations for law enforcement

14. Which technologies are commonly used for surveillance in public spaces like airports?

a. Thermal cameras for detecting body temperature
b. Motion sensors for tracking movement
c. Facial recognition systems
d. Radiofrequency identification (RFID)

15. In the context of surveillance, what does the term “surveillance capitalism” refer to?

a. The government's use of surveillance to monitor the economy
b. The use of personal data collected through surveillance for profit by corporations
c. The involvement of private companies in national security surveillance
d. The surveillance of workers to ensure corporate productivity

Assessment - True/False

Name _____

_____ 1. Surveillance can only be done with video cameras.

_____ 2. Surveillance is used primarily for monitoring criminal activity.

_____ 3. Surveillance can only be conducted by government agencies.

_____ 4. Surveillance data can be used for purposes other than crime prevention, such as marketing or employee monitoring.

_____ 5. Surveillance technologies have the potential to invade an individual's privacy.

_____ 6. Digital surveillance includes tracking online activities, such as browsing history.

_____ 7. Facial recognition technology in surveillance is widely accepted without controversy.

_____ 8. Surveillance can help increase public safety but may lead to misuse and overreach.

_____ 9. Surveillance is always legal if the intent is to catch criminals.

_____ 10. All surveillance systems have artificial intelligence to analyze the collected data.

_____ 11. Mass surveillance programs can be implemented without the knowledge of the public.

_____ 12. The use of body-worn cameras by police officers is a form of surveillance.

Assessment - True/False

Name _____

_____ 13. Data from surveillance systems is always secure and cannot be hacked or misused.

_____ 14. Surveillance footage can sometimes be used in court as evidence.

_____ 15. Social media platforms collect and use surveillance data on their users.

_____ 16. Three primary legal laws in the United States uphold student privacy and data security.

_____ 17. CCTV cameras are commonly used for monitoring public areas such as streets, malls, and airports.

_____ 18. Surveillance always involves invasive methods that violate personal privacy.

_____ 19. Workplace surveillance is often used to monitor employee productivity and prevent potential security breaches.

_____ 20. The EU is working to ban biometric surveillance in public places.

Assessment - Fill-in-the-Blank

Name _____

1. The anti-poaching group, the _____ _____, uses smartphones and livestreams of the Kruger National Park to catch poachers.
2. _____ _____ uses and sells personal information gathered for economic purposes.
3. Doorbell cameras connect to _____ to send data to users' smart devices.
4. Online data can be taken by _____ for identity theft.
5. The practice of monitoring people's activities in public spaces through cameras is known as _____ surveillance.
6. In digital surveillance, _____ tracking refers to monitoring a person's location using their mobile device.
7. _____ surveillance can be conducted through software that monitors an individual's online activities, such as email exchanges and web browsing history.
8. The history of surveillance tools in education is outlined in a book titled _____ _____.
9. _____ devices like air fryers have been found to send personal data of the user to databases in China.
10. Government surveillance of online activities has been linked to a reduction in digital _____.

Assessment - Answer Key

Multiple Choice

1. B
2. B
3. D
4. C
5. A
6. B
7. C
8. C
9. A
10. B
11. D
12. A
13. A
14. C
15. B

True/False

1. F
2. F
3. F
4. T
5. T
6. T
7. F
8. T
9. F
10. F
11. T
12. T
13. F
14. T
15. T
16. T
17. T
18. F
19. T
20. T

Fill-in-the-Blank

1. Black Mambas
2. Surveillance capitalism
3. Wi-fi
4. Cybercriminals
5. CCTV
6. GPS
7. Cyber
8. Surveillance Education
9. Smart
10. activism

Use these assessments as formative or summative assessments. Consider assessing learners at the beginning of the unit as a pre-assessment, and again at the end as a post-assessment to see their progress. Teachers can use these as graded assignments if needed.

FUTURE Problem Solving

Additional curricular resources

We hope you find this edition of our activity unit series to be a valuable resource as your students gather knowledge about Future Problem Solving topics of study.

Surveillance Activity Unit

Our activity unit on this topic contains step-by-step lesson plans for research-based independent and collaborative work for use with students in a variety of settings, including out-of-school time. The publication includes 3 extra topic-related future scenes for practice, a variety of tools, research, and metacognition activities, and a variety of specific problem-solving step activities.

Global Issues Champions Series

This series showcases student written work for the 2024 Global Issues world champion team and individual competitors by division. Their full evaluations are included. To use this publication as a coaching tool, first review the Air Quality future scene with your students. Then ask students to complete a booklet using the future scene. You can do this as a mock competition or step by step as practice. For students looking to deepen their understanding of evaluations, we recommend that you give each team a copy of the student work, step by step. Ask students to identify strengths and weaknesses in the sample work based on their understanding of the scoring rubric. Review the evaluation concepts identified in each step and look at the scores and feedback from evaluators together.

Education Standards

Our Future Problem Solving process fulfills a wide variety of education standards. We take connecting with these standards into account when developing our program materials. Teachers can easily tailor Future Problem Solving content to meet their specific education system and local requirements as needed.

How our topics are selected

Our topics represent important challenges from business, civics, society, science, and technology and serve as the thematic basis for given problem solving situations. Each school year, students get 3-5 opportunities to solve important near-future global issues based on their progress in local and regional competitions. To be considered, a topic must be broad enough to appeal to participants living around the globe, offer a range of themes and issues to explore, and be considerate of a variety of views. Lastly, of course, every topic must be accessible for all, from ages 8 to adult.

We welcome submissions of topic ideas from anyone year round. Our topics committee reviews, refines, and categorizes submissions into our diverse strands. Then options are narrowed down and screened by our regional affiliate leaders. They pre-select top candidates for each of the category strands to present to our entire global community for a vote. The community's input, including students, heavily influences the final selection. We announce topics for the upcoming competition season March 1.

About Future Problem Solving

Future Problem Solving proudly celebrates over 50 years of placing more than a million young people at the core of a dynamic, purposeful learning experience. Each year K-12 students around the world participate in a variety of challenges designed to empower curious youth to become changemakers. Problem solvers learn how to think, not what to think, and gain skills they need to succeed in work and life. Our programs help young people develop their own voices and the confidence to use them.

To learn more about Future Problem Solving, to submit a topic idea, or contact us, visit fpspi.org.

FUTURE Problem Solving

ACTIVITY UNIT

Fundamentals

Problem-Solving Tools

4

Activities

INCLUDED INSIDE:

- Research and Analysis (Step 0)
- Categories of Knowledge
- Futures Wheel
- Generating and Focusing Ideas

GRADES 4-12

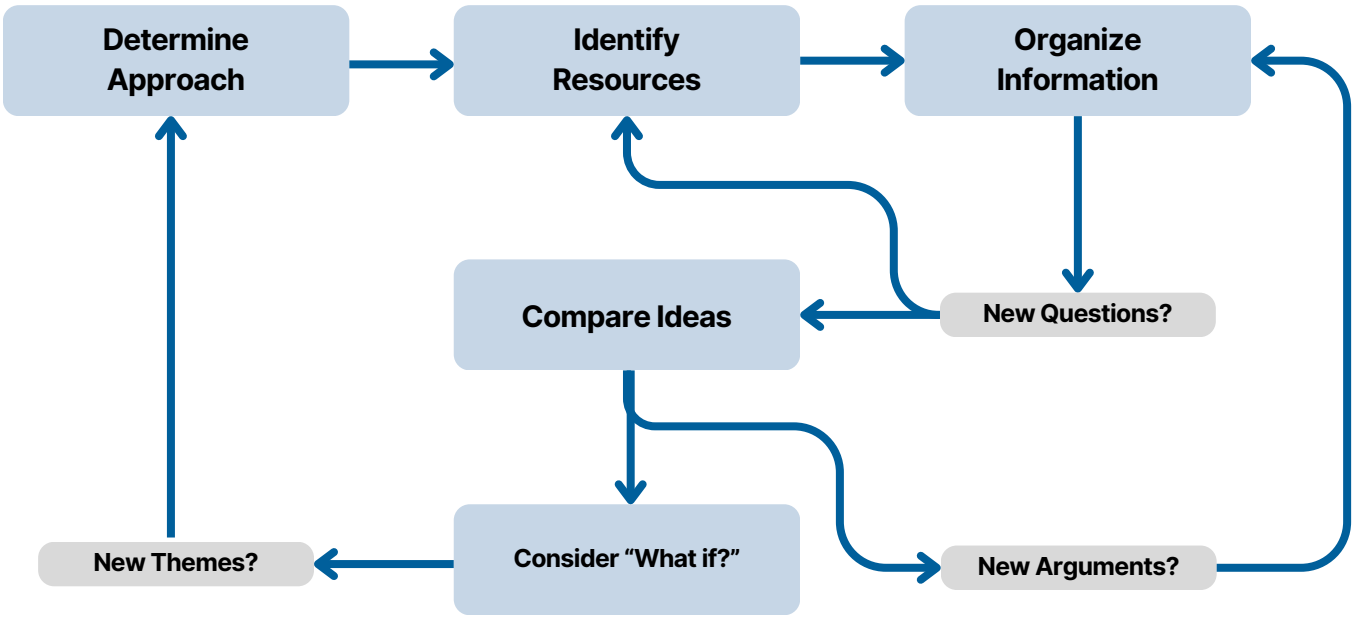
Supplemental Materials | 2024-2025

Why it's important

It has been said that research is the unofficial first step (Step 0) of the Future Problem Solving 6-step process. Research builds an understanding of our real world topics and serves as a jumping-off point when presented with a future scene. Although students do not use every piece of information they find for each topic challenge, a broad base of knowledge is important. A well-rounded understanding of the past and current status of a topic allows students to better extrapolate those concepts into the future. A solid knowledge base serves students well beyond competitions and often sparks ideas for school projects, creative writing, and beyond.

Problem-solving research strategies

A goal of Future Problem Solving is to understand the real world topic from which a given problem arises, as well as the problem itself. Gathering knowledge is a lifelong pursuit and a never-ending cycle. There are effective strategies to follow logical paths of inquiry and manage the information gained in a useful manner.



Determine approach

Determine what you already know about the topic. Generate thoughts about your knowledge as a group. Discuss thematic vocabulary that will help you locate and understand your resources. At the beginning of each topic, consider an online collaboration site to gather and organize main concepts discovered by research.

- If more than one person is working on the topic, divide up the research responsibilities.
  - One person might conduct an interview.
  - One person might search through magazines or news articles.
  - One person might search for videos.
- Organize online bookmarks and use them. Every time you find an article, video, or infographic on the topic, save the information to your online account to share with others.
- Set time limits on your research. Deadlines often create higher productivity and efficiency.

Online collaboration tools

Online collaboration tools are beneficial to organize and discuss information:

- *NowComment*
- *Diigo*
- *Virtual Classrooms (Google and Microsoft)*
- *Slack*
- *LiveBinders*

Identify resources

Thorough research on a subject goes well beyond a single article or a chapter in a book. Consider a wide range of sources to gather a broad range of ideas and opinions.

Articles

Read everything you can get your hands on – both online and in print. Magazines, books, pamphlets, newspapers, and blogs are a few suggestions. Specific sources may include:

- News articles – Consider local, national, international, and specialty papers.
- Futuristic periodicals – Examples include The Futurist, Discover, and Futurism.
- Library searches – Librarians can identify sources you may not know exist.
- Internet searches – Use key terms and concepts you know to search a larger spectrum.

People

Talk with the people around you. Interview topic stakeholders, people who impact and are impacted by the topic. Other students, parents, teachers, librarians, and professionals in the field possess both research information and a wealth of creative ideas and opinions. Contacting people is an excellent way to compile a variety of ideas.

- Researchers
- Professionals
- Decision-makers
- General public

Media

Watch and listen to the things around you – videos, movies, TV shows, commercials, radio shows, and podcasts – to gather valuable information on a topic. Look for nonfiction as well as fiction. Consider newsmagazine programming like NZ Story, 60 Minutes, 20/20, Frontline, and Panorama.

Organize information

After collecting a large volume of information, the organization process helps one to make sense of all the ideas. It also serves as a useful way to help one remember new knowledge. Similar items may be grouped together. Or consider pairing competing ideas. One of the best ways to organize information is to categorize it. As you organize ideas, new questions may arise, or underrepresented concepts may emerge. Identify new resources to help fill in these gaps.

Compare ideas

Think about and discuss the reliability of the information gathered. Are you gathering the information with any kind of personal bias about the topic? Are sources of information about the topic biased in any way? In order to know what to trust, it's important to consider the source and slant of the information being gathered.

When examining resources, discriminate between those with hard facts and those that offer only biased opinions. While both types of information can be useful, keep in mind that fact and opinion are not necessarily interchangeable.

- Who is presenting the argument? Do they have a personal interest?
- Who has endorsed or requested the information?
- Are all opinions represented?
- Have you unintentionally sought out information with a specific slant and excluded other arguments?

Consider "what if?"

Understanding the present allows students to move forward in identifying future possibilities. Future possibilities can be structured in many ways – possible, probable, preferable, and unfavorable. With the knowledge gained from your research, consider what the future might look like.

- What do you want the future to look like?
- What do you hope does not happen?
- What happens if a likely advancement occurs? What if it doesn't?
- What would an unexpected future look like?

Categories of Knowledge

The categories list that follows can be applied to each step of any research process about real world topics to expand thinking and approach themes from new or non-obvious directions.

Why it's important

Organizing information helps make sense of the knowledge gained to see how it all fits together. The goal of categorizing is to highlight connections between various pieces of information. Several types of category lists exist. You might pick one of the following ways to generate a list of people to contact for interviews. Another might help you identify common themes among the research you have collected. Categories are useful in understanding the information you gather.

Categories prepared for a specific subject

A concept map is beneficial in organizing information. Issues relating to the topic are organized under the topic with like items recorded together. The Future Wheel tool is a concept map example.

Future Problem Solving categories list

When generating ideas for completing a Future Problem Solving challenge, almost any issue or solution will fit into at least one of the categories on the Future Problem Solving categories list provided on the next page. The categories list usually serves as a sufficient starting point for identifying categories for any real world topic. Keep in mind not every topic has information related to every category on this list.

Categories you generate on your own

You may decide to generate your own category list by generating a sufficient number of categories to classify the information. Are there consistent subsets of a topic that emerge from your research? Do not divide the information into so many parts that the category list becomes a useless form of classification.

Categories that are generic systems of classification

When categories are not emerging easily, turn to some "tried and true" systems of classification. "Animal, Vegetable, Mineral" is an example of a generic system of classification. "Causes and Effects" is another. "Physical, Mental, Spiritual" is a third. You may want to make a list of other generic systems of classification you could use if more specific systems do not cause trends in the information to emerge.

FUTURE Problem Solving Categories List

STEP 1 STEP 3

Arts & Aesthetics
Arts include expression via music, painting, sculpture, theatre, film, or other creative media. Aesthetics focuses upon beauty and whether something is pleasant to view or experience.

Basic Needs
Basic Needs include food, clothing and shelter—elements important for survival.

Business & Commerce
Business includes retail stores, restaurants, offices, corporations, etc. Commerce focuses upon the trade or the buying and selling of goods and services.

Communication deals with the exchange of information.

Culture includes the customs, arts, social institutions, and achievements of a particular group. **Religion** includes a system of faith or worship.

Defense involves protection, safety, security, and/or privacy. This includes physical efforts by individuals, or groups as well as protection provided by firewalls and passwords.

Economics is the branch of knowledge that concerns the distribution, production, and consumption of wealth.

Education includes schools, training, instruction, and learning.

Environment includes one's surroundings or conditions that shape the lives of people, plants, or animals.

Ethics include the principles that govern a person's behavior. **Morality** involves principles concerning the distinction between right and wrong.

Government deals with how a community or country is managed. **Politics** involves elections and/or the activities related to making governmental decisions, especially debates or conflicts among individuals or parties having or hoping to achieve power.

Law includes the creation and enforcement of recognized laws, court procedures, sentencing, and personnel. **Justice** is the seeking of fairness and reasonable implementation of laws.

Miscellaneous
Miscellaneous is assigned when an idea does not fit within another category. If you have more than one Miscellaneous idea, and they are unrelated to each other, you may designate them as Miscellaneous 1 and 2.

Physical Health deals with the condition and care of the body as opposed to the mind.

Psychological Health focuses upon emotional and mental well-being.

Recreation includes hobbies, sports, entertainment, and other activities pursued during leisure time.

Science is the systematic study of the structure and behavior of the physical and natural world (including the wider universe) through observation and experiment.

Social Relationships encompass the connections between individuals with recurring interactions.

Technology is associated with machines, equipment, and/or certain advancements developed from applying practical or scientific knowledge.

Transportation is concerned with the movement of individuals, groups, or goods from place to place.

Name: _____

FUTURE Problem Solving Categories List

STEP 1 STEP 3

Directions:

- Write your general research topic or a specific underlying problem in the brainstorming prompt box.
- Use the categories list to focus your brainstorming and generate ideas.
- Generate ideas based on your brainstorming prompt in each category shown.
- For general topics, think about all you have discovered through your research and identify related challenges ideas (step 1).
- For a specific underlying problem, generate solutions ideas (step 3).
- Record your ideas in the space provided for each category. Try to think of at least one idea for each category.

Brainstorming Prompt:

Arts & Aesthetics

Basic Needs

Business & Commerce

Communication

Culture & Religion

Defense

Economics

Future Problem Solving Categories List, Page 2

- Education 
- Environment 
- Ethics & Morality 
- Government & Politics 
- Law & Justice 
- Miscellaneous 
- Physical Health 
- Psychological Health 
- Recreation 
- Science 
- Social Relationships 
- Technology 
- Transportation 

Futures Wheel Graphic Organizer

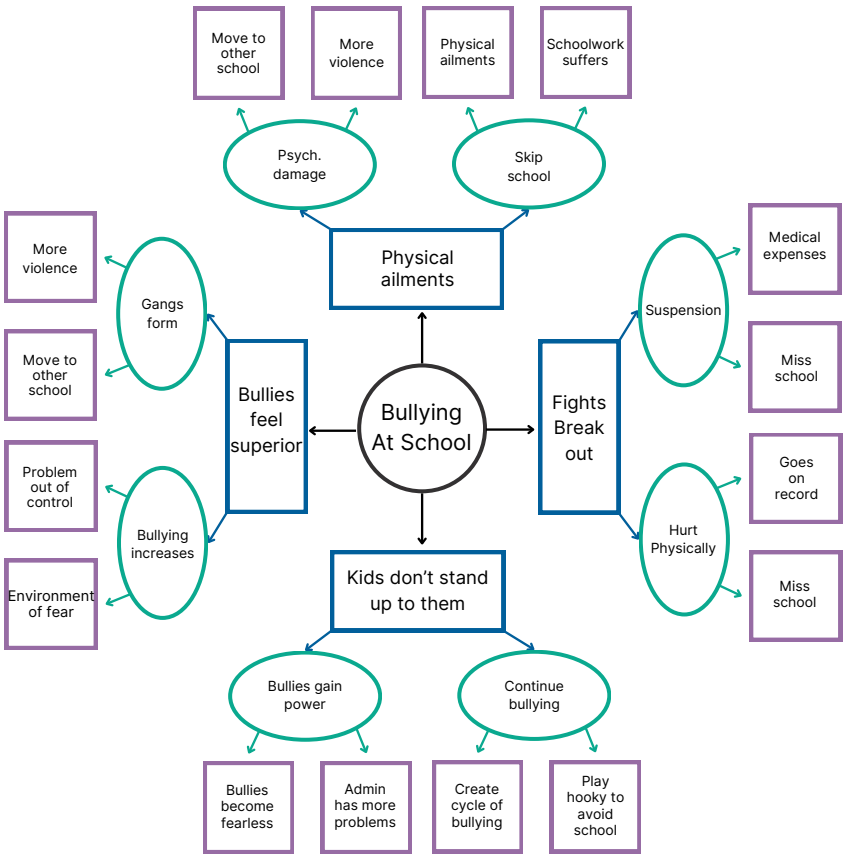
Why it's important

A futures wheel is a graphic organizer tool that allows you to predict future events. Using the knowledge you have of the current situation, consider positive and negative results of an idea, event, or trend.

A creative thinking tool, concept maps like this one are beneficial in organizing information. Issues relating to the topic are organized around the topic with similar items recorded together.

Directions

1. Put your starting idea in the center of the page in the **black** circle.
2. Fill in the **blue** rectangles with first-order effects that could result from your starting idea.
3. For each first-order effect identify two second-order effects (**green** ovals).
4. Repeat for the second-order effects to identify third-order effects (**purple** squares).
5. After completing the futures wheel, discuss which ideas on your wheel could be challenges and which others could be solutions to the given problem.

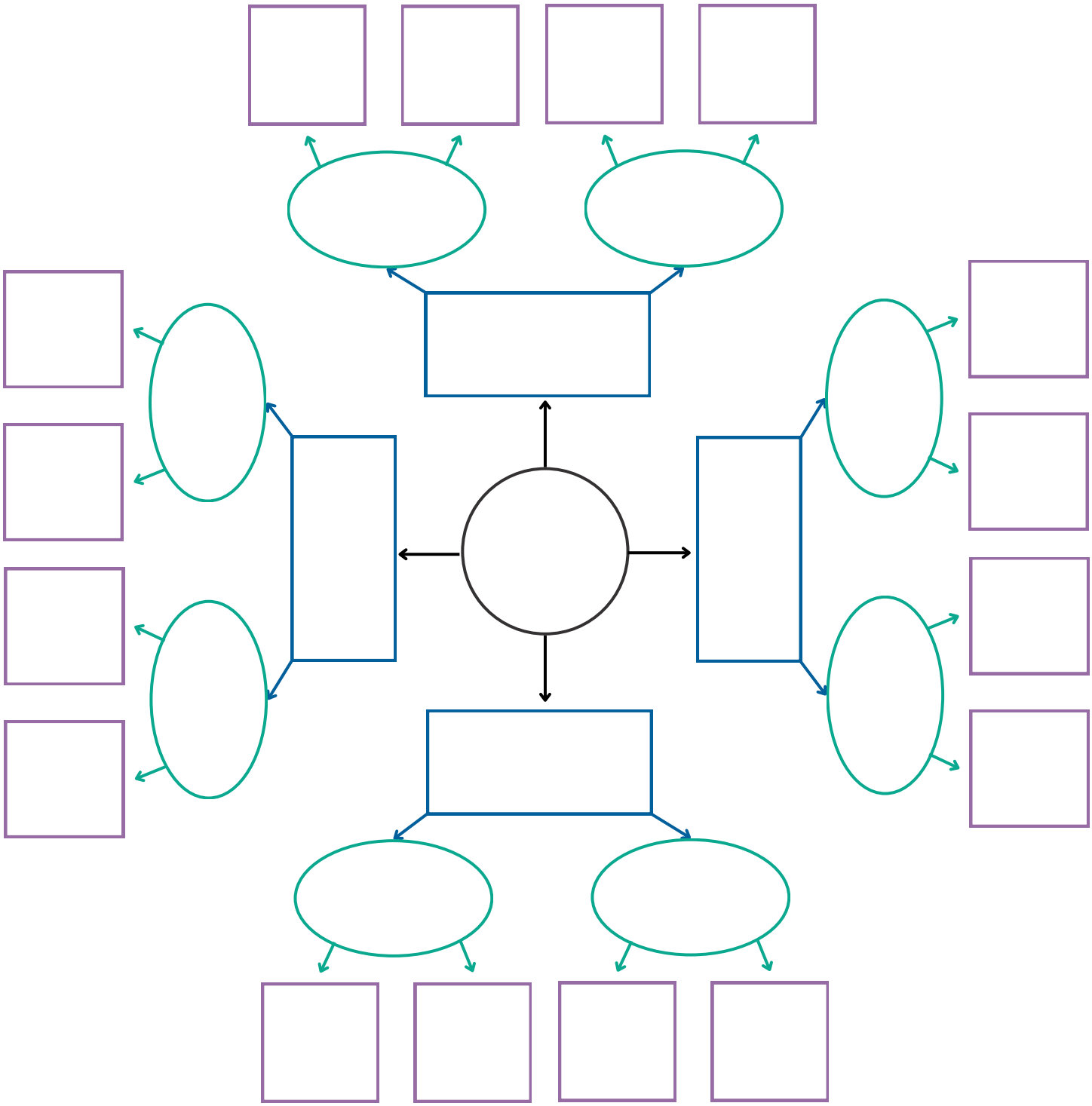


Name: _____

FUTURE Problem Solving

Futures Wheel Graphic Organizer

Problem-Solving Tools



Tools for Generating Ideas

Why it's important

Generating tools are used to stretch thinking and reach for lots of possibilities. Although they are often used in creating challenges and solution ideas during the problem-solving process, these tools are also useful when researching a topic. The most commonly known generating tool is brainstorming (and its MANY variations). As you research a new topic, use these tools to help you generate ideas to examine a wide range of ideas.

Generating guidelines

When generating ideas, it is important to keep four guidelines in mind:

- No evaluation should be given while generating ideas. Both criticism and praise are ruled out. Evaluation of ideas comes at a later time.
- Quantity is important. The larger the number of ideas, the greater the chance of reaching the best ideas.
- Hitchhiking is important. Combining and improving ideas leads to great possibilities. When generating ideas, the sum is definitely greater than its individual parts.
- Wild and out there ideas can be very productive. Offbeat and silly ideas may trigger practical breakthroughs.

Brainstorming tools

Attribute listing

Use the core elements or attributes of a task or challenge as a springboard for generating novel directions or improvements.

Tools for Generating Ideas

Morphological matrix

A morphological matrix is an analytical tool for identifying the key parameters of a task, generating possibilities for each parameter, and then investigating possible combinations ("mixing and matching"). Using a chart with 4 columns and 6 rows, identify four major aspects of the topic and place and put them across the top row (one per column). For example, row headings could be people, setting, obstacle, and goal. Generate different possibilities for each row under the 4 columns. Random combinations are then formed to create new and interesting possibilities.

SCAMPER

This tool is a lateral thinking tool to explore new possibilities. Apply a checklist of action words or phrases that start with the letters of the name to change the attributes of an idea. They are often described as idea-spurring questions:

- **S**ubstituting
- **C**ombining
- **A**dapting, Adding, Altering
- **M**inifying, Magnifying
- **P**utting to other uses
- **E**liminating, Elaborating
- **R**eversing, Rearranging, Reducing

Silent brainwriting

One of the many variations of brainstorming, this tool is done as a group. Each person starts with a sheet of paper with 3 columns and 4 rows (12 boxes). They each generate three ideas related to the brainstorming topic and write one idea in each of the boxes in the first row. Next, they pass the sheets all around the group so the ideas can be read and new ideas added, row by row, until all sheets are filled and all ideas read.

Tools for Focusing Ideas

Why it's important

Use focusing tools to evaluate, compare, categorize, and highlight ideas. These tools help students to prepare to stop generating and begin focusing their thoughts and identifying promising possibilities and directions. Simply gathering a large volume of information is not helpful if you are not able to analyze it and focus on central concepts. Focusing tools aid in selecting an idea that is workable, relevant, and unique.

Focusing guidelines

The following guidelines will help you focus:

- **Use affirmative judgment** to be thorough but positive when analyzing, refining, or choosing possibilities.
- **Follow a plan** and use the tools that assist in focusing.
- **Keep an eye on the goal** to focus on what is wanted and needed in order to accomplish the goal.
- **Stay open** to all ideas that might be workable. Look for new and unusual possibilities.

Focusing tools

Identifying hits & hot spots

Read through your generated ideas and identify those on target for your goal. Develop your "hits" into complete ideas.

Identify clusters of ideas that share common elements ("hot spots"). Discuss how the ideas are similar. How are they different? Which will be most useful for your needs?

Advantages, Limitations (to overcome), Unique Potentials (ALoU)

Consider the advantages of each idea and the limitations you will need to overcome when dealing with the topic. Look for unique potentials one idea may have as compared to another.

Tools for Focusing Ideas

Sequencing (SML)
Arrange options or possibilities in a logical order. One example is the time frame for completion (short-range, medium-range, long-range). This is especially useful in developing an Action Plan.

Paired Comparison Analysis (PCA)
When considering multiple possibilities, compare one possibility against another idea, one pair at a time, until all possible pairs have been analyzed. For example, when comparing A, B, and C, A and B would be compared first, then A and C, and finally B and C. As the favorite option is determined in the pair, assign a rank of 1, 2, or 3 according to the degree of importance.

FUTURE Problem Solving Approach

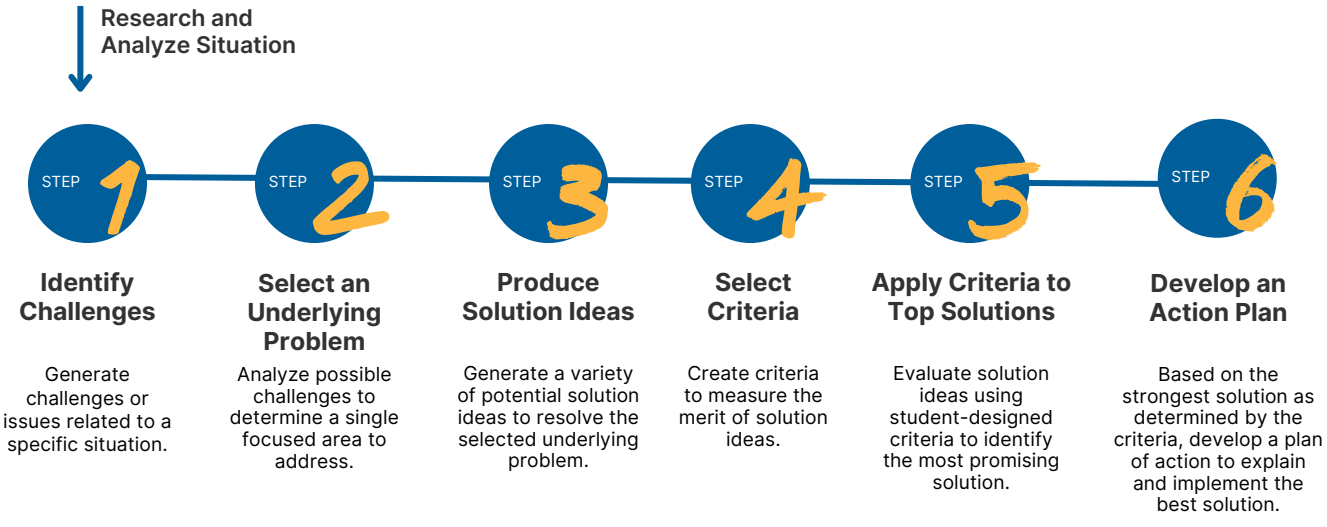
Why it's important

Once learned, our Future Problem Solving method is easy to apply in any problem-solving situation. Students learn to thoroughly research and analyze real world issues then apply the 6-step creative problem-solving process to develop relevant action plans. Students move well beyond memorization to apply learned information and make decisions. With our 6-step process, they alternate between using divergent and convergent thinking skills to develop relevant action plans to our imagined future scenes or real world issues of their own choosing. Highly flexible, the model may also be taught for use in the classroom and beyond.

Topic-specific practice

Each of our topic Activity Units includes prior future scenes on topics similar to the upcoming competition topic. Practice with similar future scenes can help students gain experience and confidence in spontaneous problem solving. If you are new to Future Problem Solving, you can learn more about the future scenarios used in our problem-solving competitions and see past examples of future scenes as well as student work in the Resources Library on our website.

Proven 6-Step Problem-Solving Approach



We hope you find our research unit series to be a valuable resource as your students gather knowledge about Future Problem Solving topics of study.

Additional resources

Problem-solving tools

Be sure to check out the additional problem-solving tools shared in the supplemental materials. The tools help students apply creative thinking to their topic research and analysis.

Topic activity unit

Our activity unit on this topic contains a wealth of curricular resources for use with students in a variety of settings, including out-of-school time. The highly engaging activities incorporate best practices and come with step-by-step lesson plans for research-based independent and collaborative work.

Topic-related practice future scenes

The topic activity unit includes one or more topic-related practice future scenes. Used in Global Issues competitions, our future scenes are imagined "what if" scenarios based on current topic information. Each year teams of experts develop descriptions of problem situations set 20-30 years in the future needing to be solved.

Education standards

Our Future Problem Solving process fulfills a wide variety of education standards. We take connecting with these standards into account when developing our program materials. Teachers can easily tailor Future Problem Solving content to meet their specific education system and local requirements as needed.

How our topics are selected

Our topics represent important challenges from business, civics, society, science, and technology and serve as the thematic basis for given problem solving situations. Each school year, students get 3-5 opportunities to solve important near-future global issues based on their progress in local and regional competitions. To be considered, a topic must be broad enough to appeal to participants living around the globe, offer a range of themes and issues to explore, and be considerate of a variety of views. Lastly, of course, every topic must be accessible for all, from ages 8 to adult.

We welcome submissions of topic ideas from anyone year round. Our topic committee reviews, refines, and categorizes submissions into our diverse strands. Then options are narrowed down and screened by our regional affiliate leaders. They pre-select top candidates for each of the category strands to present to our entire global community for a vote. The community's input, including students, heavily influences the final selection. Topics for the upcoming competition season get announced March 1.

About Future Problem Solving

Future Problem Solving proudly celebrates over 50 years of placing nearly a million young people at the core of a dynamic, purposeful learning experience. Each year K-12 students around the world participate in a variety of challenges designed to empower curious youth to become changemakers. Problem solvers learn how to think, not what to think, and gain skills they need to succeed in work and life. Our programs help young people develop their own voices and the confidence to use them.

To learn more about Future Problem Solving, to submit a topic idea, or contact us, visit fpspi.org.