School of Education
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Young People's Conceptions and Alternative Conceptions about Climate Change

Translating Climate Science for Young People
Royal Society
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Lancaster University

Introduction

- Overview of the data – analysis of student group interviews
- Broadly 'accurate' conceptions about causes, processes and effects
- Alternative conceptions regarding causes, processes and effects
- Conclusions

Overview of the Data

- Interviews were coded to give us an idea of the accuracy of students' statements about global warming
- It was not possible to use this coding quantitatively due to the complex nature of what students said, as well as the process

Overview (cont.)

- 'Accurate' statements were considered to be broadly in alignment with the scientifically accepted arguments
- 'Unclear' statements sometimes had overlap with these as it was where students did not give a complete or clear enough explanation
- 'Inaccurate' statements were when students said things that were not in alignment with scientifically accepted arguments. These are referred to as alternative conceptions.

Broadly Accurate Conceptions about Causes or Processes

- Most students are aware that burning fossil fuels produces gases that cause climate change
- Many students are aware that one of the main gases involved is CO_2
- Some idea that the warmth from the sun comes into the earth's atmosphere but not all of it goes out again
- Generally not coherently explained – often a jump from presence of greenhouse gases to increased temperature.. But..

So how do you explain climate change?

"I'd say like the factories, they burn fossil fuels like coal and oil for us so we get electricity and things like that, and then all those gases [are] released.. [and] go into the atmosphere and then when the sun rays shine upon us, they get trapped in the atmosphere 'cause those gases trap them, and that heats the atmosphere up"

Year 9, School A

Broadly Accurate Conceptions about Causes or Processes

- There will be a rise in global temperature
- Ice caps will melt and there will be an increased incidence of flooding
- Increase in unpredictable weather events
  - E.g. storms and droughts as well as flooding, unseasonal weather

Possible Effects

"I know that in Bangladesh the low-lying land would be flooded in the event of rising sea levels. That would be because of the expanding seas 'cause of the rising temperatures and melting ice-caps".

Year 11, School D

"Well, it like creates unpredicted weather and things that don't usually happen can happen".

Year 8, School C

Alternative Conceptions about Causes and Processes

- Ozone layer (most frequent alternative conception)
- Acid rain and other pollution
  - "bad gases"
- Layer of greenhouse gases
- Gases themselves are hot (very few students)

(Also see several research papers e.g. Dawson 2015)

Ozone Layer

"Like the ozone layer's been like almost eaten away by global warming so it's heating up the planet".

Year 9, School C

Ozone layer used in various ways to explain climate change, getting thinner and thicker..

Possible reasons: Layer of greenhouse gases (diagrams from text books); timing of teaching

Acid Rain

".. Like the greenhouse gases themselves, they will create acid rain which can actually erm, greatly affect erm.. our bodies 'cause.. it'll be highly corrosive.."

Year 9, School D

Possible causes: Gas involved in greenhouse effect is nitrous oxide (N_2O) and acid rain is nitrogen dioxide (NO_2); burning fossil fuels etc that may release sulphur dioxide; that a change in (acid) rain fall is an effect of climate change

Alternative Conceptions about Effects

- Exaggerated or extreme ideas about the effects of a rise in temperature
  - Very high temperatures (melting, balls of fire, dying plants and animals (including humans)
  - Floods and droughts
  - Food chains, adaptation (extinction, no food growing)
- Increased and dangerous pollution to air and water

"The world will warm up so much it might blow into a ball of fire like the sun" Year 7, School A

"… many places will just be like the Sahara, then you're just rotting away, and some places will be… submerged… And other places would be like Spain is now, except more so… Well the ones that haven't melted anyway" Year 9, School D

"And if like, some areas are hit by a horrible drought.. it will just send society into collapse as, like, the water supply is to end and people will just end up killing each other in search of food and water… and the rest of the world would just go insane, and we would all end up destroying ourselves" Year 11, School B

Causes of these Ideas?

Text books? Popular websites? Fictional stories?

Exploring SemTag Temperature: hot/on fire (Student Interview Data)

Word	Semtag	Frequency	Relative Frequency	
warming	O4.6+	225	0.25	Concordance
heat	O4.6+	196	0.22	Concordance
hot	O4.6+	141	0.16	Concordance
hotter	O4.6+	115	0.13	Concordance
melting	O4.6+	112	0.13	Concordance
warm	O4.6+	105	0.12	Concordance
burning	O4.6+	84	0.09	Concordance
heating_up	O4.6+	49	0.06	Concordance
burn	O4.6+	34	0.04	Concordance
warming_up	O4.6+	29	0.03	Concordance
melts	O4.6+	27	0.03	Concordance
heating	O4.6+	21	0.02	Concordance
heat_up	O4.6+	21	0.02	Concordance
fires	O4.6+	16	0.02	Concordance
heats	O4.6+	15	0.02	Concordance
warms_up	O4.6+	14	0.02	Concordance
heats_up	O4.6+	11	0.01	Concordance
warmth	O4.6+	10	0.01	Concordance

Exploring SemTag Temperature: hot/on fire (Student Educational Materials)

Word	Semtag	Frequency	Relative Frequency	
warming	O4.6+	757	0.38	Concordance
heat	O4.6+	335	0.17	Concordance
burning	O4.6+	139	0.07	Concordance
warm	O4.6+	132	0.07	Concordance
melting	O4.6+	119	0.06	Concordance
hot	O4.6+	76	0.04	Concordance
hotter	O4.6+	43	0.02	Concordance
burn	O4.6+	41	0.02	Concordance
melts	O4.6+	35	0.02	Concordance
warms	O4.6+	35	0.02	Concordance
fires	O4.6+	34	0.02	Concordance
wildfires	O4.6+	34	0.02	Concordance
burned	O4.6+	23	0.01	Concordance
warmed	O4.6+	20	0.01	Concordance
heating	O4.6+	18	0.01	Concordance
hottest	O4.6+	18	0.01	Concordance
warms_up	O4.6+	17	0.01	Concordance
fire	O4.6+	16	0.01	Concordance
burnt	O4.6+	14	0.01	Concordance

Concordancing ‘warm’ in Student Educational Materials

file2523356	UK use more energy on keeping buildings	warm	than on anything else. Changing climates
file2523356	always changed. There have been ice ages and	warm	periods. But never before have temperatures
file2523356	of snow by 2015. Some polar regions are	warming	at a rate two to three times the global
file2523356	climate is kept mild by the Gulf Stream, a	warm	current from the Caribbean that flows towards
file2523358	Greenhouse Effect The atmosphere keeps us	warm	by trapping heat. Some radiation from the
file2523358	wavelength EM radiation from the Sun. This	warms	the Earth's surface up. The Earth then
file2523358	hotter droughts. 4) Hurricanes form over	warm	water – so with more warm wafer, you'd
file2523358	Hurricanes form over warm water – so with more	warm	wafer, you'd expect more hurricanes. 5)
file2523358	bad news for us in Britain - if the nice	warm	currents we get at the moment weaken, we
file2523359	a lot about global warming. The Earth is	warming	up, changing our climate and leading to
file2523359	there is a problem. By day, the Sun's energy	warms	up the Earth. The warm Earth then radiates
file2523359	the Sun's energy warms up the Earth. The	warm	Earth then radiates energy back into space
file2523359	, trapping energy and keeping the planet	warm	. Without it, the Earth would freeze over
file2523359	is pumped into the Martian atmosphere to	warm	the planet up so that people could live
file2523359	dioxide might cause global warming The sun	warms	the Earth. The warm Earth radiates energy
file2523359	global warming The sun warms the Earth. The	warm	Earth radiates energy into space. Carbon

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< previous global warming are enormous. We are already seeing its effects. Mountain glaciers are retreating everywhere. Mt Kilimanjaro, a famous snow-capped peak in Tanzania, may be bare of snow by 2015. Some polar regions are ***warming*** at a rate two to three times the global average. Many parts of the world are experiencing extreme weather - high winds, heavy rains, or heat-waves and droughts. Climate models predict that winters will become wetter next >

Findings (Student Educational Materials)

- 'Severe' discourse on the rate of global warming is present in both textbooks and websites, for example:

  "Some polar regions are *warming* at a rate two to three times the global average….." (GCSE Biology, AQA).

  - Statements like these could be the source of students' hyperbolic ideas regarding the effects of global warming.

- Pessimistic and severe ideas relating to the impact of global warming are present in both textbooks and websites, for example:

  "If the Earth keeps getting *warmer*, up to one-fourth of all the plants and animals on Earth could become extinct within 100 years" (www.environmental-protection.org.uk).

  - Statements like these could be the source of students' apocalyptic ideas regarding the impact of global warming.

Causes of these Ideas?

Teachers: Is this a familiar pattern? What do you think about the text books?

Everyone: Where else do you think these ideas are coming from? Does it matter? What should/ could we do about it as a science education community?

Reasons it might matter…

- If students don't really understand the processes of the greenhouse effect leading to increased global warming leading to climate change..
- They may be less likely to really believe it
- Students have said unless people see the effects of climate change themselves they are unlikely to do anything about it.. People will not see such apocalyptic scenes
- Changes that are thought to be damaging are only 1 or 2^{o}C increase in global temperature – sounds minor

Can Climate Change be Stopped?

Students said:

- Not stopped but slowed down
- People don't want to change, or changes would be severe in terms of slowing down development and progress
- To slow it down needs fewer cars being driven, cutting down on fossil fuels, and increase in use of renewable energy sources
- Some recognised you needed government involvement, across the world, and that it is expensive

Some Conclusions and Questions

- Some students seem to think of climate change leading to certain catastrophe – is this problematic?
- Students still (and in many parts of the world) think of us having a relatively thin layer of greenhouse gases around the earth – is this problematic?
- However, ideas about what to do about climate change were reasoned and seem well thought through – students did not seem completely hopeless or powerless.

Possible Implications?

- Text books and other sources of information need to be more careful about teaching – use of models and evidence and stating possible outcomes of climate change
- Teaching needs to address students' confusion between different causes and effects of pollution(s) to enhance understanding and enable action
- Although students appear not to feel hopeless we did not ask directly about what *students* could and would do to slow down climate change – should this be explored (taught?) explicitly?