What do the learner know about clouds, precipitation, wind and greenhouse effect;

a short review of research from 1883 to 2009

Pål J. Kirkeby Hansen

Faculty of Education, Oslo University College

PalKirkeby.Hansen@lui.hio.no

oslo university college

www.hio.no

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Motivation for the research question:

David Ausubel (1968)

Educational Psychology: A Cognitive View

If I had to reduce all of educational psychology to just one principle, I would say this: The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly.

Start: Clouds, Rain, Wind, …

Granville Stanley Hall (1883)

The Contents of Children's Minds

- 200 Boston children, age 4 to 8
- explanation "in its own word" of 112 different objects and concepts:
- *Per Cent Children ignorant of it:*
  - Dew 78 %,
  - What season it is 75.5%,
  - Seen hail 73%,
  - Seen rainbow 65%,
  - Seen clouds 36%.

The Contents of Children's Minds

Citations:

God keeps **rain** in heaven in a *big sink, rows of buckets,* a *big tub* or *barrels*, and they *run over* or he *lets it down* with a *waterhose* through a *sieve*, a *dipper with holes*, or *sprinkles* or *tips* it down or *turns a faucet*. God makes it in heaven out of nothing or out of water, or it gets up by *splashing up*, or he *dips it up off the roof*, or it *rains up off the ground when we don't see it*.

The **clouds** are *close to the sky*; they move because the *earth moves and makes them*. They are *dirty, muddy things,* or *blankets*, or *doors of heaven*, and are made of fog, of *steam that makes the sun go*, of smoke, of *white wool* or *feathers and birds*, or *lace* or *cloth*.

The Contents of Children's Minds

Hall's advise:

The best preparation parents can give their children for good school-training is to make them acquainted with natural objects

J. Olsen (1900)

Children's ideas – (Denmark)

- 5600 pupils at Varde, 1898-1900, age 6-7
- *Percentage of children having somewhat clear idea of the thing in question:*

	Girls	Boys
Thunder	72	85
Hail showers	81	93
Moving clouds	81	46
The rainbow	90	78
The dew	30	46

Children's ideas – (Denmark)

Olsen's closing remarks, like Hall's, go to the parents:

In this respect we cannot too urgently say to the parent: - Converse with your children!

Jean Piaget (1896 - 1980)

La représentation du monde chez l'enfant (1926)

1.stage (5 to 6 years): **Clouds** are solids made by men or God (realism). Clouds move because men or God or the clouds themselves want to (animism); or move when we move (participation).

2.stage (6 to 9 years): Clouds are made from smoke, dust, earth or stone (causality).

3.stage (9 to 10 years): Clouds are of entirely natural origin: condensed air or moisture, or steam or heat, etc. (real causality). The development from stage 2 to 3 is influenced by teaching.

La représentation du monde chez l'enfant (1926)

1.stage (to 7 years): **Rain** is made by men or God and comes from buckets of water, taps, pipes, sinks, fountains, … in the sky or in the clouds.

2.stage (7 to 9½ / 10 years): Rain comes from human activity, the clouds move about intentionally to wherever rain is necessary and transform themselves into water or melts.

3.stage (from 10 years): A mix of learned explanations and more original: clouds are heat, wetness, perspiration, mist … and rain explains itself

La causalité physique chez l'enfant (1927)

1.Stage (average age 6 years): **Wind** is breath of men or God, or made by men or God by fans, machines, bending trees …

2.stage (average age 8.3 years): Objects that moves are believed to cause wind and the wind can accelerate itself; wind comes from the sky, sun, moon. Trees, dust, waves and clouds are setting themselves in motion to produce wind – which makes the trees, dust, waves and clouds move (!).

3.stage (average age 9.6 years): The air sets itself in motion in virtue of its own force, the air behind pushing that which is in front

1930 – 2009

support and critic of Piaget's stage theory on clouds, rain, wind ++

Lundeen & Caldwell, 1930; Caldwell & Lundeen, 1932, 1934, 1971; Maller & Lundeen, 1933; Zitz, 1937; Oaks, 1947; King, 1960; Inbody, 1963; Boyd, 1966; Tisher, 1967; Za'rour, 1976; Moyle, 1980; 1st International Conference on School and Popular Meteorological Education (EWOC), 1984, 1989, 1993, 1996, 1999, 2003, 2006; SISS 1984, TIMSS, 1995, 2003; Stepans & Kuehn, 1985; Hansen, 1989, 1996; Proverbio & Lai, 1989; Bar, 1989; Bar & Travis, 1991; Philips, 1991; Nelson, Aron, & Francek, 1992; Kennard, 1993; Mroz & Raven, 1993; Aron, Francek, Nelson, & Bisard, 1994; SAS, 1996, Dove, 1998; Weiler, 1998; Hapkiewicz, 1999; Fraser, 2000; Henriques, 2000; Pinson, 2001; ROSE, 2004; Beaty, 2005; Miller, 2005; Sweetland, 2005; Thompson & Logue, 2006; Fries-Gaither, 2008; Hubisz, 2008; Stepans, 2008; Wetzel, 2008; Wainewright, 2009

Pål J.K. Hansen (1996)

"Everybody talks about the weather …"

*What do you think a **cloud** is? What does it contain?*

- Percentage of children's answers by age, before instruction, some weeks after, 2 years after instruction

Children's conceptions of **clouds** (Piaget stage P1, P2, P3)	13 years Before in. (n=464)	13 y After (358)	15y (354)
Misconceptions (P1)	25	9	18
Mix (P2-3)	60	50	58
Satisfactory (P3- …)	15	43	24

"Everybody talks about the weather …"

*Why do you think it's **raining** from some clouds, but not from all?*

- Percentage of children's answers by age, before instruction, some weeks after, 2 years after instruction

Children's conceptions of **rain** (Piaget stage P1, P2, P3)	13 years Before in. (n=464)	13 y after (358)	15y (354)
Misconceptions (P1)	40	32	41
Mix (P2-3)	45	57	42
Satisfactory (P3- …)	5	11	8

”Everybody talks about the weather …”

*What is **wind**? Why does it start to blow?*

- Percentage of children’s answers by age, before instruction, some weeks after, 2 years after instruction

Children’s conceptions of **wind** (Piaget stage P1, P2, P3)	13 years Before in. (n=464)	13 y after (358)	15y (354)
Misconceptions (P1)	86	55	75
Mix (P2-3)	12	30	14
Satisfactory (P3- …)	2	15	11

Start: The Greenhouse Effect, …

Pål J.K. Hansen (1989)

Spørsmål om vær … [Questions about Weather …]

Norwegian pupils15 years, n=348, responses to statement:

The greenhouse effect is necessary for life on the Earth

Agree: 23.3%

Responses to 7 other statements about greenhouse effect and ozone layer (% *response*)

	n=348
Exchange greenhouse effect with effects of the ozone layer.	26.4
Confuse greenhouse effect with effects of the ozone layer.	18.1
Sum of Exchange and Confusion	44.5

Edward Boyes and Martin Stanisstreet (1992)

Student's Perceptions of Global Warming

- Constructed a scheme of 36 statements about
  - consequences(12), causes(12), action to reduce(12)
  - also to be used in 1993 and so on …
- 218 first-year British undergraduate students in biology, age 18-20 years
- Confusion of global warming and ozone layer depletion (ca.60%)
  - also found in secondary school pupils (1993)

1990 two new reports;

1993 – 2009 support and development of Boyes and Stanisstreet's works ++

van Marion, 1990; Hocking, Sneider, Erickson, & Golden, 1990; Boyes & Stanisstreet, 1993; Francis, Boyes, Qualters & Stanisstreet, 1993; Hansen, 1993, 1996, 2003, 2009; Moran & Morgan, 1993; Boyes et al., 1995Morgan & Moran, 1995; Batterham, Stanisstreet, & Boyes, 1996; Christidou & Koulaidis, 1996; Dove, 1996; Fisher, 1996, 1998a, 1998b, 1998c; Hillman, Stanisstreet, & Boyes, 1996; Mikkelsen, 1996; Potts, Stanisstreet, & Boyes, 1996; Smith & Ford, 1996; SAS, 1996, Rye, Rubba, & Wiesenmayer, 1997; Koulaidis & Christidou, 1999; Henriksen, 1998; Mason & Santi, 1998; Boyes, Stanisstreet & Papantoniou, 1999; Cordero, 1999; PISA, 1999, 2000, 2006; 2001; Groves &Pugh, 1999; Meadows & Wiesenmayer, 1999; Andersson, 2000; Andersson & Wallin, 2000; Beatty, 2000; Fraser, 2000; Jeffries, Stanisstreet, & Boyes, 2001; Henriksen & Jorde, 2001; Khalid, 2001; Gayford, 2002; Matkins, Bell, Irving, & McNall, 2002; Kerans & Carlson, 2003; TIMSS, 2003; Turmo, 2003; Daniel, Stanisstreet, & Boyes, 2004; Papadimitriou, 2004; ROSE, 2004;Schreiner, Henriksen, & Hansen, 2005; Ekborg & Areskoug, 2006Gautier, Deutsch, & Rebich, 2006; Kerr & Walz, 2007; Lee, Lester, Ma, Lambert, & Jean-Baptiste, 2007

The End?: The Greenhouse Effect, …

Pål J.K. Hansen (2009)

Knowledge about the Greenhouse Effect …

Norwegian pupils15 years, responses to statement:

The greenhouse effect is necessary for life on the Earth

Agree:1989 23.3%, 1993 30.5%; 2005 *75.0%

Responses to 7 other statements about greenhouse effect and ozone layer (% *response*) (*Significant increase (α<0.5%) 1993-2005.)

	1989 n=348	1993 n=354	2005 n=440
Exchange greenhouse effect with effects of the ozone layer.	26.4	17.5	19.3
Confuse greenhouse effect with effects of the ozone layer.	18.1	32.8	*51.1
Sum of Exchange and Confusion	44.5	50.3	*70.4