

Heat transport for 13 year olds

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Before: In a more traditional lesson without differentiation, all aspects of insulation are discussed first, and the whole task of designing a method to keep tea hot, is presented at the end.

After reversal and omission: In the small-scale whole task (only 15 minutes), students are challenged to design a tea cup that keeps tea hot, before all ingredients needed to solve this problem have been discussed in class.

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Learning Goals (stemming from different perspectives on physics and on education; aiming at different levels in Bloom's Taxonomy):

1. Students know there are three types of heat transport: convection, conduction and radiation.
2. Students know that having good isolation means you need to prevent all types of heat transport from happening
3. Students can indicate which type of heat transport is relevant in new situations.
4. Students can relate consumer needs to technological solutions.
5. Students know that one can look at physics topics from a scientific point of view, from a daily life perspective, or with the attitude of an engineer
6. Students have some insight in their own preferred perspective on physics
7. Students have some insight in their own preferred learning style.

Time	Student activity	Teacher activity
0-2	Takes book and notebook	Welcomes students
2-4	Listens	Tells students this lesson will consist of three parts: -class discussion on heat transport -design task either in group or in class -compare results class/group(s)
4-12	Takes part in class discussion Takes notes	-Shows hair dryer -Lets one student feel the top end of a metal teaspoon getting hot when lower end is in boiling water -Discusses heat from the sun coming towards us without any matter in between -discusses characteristics of the three types of transport Teacher lets students who do not raise their hands speak as well!
12-15	Thinks about the question: Is warm wind from the South mainly a matter of convection, conduction, of radiation?	Tells students the procedure of Peer Instruction question: -write down your own choice A, B or C -raise hand when asked Discuss for one minute with neighbour -raise hand again
15-18	Chooses: -solve task in group -solve task in class	Explains there is a large task to follow, those who find following lesson in class a bit boring: work independent of teacher; those who think the challenge is too large, take part in further class discussion (both options are fine)
18-20	Listens (do not shout answers)	Shows plastic tea cup and introduces the problem: -think of ways to take measures that keep tea hot for a longer time, using the words convection, conduction and radiation in your answer. Sends groups away with worksheet
20-35	Takes part in class discussion OR Completes the worksheet	Leads class discussion about the above issue Checks e-mail at 28: should a picture of a Dewar be sent to any group?

35-42	Presents results/Listens to group results	Praises students, for incorrect answers says "true in a different situation", ensures safe learning environment is present
42-45	Raises hand to indicate preference	<p>Tells: This was a lesson on three types of heat transport and isolation (because of the following no further check on students having reached this goal).</p> <p>Asks "if you would have to choose: do research on heat conduction of materials, with science perspective, or improve tea cups and look at the issue the way an engineer would do, What would you prefer?"</p> <p>-1,2, no difference</p> <p>Who chose to stay in class and regrets that?</p> <p>Who chose to stay in class and still thinks this was the best option?</p> <p>(And the same questions for: who worked in a group...)</p>

Worksheet heat

Chair (makes sure everybody contributes in discussion):

Manager (keeps track of time, decides if help is needed):

Internet person (the only one allowed to use wifi):

Book person: (the only one allowed to use the textbook):

Presenter (presents conclusions in class):

Think of three ways to keep tea in cup hot for a longer time. Use the terms conduction, radiation and convection:

1

2

3

If, after 8 minutes you are stuck, write an e-mail to h.vanbemmel for help.

Return to the classroom at , ready to present your ideas.

Subject perspectives:

- scientific (three ways heat can be transported)
- daily life (tea)
- technology (make improvements to tea cup)

Educational perspectives:

- constructivist (students build on what they know, reasoning in class depends on student ideas)
- socio-cultural (some give explanations to others)
- personalistic (learn about own preferences in perspective on physics/independency when working on task)
- ecological (I treat subject matter that is obligatory in lower grade, so I meet goals my "environment" imposes on me)
- interpersonal (mainly for those working in groups (take roles))
- academic rationalistic: explicitly mentioning different ways of looking at heat transport