# Physics, Children, Technology and Wagenschein – how to combine?

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"**The aims of Wagenschein don't fit in today's world**"- a common blame. "He's (he was) romantic, old fashioned. Our world is quite different and those children – they don't exist any more – extinct! If you build your lessons on such a base: That's irresponsible – a crime!" (very sharply formed). Honestly, I should agree with this criticism, my only suggestion might be not to throw away the baby with the bath water – focusing on the difficulties with Wagenschein's manner and neglect the advantages of his way of teaching.

What difficulties? His opinion on technology, to the modern age at all, was commonly negative. More than 15 of his papers contain the concepts of technical/technology, mostly adverse to natural science. On the one side the natural scientist, striving for cognition and presenting the results – there the technician merely usurping these results. As an example I will show some sentences of his paper **"Natur physikalisch gesehen"** [1](The physical aspect of nature, 1975) [W 2a][2] p 20:

> Most people will feel as transferred into the reign of *technology*, a kind of vestibule indeed, but really belonging to the technical world. They think as physics has to do nothing but serve the technician presenting to him the means - material and mental tool kit (apparatus, tables, laws and formulas) now used by the engineers to make their inventions. People regarding the abuse of technology with reserve, suspicion, hostility – artists first of all – will transfer this rejection to physics.

Or even more distinctly in the chapter following shortly later

### *Research and Technology*

> MICHAEL FARADAY refused, as TYNDALL reports [9], to take over "industrial work". *"Taking the duration of his life into account, this son of a blacksmith, and apprentice to a bookbinder, had to decide between a fortune of 150.000 £.on the one side, and his undowered science on the other. He choose the latter and died a poor man".* I told the story to a group of sixteen-aged boys and added:
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> "And now be aware that without this FARADAY dynamos, transformers and broadcasting wouldn't exist. But, as you just have heard, he obviously had no interest in technology and industry. What (the hell!) were the reasons to work in his laboratory, no rest but devotion?" – There was no answer.
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> [9] JOHN TYNDALL: FARADAY as a discoverer; London 1870, p. 190 •
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> In such a manner at that time – shortly before World War II – the opinion was favored, the mere usefulness would be the only aim of research.

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Even more distinct Wagenschein's discussion on the problem physics, children, technology, and school is made in the paper of 1963: „**Physik-Verstehen als Beistand für die**

[1] Martin Wagenschein himself in a later time regarded that title as inediquate – it better should have been "The Natural Aspect of Physics".

• The numbering of footnotes in these cases is taken from the original [W 8]

**Kinder der technischen Welt**“ [W163]: (Understanding physics as a support for the children in a technical world):

> At a first glance you may give a quick answer on the difference between physics and technology: Physics as an objective science shows nature, preliminarily the inorganic, as calculable and consequently available. Technology is the application of physics. Technology rules the modern world. School is obliged to lead the children to understand this modern world and resist it. :Thus a profound, not too short tailed instruction in physics, including the most important applications in technology.

But if we –nevertheless– continue reading that article unto its end, there it is:

> Since about 1900 we clearly know that it is not sufficient to know the results of natural science, but they only can be adapted by doing. Today we are clear about the fact that also this is not enough. We also have to *know what we are doing*.
> Such a comprehensive understanding is not luxurious. It is the foundation for practice for engineers, technicians and skilled workers. The understanding one is in every section superior to the merely manipulating one, as a technician he is more flexible and as a human better protected,

Here Wagenschein’s challenges: “Teach understanding” – “Understanding of the understandable, that is a Human Right” are performed.

But what about its application on technology?

As a teacher I often tried.

But there is a restriction: I never got practice in elementary teaching of science. It’s useless to search for memories in the own childhood, as I attended elementary school four years there science was taught on a low level of geography („Heimatkunde” ) and biology („Naturkunde”).the transition to physics and chemistry („Naturlehre“) was cut off when I changed to the high school („Gymnasium“) where science education did not begin before after a three years break. But already at the age of nine I had been an eager reader of geometry books, had a huge metal construction set and tried chemical experiments and tried to build radios. So the – at last! – beginning physics lessons gave little improvement of my learning and still less the one year (lack of teachers!) of chemistry instruction. Boring! My corresponding reports were ‘average’. When I – after having finished my studies of chemistry at the university with an ‘average’ Promotion, began – feeling encouraged by Wagenschein – to pour out my collected knowledge as a voluntary teacher without any pedagogic study, my pupils (m/f) always were teenagers but normally without any previous experience. On the other hand I taught chemistry only as a substitute, normally I was a physics teacher, but my experience in chemistry was often helpful to explain.

The reference to technology was established by my “hobby” electronics. At the beginning there were courses in building a radio, later projects of digital electronics. Only a few pupils were interested, but when they came, most eagerly.

Before my teaching coasted to a stop, I normally had single students to teach them interdisciplinary, and by exchanging of ideas we both gathered new thoughts. So arose a course of technology announced by a sheet of that kind:

**Lesson: 1st.** **Group of subjects: Science / History**

# TECHNOLOGY
## is the art
## of making natural laws
## useful for mankind.

**The word "Technology" is like the word "Physics" of Greek origin:**

**„Physis" means nature and**

**„Techne" may be translated as art or ability,**

**but often it means outwit.**

**The theme of the course will be:**

**How did historical events influence technology**
**And which effect had technological developments on history?**

At this point my explanation of the word “technology” may show already that I tried to introduce the subject without any prejudice.

For example I began with the following reflections:

- What really makes the difference between mankind and (other…) animals? We soon agreed about the main difference being the occupation with fire. The common statements (like tools, speech and (self-)consciousness could not stand a critical examination.
- Thus using the fire is not only typical human, but also typical technical: without knowing anything about the laws of nature you neither can ignite a fire nor keep it burning nor prevent it from spreading everywhere. It is true that you have to know nothing about science when sitting and warming near a fire or to experience the repelling action on robbers and predators strolling around. But some knowledge already is necessary to prepare a meal.
- Imagine your life without using the fire by you and/or by others
- Still enhanced by the next task:
  Imagine your existence without any technology!…

These both were insolvable problems nearly comparable to the riddle: What would have happened to you if your parents never met? But is this riddle merely a joke?

But all these problems to our environment!

Is technology an evil, maybe a necessary evil? Are we confined “somehow” to arrange with it? Wagenschein’s several statements lead to his assumption. Where are the problems?

> *Preliminarily as an insertion an episode from early times of my teaching: Handicraft with radios. We were just decomposing a wired broadcasting receiver – in Switzerland you had, if connected to a telephone, the possibility to receive broadcasting without being disturbed by lightning, as today by Internet) and there one of these louts asked me: “Hey, Herr Kohl, who does a computer work?” Even if I was knowing, I would not have been able to explain (and maybe would have tried…) But I (fortunately!) did not know. But I could not get the question out of my mind – and meanwhile I believe I can explain the main principles rather well[3] – and should have to do it better. I cannot ask Wagenschein if he could live with that —.*

The episode shows up another problem concerning Wagenschein’s concept and teach youngsters in technology: The surroundings of children are quite different from these to teachers while they themselves were children! We may deplore that but should ask ourselves how much of that compassion is nothing but glorification of nostalgia – desire to the own youth... (If I would teach history, I would introduce to myself and my pupils the famous French king Louis XIV –le roi soleil– as a poor devil

[3] An early concept (not yet revised) you can get by reading http://www.martin-wagenschein.de/en/K-Kohl/Informat/Informat.htm

neither knowing of W.C. nor toilet paper, but full with fleas – do you want to exchange?)

No – the problems to environment – by precaution[4] they are not my theme.

Pedagogues and the children trusted to them They should get them at their world. Teaching matters – which matters are interesting for children? "Car" might have been among the first words of their baby talking – and one of their first toys perhaps made from red plastics with pop-eyes in the place of floodlights – don't worry! Honnie soit qui mal y pense! Or a remote controlled TV… A child of school age – will it dare to ask the teacher (after it has been so often confronted by the parents to the answer: "You will not yet understand!" as the parents would have had to confess their ignorance)

Yes – it is a difficulty to "teach understanding" of technology

Yet another Wagenschein citation:

> In the field of technical *applications* it is not done by referring to as many as possible constructions and inventions. The *principle* of the dynamo, the radio is important above all. Only by a few *selected* inventions the way of perfection from the physical principle to technical usefulness has to be followed and revived as a *mental* process. – In every case the *usefulness* of mathematical science of nature keeps danger and advantage in it. It misleads to a greedy
> - and in conjunction with an insincere strive for better education it leads to a superficial overload of instruction. But it opens the possibility to build on the reality and the daily tasks. Compare it to the corresponding capacities of ancient languages and consider the disregard of High School to many people having a feeling for higher education.
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(From „Zur erzieherischen Aufgabe des mathematisch-naturwissenschaftlichen Unterrichts" (*The educational task of mathematical-scientific instruction*)[1933] [W 47], in „Ursprüngliches Verstehen und exaktes Denken" (*Original Understanding and exact Thinking*) (UveD1) [1970] [W 8], p. 27. – Highlighting by Wagenschein)

The technology of our time is inexplicable

But was it explicable in former times for its contemporaries?

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[4] As I think., by thoroughly deliberating this matter it's too "dangerous" to be seen near a Cynic. Or isn't it an inappropriate cynical way to say: "as long as a human life's worth is more than the life of a tree there always will be more and more humans and less and less trees…" Or, concerning the problem of $CO_2$ by our burning of fossil combustibles: "And if you are extremely straining to save the climate – do you really believe a source once detected will stay unexploited? It may last longer to burn all these mineral resources, but they will be burnt."

It's the dilemma of human nature (Human kind and the ideal of humanity – they can't come into a synthesis).

It's the dilemma of technology (The application of technology will create problems even not removable by (may be another) technology. It's the cat's problem climbing a high tree…

Our welfare is obviously dependent on growth though a primitive calculating may show, that a continuous growth obviously is impossible. What does at all mean "welfare" – "humane existence"?

And if I say: "I am a physics teacher - that is a theme for Social Studies." – This would be the peak of cynicism!

Always business secrets were concealed cautiously. Why? – workplaces were endangered!
But it is a fact that even by thorough inspection there is *no insight* of the function.

**Technician:** The 'Homo Faber' by MAX FRISCH is not strange to us – we know people who feel able to explain anything and thus make perform it. Max Frisch shows to us the failure of this character. MAX EYTH, another writer was singing a hymn on technology such as in his autobiographical book "Behind plow and vise" .
But there is, too, ANTOINE DE SAINT-EXUPÉRY, a pilot and engineer, able to repair his aircraft by himself and, besides that, a very thoughtful man. He really could be a model. Wagenschein cites him several times but not regarding him as a technician.
Max Eyth is not quoted by Wagenschein, only 'Homo Faber' with his restricted sight of things.

- When I was a child I wanted to read Max Eyth and was eager to write in the way he did. To his sight of things I unconditionally would have inhered. His world had been my world of desire. Engineer, technician – possibility of making would have fascinated me without any condition
  Really? Would I have been misled, educated the wrong way?
- Today „Die Wolke" ('The Cloud' - a book describing the apocalypse of a nuclear plant in Germany) is read, warnings about electric smog and genetic engineering spread, we bother about balanced food.
  Is that wrong now?
- "A real ecologist can't stand technologies, But gladly uses indispensables", I formulated along Goethe's Faust in Auerbach's cellar: "Real Germans can't abide a Frenchman, And yet they gladly drink his wine". Reason to my "dirty remark" was the abundant use of the photocopier by the staff of the 'ecological` oriented École d'Humanité.
  To preach for water while drinking wine… I'm not against water-preachers as long as they do not try to convert me and also I'm not against wine-drinkers as long as they are not intoxicated and try to force me to drink too. I agree with the 'Old Fritz' (King Frederic the great) whose edict was 'that everyone could be blessed according to his own façon'
- To deliver a protest against the antenna in the neighborhood to the authorities by the mobile, to fly to a climate conference in Japan or Southern America, to blow the alarm-whistle or beat pot lids to demonstrate against noise – to do that and find it right – I think it false, at least stupid, perhaps even insincerely mendacious

I**nventor:** This word never reached the marking out of the subject indexes in his books, but in some of his texts it is used, such as. in „Zur Didaktik des naturwissenschaftlichen Unterrichts" (Didactic of science instruction) a lecture of the year 1959 [W145] (UveD1 [W 8] p.366) Normally he puts the inventor on the technician's step. In this lecture he emphasizes that he has no direct experience in primary school, his contribution is only of ba-

sic style. Here, too, it is of importance to him to show the difference between exploration and invention and thus a difference in quality between physics and technology.

Essential contributions to our theme can be found especially in the third part of the lecture, containing the following text:

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Now, by the third part, I arrive to some practical advices, slackly lined up hoping to result without difficulties from he aforesaid:

1. I see three approaches to physics
   a) from nature, the most 'natural', but nowadays often blocked.
   b) from inexplicable technical equipment, fascinating, but not easy.
   c) from trade and tools: the easiest and earliest. Here is understood while nature and machines are behind a curtain of magic.

2. Although: accepting the *technical* fascination of the youth. Therefore beginning, *too*, with technical equipment, not too complicated. Not as "application" of physical laws treated in advance, but as a way toward them., That means *excavating nature in technical equipment*.
   *Technology misunderstood makes false magic – Misunderstood physics deprive nature. Understanding physics adequately, deprives machines but will not hurt the charm of nature.*
3. Once the children should merely *discover*: "How will electricity and magnetism depend each from the other?" at *another* opportunity let them merely *invent*: "How can I invent – not only 'construct' – an electromagnetic interrupt to a current?
4. Some essential properties of a physics teacher:
   He should be connected to the whole nature, not only physics and not only technology.
   He must not despise technology.
   Unconditionally he should have read a standard author of emerging natural science (as KOPERNIKUS, GALILEI, KEPLER, GUERICKE, PASCAL, NEWTON) originally.
5. *Beginning*: "Outdoor" or in a workshop is better than school
6. *Beginning*: As early as in a wholesome project children show disposition
   *Later* (about the 7th year of school):disintegration of a still undivided view of nature.
   That does not mean[5] collecting subjects as they will not exist yet for a child but comprehension. A lake as a theme may make the feeling: subjects do not handle different things but look at a thing by different aspects. That is even true for the High School[16] (it is a task for the "transition stage" to upper classes).
7. As soon as it becomes physical: single acts, *singular crystals of understanding* – to be cultivated carefully, note them, collect them. "Understanding" means: recognizing the astonishing as for a long time recognized. Sound comes running like a ball, No wonder that the milk doesn't fall out of the bucket when I'm swinging it over my head – *without* the bucket it would fly away the similar curve.

[16] Comp. Der math. u. naturwiss. Unt. VIII (1955/56). p. 182.

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[5] Comment on a property of the German Language: „Fach (pl. Fächer)" means 'box, drawer' The *singular* word „Fächer" is to be translated as fan. So there are different meanings of the word Fächer. Wagenschein (and I) refuse the separation into different boxes and favor the comprehension expressed by a folding fan.

8. Never *measure* just for measuring!
Don't do before the object calls for to answer a question. I know a small rural community home: The children had built, together with their teacher, a small swimming pool – They finished in April. The boys wanted to test it immediately- "It is too cold!" – "But from our new water-boiler we can pour 80 liters of boiling water!" –"Well, let us do!" – That led, beneath other aspects, even to the introduction of thermal units.

9. *Mathematification*, Formulas. LICHTENBERG, who should have to know it; says: "…believe in … mathematics absolutely necessary to physics, is a stupidity, as when that really takes place, the best already has been found. Bringing it to a state where the physicist can render it to the mathematician, that is the thing![17]" Mathematification is the *last* step: "The more I compress a volume of gas the more it will resist" may show more understanding as the formula "$p \cdot v = const.$"
Such constructions of *if-then, the more… the more…* are a *legal* step of scientific thinking – physicists describe it as "q*ualitative*". This is a pity, because it is quantitative already. High school sees it of little value, primary school therefore as childish. It is not.
EINSTEIN remembers: "I, too, had the luck" (aged between 12 and 16) "to get the most important results and methods of all the natural science by an excellent popular description nearly totally reduced to be qualitative[18]".
Obviously it had no negative effect.

10. More important: The language
The so-called "exact phrase" and the sterile jargon are something that should finally be mastered. This is not achieved by the bold and memorized mnemonics. Not by linguistic correcting - in flagrant- a child who is advanced into the venerable status of stammering thinking, but to reach the last by the way, when you first think of more valuable: that the children speak and write in their own living language. If a seven year old, playing with a magnet and nail exclaims: "It's jumping already, if it's far away,"[19] so that is unsurpassed. And dialect is conducive

*Essays* of this kind we need. - No fear of figurative language. "jumping" is not worse than "A force acts upon it." Scarcity is a late virtue. It depends on something else. If we compare the tap water of the textbook: "Let swim a magnet on water, it will show in

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[17] aphorisms. Insel Library. Vol 33 P 5
[18] Albert Einstein as a philosopher and naturalist. Stuttgart 1951 p 5 f – There probably is meant A. BERNSTEIN Scientific chapbooks. 5 vols Berlin 1891
[19] A. BANHOLZER: Die Auffassung physikalischer Sachverhalte im Schulalter (The perception of physical facts by school age). Tuebingen dissertation 1936 p. 48 f. {1341}

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the north-south direction," we compare with the source water of a text from 1269, written by the Crusader PIERRE DE MARICOURT[20]
"Take a round wooden vessel ..., there into put the lodestone ... and this now, with the stone in it, put into another big vessel full of water, so that the stone in the first vessel sits, as the sailor in the ship, but the first vessel sitting in the second, spacious, like the ship on the waves is driving ... the stone mounted this way now turns his little vessel to the North Pole until the North Pole of the stone shows just to the north pole and the south pole of the sky just to the south pole of the heavens. And, of course, if it is turned away thousand times, a thousand times in his situation it will turn back by God's will."

This is the language of originality. Just by this way our children want to learn writing, just as original and as accurate. It seems to me we prevent them. - And how *young* might you be to see this piece of physics and to describe it.

11. No *hasty* advanced tale of *atoms, electrons,* and similar realities that are not on the level of palpable reality, the visible and audible phenomena, but are formed only by thinking on them.

Quite contrary to my own principle: At first the experiment, and afterward the conclusions even high school already tells the beginner of molecules, atoms, electrons, without the phenomena demanding them. This is copied by the elementary school, well-conscious. Does this not mean the penetration of the corruption of understanding into the school?

Instead of the early suggestion: "You have to imagine, small electrons are flowing in the wire" the teacher should say, "Look at this glowing wire stretched between the poles of the battery: you can see some flow? You see even *electrons*? Take good care of them!"

I know very well how hard it is: The teacher is not prepared to it because the high school graduate is not, because the junior teacher is not…

12. Dwelling at the *phenomena* does not prevent from seeing *relationships.*
At the beginning everyone of us will regard water as a peaceful element. When it boils that will be because we force it by heat..
But if you see boiling it coldly by vacuum. The face of the whole matter will change: All water *wants* to boil by itself. The pressure only of the atmospheric ocean will repress it.
Herein a lot of other phenomena might be included: Boiling point shift, evaporation, diffusion, internal pressure of gases, BROWNian motion.
Result: Matter appearing so peaceful "has a punch": a secret aggressiive drive. This is the phenomenological side of the kinetic theory of matter. (Here we can learn some of the pedagogy of the Waldorf schools[21])

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[20] Reprints and writings on meteorology and terrestrial magnetism, Ed G. Heldmann. Berlin, 1897. No. 10 Rara magnetica.

[21] HERMANN V.. BARAVALLE: physics as a pure phenomenology. 3 volumes. Bern: Troxler publisher. - (Even if you, like me, are not anthroposophist, you may refer to the serendipity of Waldorf pedagogy that so often refers on GOETHE, and take precious deviations from the norm that can be detached from the ideological foundations of the doctrine of RUDOLF STEINER.)

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13. This does not mean to get out of the way of theories, images, models: Of course not, if they arise by the matter to the children. Children like t build theories. If an uncharged electroscope coupled to a charged one by e wire, gets its “kick”, they may (in Darmstadt) cry out:"Ewwe isses eniwwergelaafe!": - “It just ran over” This “it” is the – totally invisible – electricity, precursor of the “amount of charge”.

14. Much can be understood by *a simple amount of thinking*. More than the primary teacher might know. A High School graduate , in general, does not know, why he is Copernican. So he contents himself later, as a teacher, trying to illustrate the Copernican system, which will not bring any understanding. To look for a simplified, but still precise proof is an important task, where the high school teachers can be very helpful[22]

15. On paths of thinking, smoothed that way, nearly bare of mathematics, nearly without the imagination of any model, you are at the end of 9th or 10th year of primary school, at the end of the middle level of High

School. There you can create a simplified canon[23], a compendium of physics, containing the single crystals of understanding collected before (besides some things to be added, even demonstrated or "lectured") Systematic work is not locked away from primary school. But it is to be placed at the end. It is the aim, not the path of instruction.

16. Into this canon exemplary deep drilling can be placed, illuminating the previously mentioned functional goals (and others). How – that only can be told by great detail. As I did often before[24], here I and you may be contented by this hint.

17. To make believe earth being a sphere, an illustration (by a globe) is not sufficient, and even an exact deduction ("you can surround it by any direction") is not sufficient. It is too fragile. Being convinced is more than admission. It has to be assimilated deeply. Only a few graduates of High School have thoroughly thought the antipodean problem as to take off the fear of falling away during night from a thoughtful child having heard it too early.

18. I do not know to reach this assimilation better than by common instruction of boys and *girls* (not necessarily equal in age!) and align to the girls. Then it is correct for the boys. As our male temper is better disposed to split off logical understanding than to dis-corporate it. I cannot confirm the assumption girls are not adapted to physics – assimilated well. I did not find out that girls

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[22] In respect to astronomy I have tried by „Die Erde unter den Sternen" (The Earth under the stars) Weinheim, Beltz 1965 [W 4] – further in: „Der Physikunterricht" (Physics instruction) No. 1, Klett, 1965 [W 10]

[23] For details see chapter XVI of my book "The pedagogical dimension of physics." Brunswick in 1962.

[24] See, for example: „Zur Klärung des Unterrichtsprinzips des exemplarischen Lehrens. In: Die deutsche Schule" (To clarify the principle of exemplary teaching. In: The German School 1959. Pp. 402 ff [W146].

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a stronger assimilation tan the male knight De Maricourt.
Favorable by this aspect is now more and more women become elementary school teachers .

19. What can a teacher do, even in elementary school too, especially do to let physics be experience physics as an aspect of nature (except the exemplary deep drilling, so to speak, "under the table")?
He never should act like showing, that earlier and original understanding of nature and also later artistic or religious experience of nature are to be dismissed as illusions by physical determinations.
He should never be as if the and more primitive understanding of nature, and also later artistic or religious nature experiences, dismissed by the physical findings are illusory.
He never should speak of "apparent" motions of celestian bodies but at the most their "motions referring to us". He should not give optics the title "The nature of Light" and he never must say (though Bacon did so): Warmth is "in reality *nothing else but* molecular motion".
He should not speak of the lines of magnetic force as if they were tentacles.

He should not leave it to the teachers of German or religion to show that some advance might be a regression. An adequate example might be the modern peal of bells without a bell. Automatically beaten small rods of bronze make a sound, by being amplified electronically thousands of times not to be distinguished from real bells, but cheaper.. "It's really the *same*" the inventor may say "Sound *is* 'nothing else but' shaking the air. Arguing that way shows pure physicalism. – Children feel the loss. You cannot see a pealing bell swinging in front of the sky. You cannot see as you can possibly see in Italy the moving figure of the bell-ringer perhaps different from place to place, thinking somewhat vy himself during ringing. All this you could hear by .imagination.
In high school the physics teacher should be aware that he will never understood as if he meant: The color *red* is "in reality nothing else but" an electromagnetic frequency of $4 \cdot 10^{14}$ hertz.
I conclude: I wish physics tp be taught as a special and restrictive way of understanding nature – historically developed but renewed again in the child. Then for the teacher the logical stance would merge with the genetic and psychological one,
Maybe this could help – in the sense of the „Rahmenplan" (Framework Plan) of the „Deutscher Ausschuss" (German Committee) – to connect: the modern working world and European educational tradition.
All I suggested is intended to teach the child really *understand*, until understanding of understanding. The understanding one is always superior to those who are only manipulating and only functioning: This basic equipment for the practical requirements is nore flexible, and he himself as a human being is better protected.

As far as this these conciliatory proposals of Wagenschein. I can agree them. Particularly interesting is, I think, the idea of a kid-proper access to physics by technology, so once again:

2. **Although: accepting the *technical* fascination of the youth. Therefore beginning, *too*, with technical equipment, not too complicated. Not as "application" of physical laws treated in advance, but as a way toward them., That means *excavating nature in technical equipment*.**

   ***Technology misunderstood makes false magic – Misunderstood physics deprive nature. Understanding physics adequately, deprives machines but will not hurt the charm of nature.***

That should be followed!

But how?

We are overloaded with equipment in such a way that the expression "trashed" can be used . How can we pick out one example of this trash heap (where the devices anyway will soon end up ...)?

The example should be:

- Interesting to the children – worrying but not making them afraid. Favorable is the “introduction” by themselves.
- It should include the possibility to be explained.

  This is a real challenge to the teacher. She or he should be acquainted with it. Not only by knowing the “instructions for use” but having understood it. Further conditions to a model to introduction:

  It must be “modern”, otherwise the children will soon be frustrated in their way of attendance on the other hand it should not been foreseen that it soon will be “out of fashion” because then it would be a waste of time.

  At this point Wagenschein’s demand “not too complicated” already makes it dubious – It may drown the whole project: for example: a modern pocket torch is not easy to explain but it obviously will be boring. Children of today have

- Mobiles with a camera
- I-Pads perhaps with a GPS based route planner
- Calculators
- Mountain bikes
- Remote controls for TV and anything else
- Model racing cars
- And so on…

Oh, the mountain bike is suitable as an introduction! As there is a lot to be seen and handled, quite contrary to the electronic equipment mentioned above (at the best understandable principles but there “nothing can be seen”.

The technology of a mountain bike is a suitable way from technology to the laws of nature to physics. And therefore it not necessary to swish through the forest. The historical development already serves out a lot. And mere physics is not losing with the questions:

- Where does it come from to bike without falling on the road?
- How is it additionally possible (though it is forbidden) to ride freehand?
- Why do the brakes go hot when you go downhill?
- Why there is only one connecting wire from the dynamo to the lights?
- And so on…