Why is it so difficult to teach critical thinking?

Almost everyone will agree that the main, but rarely achieved aim of education is to teach critical thinking. Components of critical thinking is considered to be the ability to see both sides of the issue, the ability to be open to new information that may refute your ideas, the ability to reason impartially, to require that every statement is supported by evidence, draw conclusions and generalizations from present facts to solve related problems. While there are specific types of critical thinking, depending on the object of learning — what we mean when we say "argue like a scientist" or "thinking like a historian".

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These common notions very often turn into calls to teach "critical thinking skills" and the abstract talks about that top rated research paper writing services students need a better reason, to rationalize, and the like. Business leaders and recruitment agencies at the highest levels urge better schools to teach children critical thinking. The College Board recently revised the state examination of the SAT so it is more in keeping with these objectives, one of the corporations have offered a special test of critical thinking skills in College students.

All this is not new. In 1983, the national Commission on education and professional development, introduced the report "a Nation at risk". It turned out that a significant number of 17-year-old owns advanced intellectual skills which the country needs.

It was claimed that almost 40% of graduates are unable to draw conclusions from what they read, and only fifth of them could convincingly articulate thoughts in writing.

After the publication of the report have become popular all sorts of programs teach students critical thinking. By 1990, most States had developed guidelines for teachers on the teaching of such thinking. The most common program of this kind — Tactics for Thinking — allowed to sell 70 thousand manuals. For reasons that I will explain below, the program was not particularly effective — we to this day continue to complain that students are unable to think critically.

Alexey Tyranov "Girl leaning on hand"(source: Wikipedia)

After twenty years of complaints and appeals that did not lead to improvement, perhaps it is time to ask the key question: is it possible to teach critical thinking? Long-term studies of cognitive processes lead to a disappointing answer to this question. Previously it was assumed that the appropriate skill of thinking — something like Cycling, which once mastered, can be used in any situation. Cognitive science has proven that thought processes similar skills.

"Blind selection": in reality and in fact

Thought processes are inextricably linked with the content of our thoughts. Accordingly, reminding the student to "look at the problem from different points of view," we only accustom him to the idea that he must do. But if he does not know too much about the object of reasoning, then he will not be able to judge from different points of view. You can get to learn the dogma about how one should think correctly, but without the accompanying knowledge and experience the students are unlikely to be able to apply the advice into practice. It is pointless to teach facts, not allowing to understand how to use them, and equally pointless to teach critical thinking devoid of factual content.

In this article I will try to tell about the nature of critical thinking, explain why it is so difficult to use and the training and talk about how students master a particular type of critical thinking: thinking scientifically. However, we will see that critical thinking is not a set of skills, applicable at any time and in any context. This is a special ability in which he can succeed three-year-old child to fail a professional scientist. And very much depends on the practice and subject knowledge.

Why critical thinking is so hard?

Educators have long noted that attendance and even academic performance do not guarantee sound reasoning. There is a strange trend: "right" thinking, which is taught in school, makes a child cling to particular examples or types of problems. For example, solving a math problem, students can estimate before computing what the answer may not be in any case, but in a chemical laboratory it can easily be wrong. And the student is able to thoughtfully talk about the causes of the Civil war of 1918, and did not think to ask yourself about how the Germans were treated to the Second World.

Why are students able to think critically in one situation, numb to another?

Simply put, the thought processes are tied to what exactly we think. Let's look at this process in more detail on the example of well-studied way to think critically: the decision of tasks.

Artist: Oscar bjrk(source: Pinterest)

Imagine elementary school students who solve problems like "I had five apples." Why do those who can solve the problem about the Apple, succumb to the problem about with buckets of water, even though mathematically they are the same? Students here focus on the story problem (its surface structure) and not on mathematical meaning (deep structure). And, although they were trained to solve a special case of the task is described in the textbook change, the juniors can't make it to a familiar solution, because they do not realize that the problem is mathematically identical.

To understand why the surface meaning of the task is so distracting and why is it so hard to use tested solutions in unfamiliar situations, let us consider the mechanisms of understanding.

We automatically interpret everything that we hear or read, based on the fact that we already know about similar things.

Read this paragraph: — After years of pressure from the film and television industry, the President of China has sent an official complaint on the violation of the rights of American companies. The company felt that the Chinese government imposes strict limitations on the legal distribution of American entertainment products in the country, while the Chinese market piracy is rampant, and American movies sold on the black market.

Knowledge of context allows you to continue reading, reducing the range of interpretations of the text. For example, if you continue you will come across the word "Bush" you will not guess it refers to former U.S. President, the Australian Bush or the eponymous rock band. The word "piracy" is also unlikely to remind you of one-eyed sailors, yelling "On Board!". We perceive the world in such a way that incoming information is linked with what you thought a second before. This significantly narrows the range of interpretation of words, sentences and concepts. The advantage of the process is that we are faster and easier to understand, about what speech. The reverse side that continues to elude us the underlying narrative structure.

The less ideas for interpretation arises in us when reading, the rather it means that we focusareas on the surface characteristics. Here's another example — the subjects in one experiment had solved such task:

Child's task: — members of the school orchestra for a long time rehearsing the parade for the annual reunion. First, they marched in columns of 12, but Andrew was behind alone. Then stood in columns of eight, but Andrew has not got places in a system. Even when I got up at three, repeated the same story. Finally, enraged, Andrew said that you need to join the ranks of five people, then nobody would be superfluous. He was right. We know that in the ranks were more than 45 but less than 200 musicians, how many were participants in the school orchestra?

Prior to this task, pupils read a detailed explanation of several other tasks. One of them had a similar problem about the orchestra, but it was said about vegetables. But only 19% of students were able to "identify" the problem about vegetables and apply it to the example about musicians. How did it happen?

When the student reads the problem "with the story," he interpreterpath it in the key that I read before that. Unfortunately, the difficulty is that the need seems to be information linked with a superficial sense of the problem. The student thinks about the band, school, musicians and cannot think about the deep structure of the problem, to bring it to a common denominator with the problem about vegetables. The plot lies on the surface, but a mathematical way. Because the first task does not help the most in addressing the latter: in the minds of students, one was about vegetables and the other about the parade of musicians.

Knowledge helps us to penetrate beyond the outer shell of things

If knowledge about the solution would not have worked at the task with a new description, in schooling would be pointless. However, sooner or later need an understanding there. It's hard to say how it arises and why, but for educators in this sense, two factors are important: the presence of the student ideas about the internal structure of the task and the knowledge that this is the structure you need to look for.

Artist: Ellen Emmet Rand(source: Pinterest)

I will focus more on both points. If a person is familiar with the internal structure of the problem, it is easy to teach the solution. Understanding of the structure may come after a long study of a specific task or different tasks with a similar structure. When a person constantly decides the same, he perceives the internal structure is already on the long description of a task. Here's an example:

Another problem: — a treasure Hunter wants to explore a cave in the mountains near the beach. He suspects that the cave many moves and branches, so he is afraid to get lost. Maps of the cave had not, in the backpack only ordinary objects like a flashlight. What to take to definitely not get lost and get out of the cave?

The solution to this problem is to put in a backpack of sand from the beach and sleep on the way to the cave, leaving behind a trail by which to get back. Among the respondents, American students have come to this 75%, but among the Chinese — only 25%. It is assumed that the highest result among Americans due to the fact that most of them grew up hearing the tale of Genzel and Gretel, where the brother and sister left the trail to return. In the experiment, students are then asked to solve a riddle, the answer of which is similar with the motif of Chinese folk tales, and the percentage of correct answers among the Americans and the Chinese have changed exactly in the opposite direction.

So, the constant reference to a certain task helped the students immediately identify the underlying structure of this task in another example. Americans are not reflected on the conditions, and immediately thought about the subject, which will help them to leave a trail. The inner meaning of the tasks that are so etched in their minds that they immediately identified.

The search for a deep structure helps, but not too

Why do we need universities

We now turn to the next factor that helps in learning despite distracting differences in the appearance task descriptions is knowledge about what you need to look for the internal structure. Suppose I say student a decisive task with the orchestra that it is similar to the problem about the garden. He realizes that both problems have something in common and try to determine what. Students can come to this and no hints from my side.

For example, they might think: "if we solve this problem in math class should be the mathematical formula that will facilitate a solution." You can then delve into his memory (or textbook) and find out which formula is suitable.

This is exactly what psychologists call metacognition, or control thoughts. In the introduction to the article I mentioned, that can inspire students maxims about how they ought to think. Scientists refer to these maxims cognitivity metadatavalue strategies. It is small fragments of General knowledge like "look for the internal structure of tasks" or "consider both sides of problems" that the student can memorize and use them to convey their thoughts in a productive direction.

Artist: Walter Firle(source: Pinterest)

To help students better manage their thoughts was one of the goals of the programmes of critical thinking, popular twenty years ago. These programs were not very effective. His modest achievements they owe to the education of children metadatafilename strategies. Students learned to avoid common mistakes in reasoning: to address the first conclusion which seemed logical to seek only evidence that confirms our opinion and ignore evidence to the contrary, to overestimate their strength, and the like. That is, the student who said many times to pay attention to both sides of the problem, sooner or later started to think about it himself, faced with a new challenge.

Unfortunately, anything beyond that meteozavisimye strategy, we can not give. They tell you what to do necessarily, but not talking about how to implement it.

For example, when students still said that the task of the orchestra is similar to the problem with the garden, it has increased the number of solved problem (35% vs 19%), but the majority still are unable to solve it even knowing what to do. You can know that it is impossible to stay on the first reasonable-sounding solution to the problem, but can not find other solutions or to determine what makes the most sense. For this you need to have knowledge in this field and their application.

Critical scientific thinking is so closely linked to the need for knowledge about the subject matter that teachers have the right to ask: isn't it easier to teach critical thinking in certain areas of knowledge. The answer is easier, but not much. To understand why, we turn to science and consider the phenomenon of scientific thinking.

Is it easy to think like a scientist?

Training scientific issues had been the subject of intense research for decades, and these studies can be divided into two branches.

The first refers to how children learn scientific concepts — for example, how they overcome naive conceptions about motion and replace them with representations of the physical processes.

Lameness mathematics education

The second branch belongs to what we call scientific thinking produced in the mind operations that govern the scientific process: build a model of the selection hypothesis, conduct experiment to test hypothesis, data collection, interpretation and so on.

Most researchers believe that scientific thinking is one of the subtypes of thinking used by children and adults. It makes scientific knowledge about when it should be used, and sufficient information and experience to apply.

Research shows that the ability to reason is not enough. Children and adults are constantly misapplied thinking skills in similar processes.

Consider the example of importance for the understanding of cause and effect in science: conditional probabilities. If two things happen at the same time, probably one caused another.

The problem in understanding conditional probability: — Suppose you started taking medication and noticed that you became often a headache. You suspect that the drug affected the headaches. But it is also possible that the drug increases the chances of the occurrence of pain only in certain conditions.

Applying notions of conditional probability of events is a key to scientific thinking, because it is important to understand what is causing what. But people usually understand this issue, depending on how worded question.

Studies have shown that adults understand the problem of conditional probability, but are unable to use it in many appropriate cases. Even professional scientists can prevent a logical error in reasoning about conditional probabilities (as in other arguments). Doctors often underestimate or incorrectly interpretiruya new information about the patient, contrary to their diagnosis. Doctor of science become a victim of false reasoning, when faced with a problem in an unfamiliar context.

Artist: Yevgeny Katsman(source: Pinterest)

At the same time, small children can sometimes talk in terms of probabilities. In one experiment, three-year-old children were shown a box from which music plays if you put one of the two dice or both. The children not only easy to figure out which cube includes a machine and figured out how to turn it off — putting "outside" the cube.

Insights from these experiments can be done are: children are not as stupid as you might think, and adults (and professional scientists) are not as smart as you might think.

What would it be? First of all, the General idea of critical, scientific, historical thinking about the amount of some skills, apparently, wrong. Critical thinking cannot be reduced to skills in the traditional sense — in contrast to skill, it will not work to apply whenever you want.

Bookmarked: the most important thing about cognitive skills

Suppose I told you that learned musical notation. You will understand that I will be able to use this skill at any time. But, as we noticed when discussing conditional probability, and people can use critical thinking without training, and to refuse it, even with extensive application experience. To understand that critical thinking is not a skill, it is very important. This suggests that training students to think critically has less to do with learning new ways to think, and much more — with learning about how to use the right arguments at the right time.

Again turning to science, let us ask ourselves a question: is it possible to teach students to think scientifically? In some way. Remember that discussing the tasks we set: students can inspire metadatavalue strategies that will help them to see through the external description of the problem and identify its deep structure, a step closer to the solution. Roughly the same can be done in the area of scientific thinking.

But, as in the solution of problems, such strategies only teach you what you need to do, rather than give the knowledge on how exactly. The good news is that in scientific fields there are more tips that will help the student to understand what metadatavalue strategy to use. Teachers will paint a clearer picture of what areas of knowledge should be given special attention to allow students to use their strategies.

The task for the juniors: — So, two scientists taught students in second, third and fourth classes the concept of controlling variables. It consists in the fact that in the two compared positions are all the same except for one variable, and need to explore. Scientists explained in detail how this concept helps in conducting the experiments, and then gave the students for the experiment of the spring. They were asked to answer which of these factors determines how much the spring is straightened after compression: its length, diameter of coil, diameter of wire, weight?

The study showed that elementary school students not only understood the concept of controlling variables, but also remembered and used it seven months later, with other materials and by other scientists. The students realized that once again the experiment is done, and remembered what metadatavalue strategy already used.

Why scientific thinking depends on the amount of scientific knowledge

Experts in teaching science recommend to teach scientific reasoning in the context of General knowledge about a certain subject. National research Council says, "Theory without practice and learning practical work in isolation from scientific theory likewise will not lead to success".

To this conclusion came the realization that the knowledge about the subject is necessary for scientific thinking. For example, it is important to know that for the experiment a control group. But know this — does not mean to be able to create it. It is not always possible to create two absolutely similar groups should therefore be provided, what factors the groups may differ, and which for purity of the experiment must be the same. So, if we investigate the speed of reaction, the control group should be selected according to age, but can vary by gender.

This is not the only example of how background knowledge helps to argue scientifically. Take the development of a research hypothesis. For different situations you can come up with many hypotheses. Suppose the car has A smaller gasoline consumption than a car, and you want to know why. Machines seriously differ among themselves where to start to compare? With engine size? Tire pressure? The key to the formulation of the hypothesis in this case — meaningful. You are unlikely to talk about the consumption of gasoline based on the color of the car. However, if it suddenly will be meaningful, for example, the teenager I painted my car red and started to drive like mad, will have to explore this factor. Thus, the representation of the meaningfulness of one or another factor depends on our knowledge in this field.

(source: Pinterest)

Other data indicate that familiarity with a particular area of expertise allows us to simultaneously operate with different factors and to design more complex experiments. For example, in one experiment, eighth graders are faced with two tasks. In one they had to maintain the life of imaginary animals in a computer simulation, by controlling the conditions of their environment. In another they were asked to assess how the surface area of the water in the pool affects the speed of cooling of water in it. In the first case, the students did a little better — probably because the factors that should be assessed, was more familiar. Children familiar with what influences the existence (food, presence of predators, light), but they have less experience of monitoring drivers of change in water temperature (volume, surface area). We see that the "control variables in the experiment" is not some abstract process, it is also influenced by the beliefs of the experimenter about these variables.

Critical thinking: basic principles and techniques

Initial knowledge and beliefs not only affect what kind of hypothesis we would rather choose to study, they also distort our interpretation of experiment data. So, in the same school appreciated the level of knowledge of students about electrical circuits. Then these high school students took part in three weekly sessions lasting 1.5 hours, where using the computer, they simulated the schemes and did experiments to understand the workings of electricity. The results showed the dependence of the insights of students from their initial knowledge about the subject. Those who have begun to experiment with a better understanding of the subject was more informative experiments and better manage the results.

Other studies led to similar conclusions. It was found that abnormal or unexpected results of experiments are important for the emergence of new knowledge. Data that seem odd because they do not fit into our model, very informative. They show that our understanding is incomplete, and lead to the development of new hypotheses. But you can characterize the experiment as "abnormal" only if you already had an idea of what he will bring. But this view is based on General knowledge of the subject, as well as your new hypothesis which will have to take into account previous abnormal result.

The idea that scientific thinking should be studied as scientific problems, as such, is also confirmed by the research of scientific solutions — those that can be solved like the problems from the textbook, not experimentation. A meta-analysis of 40 experiments have shown that in the task of effective approaches based on building a diversified knowledge base. Ineffective approaches focused on solving a specific problem, ignoring the knowledge necessary for understanding this decision.

What did we learn from all those studies?

- First, critical thinking (as well as research and other related types of thinking) is not a skill. No mission critical-thinking skills that can once and for all to master and use, regardless of the context.
- Second, there are metadatavalue strategies in which you can learn, and that will help critical thinking.
- Third, the ability to think critically depends on subject knowledge and experience.

Thus, for teachers the situation is not hopeless, but, as expected, to teach critical thinking is no easy task.