No Problem? No Research, Little Learning ... Big Problem!

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ABSTRACT

The motivation to carry out this study stemmed from the generalized perception that nowadays youth lacks the skills for the 21st century. Especially the high-level competences like critical thinking, problem solving and autonomy. Several tools can help to improve these competences (e.g. the SCRATCH programming language), but, as researchers and educators, we are mostly concerned with the skill to recognize problems. What if we do not find problems to solve? What if we do not even feel the ***need*** to find or solve problems? The problem is to recognize the problem; the next step is to equate the problem; finally we have to feel the ***need*** to solve it. No need? No invention. Recognizing a problem is probably the biggest problem of everyday life, because we are permanently faced with problems (many ill-defined problems), which we need to identify, equate and solve.

Keywords: Intuition, Curiosity, Problem Recognition, Creativity, Problem Solving, Critical Thinking, Research and Education

1. RATIONALE

Youngsters seem to be more and more passive consumers, little autonomous and less motivated intrinsically for learning at school. The innate curiosity, imagination, creativity and the need that is the mother of invention all vanish in most pupils along 11 to 12 years of pre-university school. Therefore, youngsters do not develop high-level competences that can make them pro-active, autonomous, critical citizens, inventors and constructors in the future. In fact, most of our students even lack basic skills, which are needed to work, for instance, in a lab. They (male or female) do not know how to properly use a basic tool like a screwdriver. Even more worrying is the fact that most of the colleagues in the Geology department of a Faculty of Sciences have a very poor scientific production, and for one very simple reason: they cannot find problems to solve.

2. PREMISES

As basis of argument, let us assume that some very well-known sayings are true: (i) "*He who can no longer pause to wonder and stand rapt in awe, is as good as dead: his eyes are closed*" (A. Einstein); (ii) "*The intuitive mind is a sacred gift and the rational mind is a faithful servant*" (A. Einstein); (iii) "*The need is the mother of invention*" (old popular saying); (iv) "*To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science*" (A. Einstein); (v) "*The important thing is not to stop questioning*" and "*Imagination is more important than knowledge*" (A. Einstein), who also recognized that "*It is a miracle that curiosity survives formal education*", which seems to still hold.

These famous sayings illustrate the problems we recognize in Natural Sciences students. The problems are related to observation, intuition, need, (intrinsic) motivation, recognition of problems and problem solving. Because one of us travels regularly to many universities around the world, he has recognized these problems everywhere.

3. PROBLEMS

3.1. Observation

A basic and fundamental tool in sciences is observation. However, the present-day school does not teach the students to observe carefully and in detail, and to describe, in drawing and writing, with the rigor of science.

Our personal experience in the activities of teaching and scientific research has taught us that our eyes see what the brain is educated to see [e.g. 1-4]. This means that we first do a preliminary observation, then we use critical thinking to analyze the data, and finally usually come to the conclusion that the observation is insufficient or even irrelevant. Typically, we soon realize that we have problems to solve and so we need more observation and data. But now the brain is aware of what we need to look for (our eyes see what the brain is educated to see), which is the relevant data that will help to solve the problem.

3.2. Attitude

The ***need*** is the mother of invention. However, most kids nowadays have no needs, probably because parents in the so-called "first world countries" give them everything, especially the superfluous, and not as a reward to anything.

The present-day helping culture is eroding autonomy and self-reliance [e.g. 5-8]. Nowadays parents make life too easy to their kids, by removing every obstacle (however small). The result is that they are not being prepared for real life, which is full of obstacles at every step. Nowadays parents ignore a fundamental premise: "*Adversity builds character*" or "*What does not kill you makes you stronger*" (Nietzsche).

3.3. Where Is The Problem?

High-level skills like critical thinking, problem solving and autonomy are all inherent in Problem-Based Learning (PBL) [e.g. 9, 10]. PBL can very successfully teach us how to solve problems; however, PBL by itself does not teach us how to find/recognize problems. What if we do not find problems to solve? What if we do not even feel the ***need*** to find or solve

problems? The problem is to recognize the problem; the next step is to equate the problem; finally we have to feel the ***need*** to solve it. No need? No invention. Recognizing a problem is probably the biggest problem of everyday life, because we are permanently faced with problems (many are ill-defined problems), which we need to identify, equate and solve (without recourse to a psychiatrist, who will try to help one recognize the problems).

Although experimentation and modelling are fundamental tools in basic Physics and problem recognition, experimentation at pre-university level is absent in Portugal. The school textbooks for Natural Sciences are misleading and ineffective, because all the so-called "*experimental activities*" (with no exception) are either physically wrong or no more than poor laboratory activities.

3.4. Intuition And Motivation

As recognized by A. Einstein, *the intuitive mind is a sacred gift*; it is indeed fundamental in science and in the recognition of problems. Children naturally and unconsciously develop intuition, which is our background knowledge of the way things work, gained mostly from everyday experience [e.g. 11, 12]. When a child throws a ball vertically in the air, he intuitively (unconsciously) learns that the ball has some weight, that he has to spend some energy to throw it high (do some work), that the ball will slow down on the way up, come to a stop, and then accelerate downward back to his hand, where he will feel the impact. Without knowing a thing of Physics or Mathematics, he was introduced to many important concepts of Classical Mechanics. He does not know of them formally, but he knows how they work. So what should be a major objective of the School? Take this everyday life intuition of how things work and educate it [e.g. 13, 14]. However, it does exactly the opposite ("*It is a miracle that curiosity survives formal education"*, Einstein). Intuition may be wrong (e.g. it is not the sun that moves everyday from E to W, it is the Earth that rotates in the opposite sense) and must be corrected in a modern society. In a primitive society people did not care about correction or education of the intuition, because their main objective was the preservation of the species. Only later the human kind decided that this was not enough and started paying more attention to the intellect. We now live in an age of transition from primitive instinct/intuition/physical based society to a higher-level intellectual society. This time is dangerous because we are not as intellectually evolved as we often pretend to be. And this generates too many conflicts in the present human being, caught in a hybrid stage made of primitive instincts and higher intellectual development. But, paradoxically, the present-day school kills the most genuine high-level innate skills (curiosity, imagination and creativity) and does not promote the autonomy so necessary in the modern society and so basic in the primitive societies. An Einstein's quote pops to my mind: "*Only two things are infinite, the universe and human stupidity, and I am not sure about the former*".

Motivation is probably the biggest challenge: how can we trigger/develop intrinsic motivation, so critical to transform our pupils into students?

3.5. Critical Thinking

Most of our pre-university students, and none of our under or post-graduate students at the university question what we tell them, or what is written in textbooks or scientific papers. They do not even question the beautiful rocks we take them to observe in the field.

Many of our students, at any level, present, as the result of a problem, two very different values, one determined graphically and the other analytically, for exactly the same angle, without recognizing that one value is obviously wrong.

4. POSSIBLE SOLUTIONS

How can we improve students' observation skills? They should be taken more regularly outdoors to observe and describe large-scale and small-scale features. They should be taught how to collect relevant data according to different objectives.

How can we improve the students' ability to recognize problems? Scientific drawing, writing and experimentation are excellent ways. When we draw, we become aware of geometrical problems and what is relevant according to the objectives; when we write, we usually find that the data is insufficient or even irrelevant for the proposed objectives; when we experiment and model, we realize that we have mechanical problems to solve.

How can we improve students' problem-solving skills? What skills do students need in order to solve problems? They need: logical reasoning; know how to split complex problems into simpler parts; identify and eliminate bugs; and concentration and perseverance. When the students use a programming language like SCRATCH [e.g. 15-19], they develop all these skills, and they soon find problems that they immediately have (feel the need) to solve in order to advance with the project. Moreover, when trying to solve problems, the student is faced with new concepts that he is really willing to learn in order to achieve his goals. Projects developed with programming languages like SCRATCH have the ability to trigger the need that is the mother of invention, and lead to the intrinsic motivation that separates pupils from students.

The roles of Science and Mathematics are growing fast in our society. Mathematics teaches us how to solve problems in a logical and rational way. If it is important to know how to solve problems, it is not less important to know how to recognize and formulate them. However, Mathematics does not teach us how to find or recognize problems. This is a major role of Science that urgently needs to be taught to our youngsters (at least). With experimentation, students learn the most basic and fundamental practice in Science. Students even learn how to use basic tools (e.g. hammer, screwdriver, pliers, ...) when they are faced with the need to build new apparatuses to realize the experiments. Students even learn how to properly use a modern basic tool like the computer (usually used by youngsters for games) when they use programming languages like SCRATCH.

5. CONCLUSIONS

Regarding observation, we should always keep in mind that the eyes see what the brain is educated to see. Otherwise we are blind to many relevant details and many problems.

We need to improve the student's innate intuition and educate it. This is likely the easiest way to motivate students.

Ultimately Science and Mathematics can help us with everyday life, because we are permanently faced with problems, which we need to identify, equate and solve rationally.

We try to teach our students, in 12 years of pre-university school, the science that took humanity thousands of years to develop. This is absolute nonsense! The solution could be to work only a few fundamental physical processes with students, and use the most basic and fundamental tools – observation, experimentation and analysis – to understand them.

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