# About Methodological Basics of Interactive Teaching-Learning

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*Abstract:* - A computerized educational (CompEdu) platform for turbo machinery used for lecturing and for self-study by students in several courses at the Energy Technology Dept at KTH is analyzed as concern to methodological basics for its further improvement and development, as well as the most optimal use, both by teachers and students, including the self-study and distant learning. The main objective of the platform is to enhance the learning by providing to the students and teachers the necessary multimedia tools. The advantages of interactive learning and teaching and the most important achievements of psychology and pedagogy, which may help to improve the system and have to be implemented, are discussed.

*Key-Words:* - Interactive, Teaching-Learning, Computerized Education, Methodology, Psychology, Enhancing

## 1 Introduction

The CompeduHPT project started by Director of Energy Technology Dept Prof. T.H. Fransson around 1996, when the first educational program was developed at the Division of Heat and Power Technology (HPT), Royal Institute of Technology (KTH), in Sweden, Stockholm. The idea was to integrate the slide shows with the other educational tools: animation, simulation, videos, case studies and virtual laboratory exercises, etc. The first general view of the CompEdu is shown in Fig. 1:

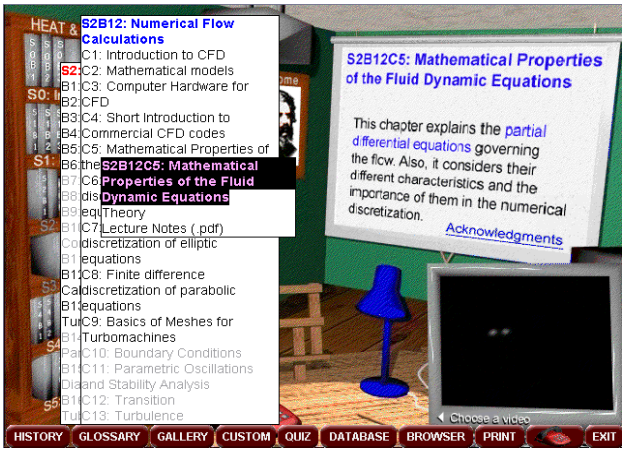


Fig. 1: The the main interface of the first CompEduHPT platform

The concept and the potential educational benefit attracted the intention of some professors and industry experts leading to the establishment of a collaborative activity around the e-learning platform [1-9]. The development is carried out at KTH by a multi-disciplinary team. The early success has encouraged developers to investigate further and lead to the development of other designs.

This method of teaching when the students are not required to be present at a specific location during the study fits well for the distant education, which converges to the conventional education. Multimedia allows using the several different media to deliver the information (text, audio, graphics, video, animation, etc.). Technology enhanced learning existed for thousands years starting from using any kind tools.

According to the hypothesis of Vygotsky [10], humans use objects from their surroundings to strengthen mental processes. "The use of artificial means, the transition to mediated activity, fundamentally changes all psychological operations just as the use of tools limitlessly broadens the range of activities within which the new psychological functions may operate. In this context, we can use the term higher psychological function, or higher

behaviour as referring to the combination of tool and sign in psychological activity."

The multimedia technology is enhancing learning, especially when it works in accordance with our body/mind psychological preferences and in a harmony with the object we are interacting with. Without a tool such particular interaction may be less efficient or even impossible in some situations. An example of a simplest technological enhancement is the paper and the pen helping to imagine and memorize the studying object.

Graphical symbols help coding the complex issues, e.g. some numbers or ideas, without which we have difficulties in operation with in our minds during a study of new subject.

# 2 Problem Formulation

First of all let us shortly analyze some most exciting histories of the successful enhancement of the educational process and then generalize the known experience for further use.

## 2.1 Teacher-Novator Viktor Shatalov

Interesting to note some exciting teaching experiences during the last decades, e.g. from Ukrainian teacher-novator V.F. Shatalov [11-13].

After 20 years of experimenting with small groups, in 1971, Viktor Shatalov began teaching his students mathematics, physics, and astronomy in a regular secondary school class in Donetsk, Ukraine. These subjects are traditionally considered to be the most difficult in secondary school, and therefore, the general opinion is that the progress in these subjects depends almost entirely on the natural abilities of the pupils.

Shatalov's first big class was a problem, since the average grade point in physics and mathematics in the class was 2.7 in a 5-grade system, when 2 points is, in fact, a total lack of knowledge. He was supposed to teach this class during the three years remaining until its end.

At the end of the second year, a representative of the USSR Academy of Pedagogical Sciences conducted a 12-hour test throughout the secondary school program for Shatalov's students and was amazed that most students chose more complex tests and successfully coped with them. At the end of their studies in the class, only three of the 33 students had 3 points, while others had higher marks. All 33 graduates from the class successfully studied in higher educational institutions, despite the fact that they did not have a penchant for mathematics! Shatalov worked on this miracle more than once. Not so long ago, he taught the traditional 35-hour astronomy course for 32 hours, and all students received a grade of "five." Now he is 91-year old man and still continues his activity in teaching.

### 2.1.1 Pulsating Knowledge

The core of the Shatalov's method is a peculiar scheme ("reference signals page"). He noted that knowledge can exist in two forms: detailed and concise.

When a teacher explains a lesson, even the best students do not try to remember what he says literally. And it is not necessary. The general scheme, plan, a set of key concepts can be called the lesson code that is formed in the mind of the student. The student's problem is poor memorization, and the inability to make this diagram or plan, this set of key signals. It compiles inefficiently, or distorts it.

Shatalov exempts students from this task, which is beyond the power of many. For each topic, he draws a diagram of reference signals, which consists of a notebook page with a list of lesson keywords, very brief basic conclusions, extracts from diagrams and examples. They are presented in a specific order, with color coding, in all types of frames, with arrows, links and connections. Deciphering and understanding such a sketch on physics is difficult without a detailed explanation, after which the sketch comes to life. Scientific terms and symbols acquire meaning. Sometimes they can be made funny.

Teacher teaches: this is detailed knowledge. Then he repeats in accordance with the reference signals (compressed knowledge). Pupils analyze the material at home, using their schemes and textbooks (knowledge is detailed again). Further, pupils' knowledge is checked in a concise form, and not in detail! Experience has shown that it takes no more than 12 minutes. They write by heart yesterday's scheme, one page.

Those who do not understand the material or did not listen to the teacher, or did not do their homework, cannot complete the task, even if it is easy for anyone who tried to understand, who was listening to the teacher and then worked independently, no matter how limited its capabilities.

Shatalov collects written homework and sorts it with grades: 5, 4, 3. He does not correct mistakes, because immediately after studying their grades, the students go to the blackboard and, using their scheme, repeat (the knowledge is detailed again).

They are looking for their own mistakes. Teacher constantly looks at the gaps in the knowledge of his students.

### 2.1.2 Using the Reference Signals in Pulsating Knowledge Process

In practice, everything is quite simple. The teachers explain the material, and then repeat their explanations using reference signals. They can repeat difficult moments for the third and fourth time, and the interest of students does not decrease, but increases.

There is no memorization and no fear of forgetting anything. All that the teacher wrote on the blackboard, the students take with them home in the form of control signals.

Soviet psychologist Peter Zinchenko with his precise experiments showed that memorizing and understanding are mutually exclusive mental processes: those who tried to understand and remember will not understand and remember. “You just have to understand!” says Shatalov. And his students, accustomed to new methods, do not get scared when they do not understand something, and do not stop listening to him. They know that everything that they failed to understand will become clear with a second or third explanation.

Thus, the process is as follows: students in class write sketches from memory, evaluate and listen to the teacher's explanations. Then - new material. Knowledge is condensed, detailed, compressed again, detailed again - it pulsates - and finally, with the help of these procedures and repeated repetitions, it is perceived and remains in the student’s head. So the ideal of Shatalov is achieved.

According to the innovator, the student should be able to answer your questions on the subject, even if he "woke up in the middle of the night." Some may ask, “Do children not find repetition boring?” No, this is not boring, because children enjoy the work that gives the result. They understand that they even cope with this “hated math”, and they are not afraid of any objects.

The same work will seem new to us, if the end result, the goal, will change. The first time they listen to the plan is to understand; secondly, to test their knowledge. At home, they analyze it to memorize, and in class they write it to inform the teacher. They listen to their classmates to test themselves and make sure that the teacher gives them the grade they deserve. It's almost like doing something else. Meanwhile, the sketch in front of the student, and even those who have a bad memory, gradually retain it.

In addition, the method develops memory faster. Interestingly, students develop the ability to highlight the most important points in any text and mentally turn it into a concise and precise scheme, which means they understand it. Thus, in the class of literature, when the teacher explained Tolstoy's “War and Peace” in a traditional manner, the pupils of Shatalov listened and made up “shatalov-like” outlines of reference words, arrows, circles and the like.

Gradually, the work with reference signals was simplified. The outlines were printed in advance. Pupils should paint their houses only according to a predetermined color scheme. Progress has become even faster.

They are not prone to verbosity, so students understand them better. In turn, the students, guided by their outlines, should not wrestle in order to answer the teacher's questions. They speak fluently. Teachers do not need to strain to assess students' knowledge. They can devote more time to the student's speech and use mathematical terms correctly. In order to speak more and develop speech skills, they spend “days of mutual control” when students question each other.

Even weak students understand that they can succeed; they have a chance to get a good grade. All they need is to listen to the teacher's explanations and study at home with a plan. So students gradually begin to study mathematics, which seemed unbearable, and now gives them pleasure.

Students become supporters of these new methods. When the process of teaching and learning becomes reasonable and productive, students stop asking, “What should I do? Do I need math?" or "Why should I study?". Why solve math problems? Solve them.

### 2.1.3 Perception and Presentation of Knowledge in a Concise Form

Finding a single method of perception and presentation of knowledge in a concise form, Shatalov solved several pedagogical problems that seemed intractable for the school system. He graphically showed children the mental activity involved in the study of the theory (the dynamic process of compaction and detail). He found a way to encourage them to apply themselves to this purely mental activity, and at the same time greatly simplified the teacher’s control over the efforts of the students.

The quality of teaching - amazing flexibility. As soon as he comes to solving problems, he completely changes, as if all his principles have been replaced by completely opposite ones! When

studying the theory, at each stage there are assessments, continuous monitoring to stimulate rigorous academic discipline. In solving problems, he gives them unprecedented freedom and no marks - only help and benevolent consultations in order to develop self-confidence and free their creativity. If students know their theories, solving a problem is 90 percent dependent on their self-confide.

Students do not need to copy each other's work or tailor their decisions to any particular answer; they should strive not for good grades, but for difficult problems. You start to feel the atmosphere of sports excitement: who chose and solved the most difficult task? The class turns into a group of interested mathematicians.

Shatalov starts from afar. He solves the standard tasks in the classroom - just listen and try to understand - and then he gives his students the same problems they need to solve at home. They do not look the same, but they are, and he puts the marks for their "re" decision at home. He believes that in the initial period, independent analysis, if a solution is developed in class, is a major achievement, for which there was an initial condition: to work with the help of a teacher. This he adheres to.

After the six months, his students begin to solve standard tasks, including with the help of a teacher, if necessary. Only then begins the independent solution of problems. Finally, it gives students non-standard tasks for independent decision making.

Now, what do the students really need from their teachers? The list of desired qualities may be endless, but the first is to be sure that with this particular teacher, students will overcome all difficulties and learn the subject. Shatalov is doing everything to support the student's faith in his success. And - faith in these very creative abilities, which sometimes rise to extraordinary strength.

## 2.2 Interactive Teaching Methods

Challenges and perspectives of the Interactive teaching methods were considered in many papers, e.g. [1-9, 11-14]. For example, in [14] the detail comparative analysis of the active, passive and interactive methods is done.

Interesting that interactive learning helps the learner not only to easily acquire new material but to memorize it for a longer period of time. The diagram in [14] shows that through passive learning, the learner can memorize only 30% of the material, while the interactive learning enables to memorize 90% of the received information.

More in detail, it is said that after 2 weeks of study there is tendency to remember:

- 10% of what we read
- 20% of what we hear
- 30% of what we see
- 50% of what we see and hear
- 70% of what we say
- 90% of what we say and do

Probably it is very approximate estimation, at least the linear dependence in the data above is very suspicious: 50% of what we see and hear is divided exactly on the 30% of what we see and 20% of what hear. But in general it is useful to keep in mind and use it in the teaching and learning.

Challenges and perspectives of the Interactive teaching and learning methods request further investigations as concern to both, the methods and their specific implementation. What has to be in focus is presentation of the teaching materials, which has a lot of different features.

Now revolutionary development of the information technology and communication tools requires some separate specific study for their optimal implementation into teaching process, especially distant learning, which becomes more and closer to the traditional class teaching.

### 2.2.1 The CompEdu HPT Platform

For example, the interactive teaching-learning platform of the Royal Institute of technology (Energy Technology Dept) [4] contains the elements presented in Fig. 2 and Fig. 3 below:

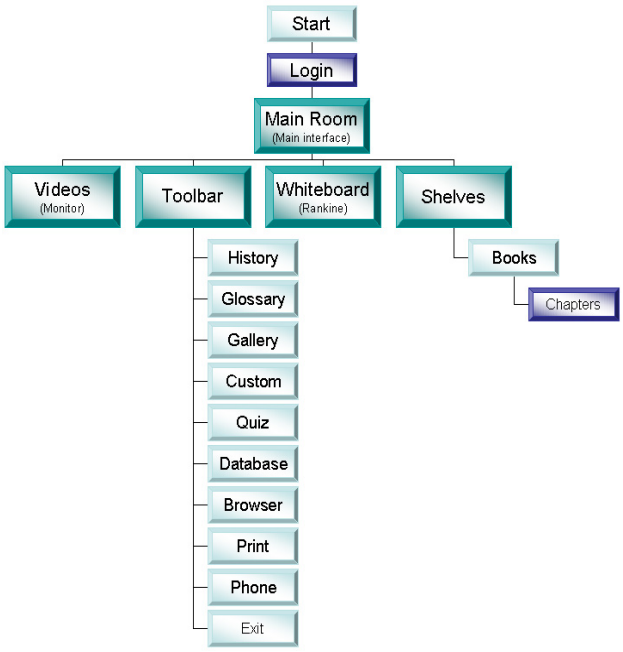


Fig. 2 Outline of the CompEduHPT Platform

A lot of investigations have been performed as concern to optimal structure of the system and

presentation of different educational materials. For example, in the chapers with many long mathematical formulas there is a question of how many hyperlinks and their levels must be done to not confuse the student.

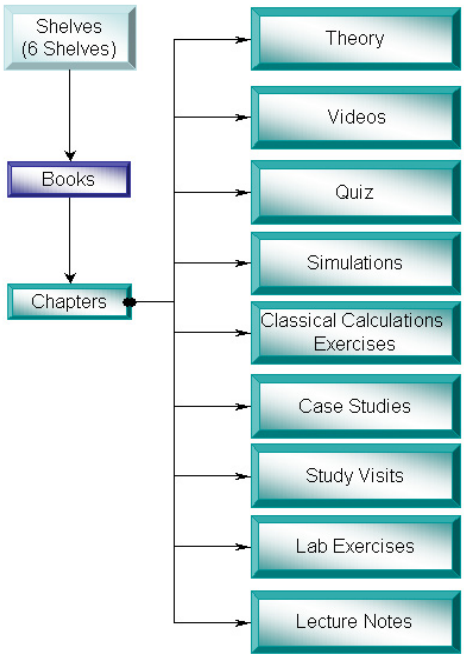


Fig. 3 Elements of CompEdu HPT Platform

Execution of the tasks and exercises will contribute to a better understanding of the learning material and to a development of the students' practical skills. The main difference between traditional teaching and the use of CompEduHPT for learning and teaching, is that for the latter case understanding means being able to apply the knowledge in practice, and it is often better to prove a result to oneself rather than to read about how to prove it (although both methods of learning are of course useful).

### 2.2.2 The CompEdu CFD Chapters and E-Book

The CompEdu chapters and e-book on CFD (see example in Fig. 4) contain first of all short but thorough review of the basic course on numerical continuum mechanics that is read in the last two years of study in mechanical engineering faculties at most universities.

Conscious of the extensive literature on computational thermofluid analysis, the authors have tried to present a self-contained treatment of both theoretical and practical aspects of boundary-value problems in numerical continuum mechanics. First some basic knowledge of university-level mathematics and fluid dynamics is given.

To understand the material, the reader should know the basics of calculus, differential equations and algebra. For the advanced reader these chapters can serve as a training manual. Nevertheless, it may be used also as guide for practical development, investigation or simply the use of any particular numerical method, algorithm or computer code.

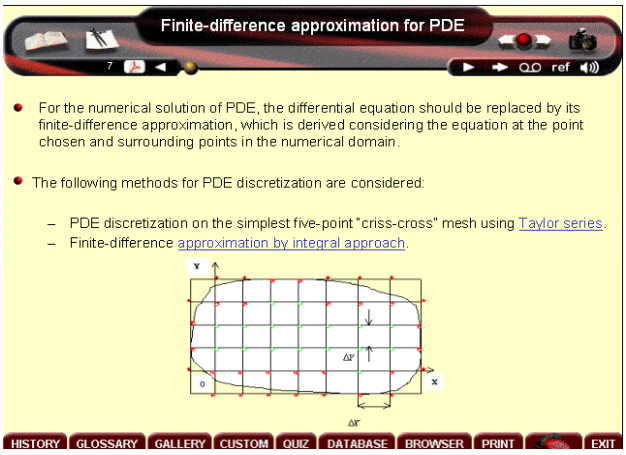


Fig. 4 The main page in the interface of the CompEdu book "Numerical Calculations"

In each CompEduHPT chapter on numerical methods and in the e-book, some typical problems and exercises on practical applications and for practical work on a computer are proposed to the reader, and it is intended that these be done simultaneously.

The basic course in numerical methods, contains a description of the mathematical behaviour of partial differential equations (PDEs) with their classification, which is then followed by the basics of discretization for each type of equation: elliptic, parabolic and hyperbolic. The most effective and useful finite-difference schemes known from the literature and from the research work of the authors are outlined for each type of PDE.

Some of the most important classical problems from the field of continuum mechanics are considered, so as to show the main features of the PDEs and their physical meaning in fluid dynamics problems. This course, interactive lectures plus e-book aim to provide the finite-difference approximations of the basic classes of PDE for examples from continuum mechanics, as well as to teach numerical continuum mechanics, through a deep understanding of the behaviour of each class of PDE. This, in turn, helps to clarify the features of physical processes.

The students can combine different ways of study according to their needs and individual preferences. They have CompEduHPT main pages

to get the basics in short, popups for more information, practical training in two different forms, movies, animated solutions of the problems, etc. For more advanced study the students have also electronic books (e-book) with the whole course on numerical simulation theory, examples of the problems solved, numerical algorithms and computer codes for real scientific and engineering problems.

# 3 Development of Creativity

The problem is in focus of the scientists and practical teachers from many different fields of study: sociology, psychology, research and education by a number of directions, etc. For example, in the monographs [15, 16] the latest research of such problems as genius, creativity, intelligence, consciousness, knowledge, and skills are analyzed. The structure is considered for the creative process. An attempt was made to connect the neurophysiology, psychology and the latest neuropsychiatry to get the structure of the intellect (mind). A detailed theoretical and philosophical analysis of the phenomena inspiration and insight was conducted. Based on recent research decades in the work recreated the structure and model of consciousness, allowing to explain the accumulated psychological science millions data, as well as allowing to predict the new results.

## 3.1 Philosophy of Creativity

### 3.1.1 Philosophical work

Philosophical work should put completely the new questions of science, chart ways for accurate theoretical research and open your eyes to new areas of research. But at first thought must at least grope for these paths so that science can confirm or reject them. Philosophy does not only consider common questions, but also partly serves as a “brain assault "when to address the problem is considered and lists all the options, including the incredible, impossible, controversial, and unimaginable and the contradictory ones.

Pretty it is conclusively shown that if one restricts the ideas at this stage putting forward hypotheses and ideas, then the performance of the group people dramatically reduced.

### 3.1.2 What is the Insight, Holistic Coverage, Holistic Hypermnesia?

Holistic state is detected and repeatedly described. Psychologists over the past decade stated the simultaneous awareness of many elements at once - from hundreds to dozens thousand. So, a lot of people who visited the clinical death describe the experience of memories of their whole life instantly, immediately, simultaneously. "I saw scenes of my life from present to the child in my crib with bars".

Such the same condition is often described by survivors of instantaneous death danger. Yogis and even autists describe similar state of simultaneous coverage. Partial coverage states the sets of elements during illumination are described by famous creators, etc. All such phenomena are characterized by proven simultaneous awareness of many elements at once (sometimes tens of thousands or more).

### 3.1.3 Brain Rhythms, Wave Processes

There is definitely a connection between hypermnesia (natural absolute recall) with holistic states. So, people with very good memory definitely had holistic abilities.

For example, Lenin, who could quote book pages, read entire pages of books very quickly. Napoleon, distinguished by outstanding memory and remembered by to the names of tens of thousands of his officers, argued that cover immediately the mind map along with other materials. "My genius was, he wrote, that with one quick look I covered all the difficulties of the case, but at the same time all the resources for overcome these difficulties; it owes my superiority over by others ...".

Mozart, able to remember a symphony, with inspiration could encompass the whole future creative work at the same time. There is evidence that people capable, like Mozart, remember, for example, the whole symphony, they did it, like Mozart during time of inspiration, immediately. Repeat, they claimed to be recalled the whole symphony at once, completely, instantly.

The phenomenon of "hypermnesia" is generally recognized and mentioned in many sources and works. But recently it has been discovered that the brainwave circuit that accompanies it is one of basic in human life. So we are not dealing with phenomenon, and from one of the basic foundations of thinking. It is understandable - holistic hypermnesia of all life is actually absolute memory, and we can conclude that once it exists, once there is an opportunity to remember everything that passed through the organs perception and the brain, then, it is the basis of the phenomenon of memory.

But simultaneous coverage (awareness) of the set of elements is actually a thought in its best expression, and once such a holistic phenomenon exists, especially in infants (by similarity of electroencephalographic "schemes"), so it lies in the very basis of consciousness and mind. Holistic coverage of life, same as well as individual phenomena, there is in fact the basis of Mind in general.

The brain scheme accompanying the "holistic hypermnesia" or "holistic states" - one of the basic foundations of consciousness. This and creativity, and sleep, and infancy with a part of childhood, and a state diagram autist with phenomenal abilities are all by [15, p. 32] assumed that so far we have not seen an iceberg, that is, not noticed a basic system of thinking.

The classification of types of thinking is roughly represented in the following way [15, p. 34]:

- holistic;
- sensual;
- figurative (sensory): happens according to the characteristic consistent, for example as a film strip, or holistic, like a sculpture, and includes all variations of perception - visual, spatial, sound, tactile, etc. (some psychologists, however strange, allocate up to 60 types of differences in perceptions);
- verbal-logical, focusing on individual object;
- corporal, super concentration, bodily skill.

The reviewed classification is based on the brainwave patterns, that is, on typical schemes of amplitude-frequency characteristics of the electric encephalogram (EEG) cerebral waves for the both hemispheres. In other words, on processing dependence of the amplitude of brain waves on the frequency (meaning processing of gamma, beta, alpha, theta, delta brain waves in frequency (Hz) and amplitude, as well as other mathematical processing methods and presentation of the results.

What caused the appeal to brainwave patterns, generalized for the hemispheres in particular and for the brain as a whole with using special methods? Reliance on results mostly continuous long-term (monitoring, visual observation, visual and mathematical assessment of dominance) EEG studies using routine and creative tasks. Also - creative self-observation, study special conditions, biofeedback and introspection in its classification, which is caused by the fact that the proposed processing schemes signals of the brain in real time in the study of conditions in unlike conventional methods of observing and recording waves, proved to be informative enough. So that one could predict the appearance of states and also ensure them classification.

## 3.2 Nonverbal thinking levels

Nonverbal thinking levels like full intelligence not only made conclusions, but also have made tables of levels of thinking depending on the brain EEG patterns [15, 17]. The conclusions are simple: not only there are nonverbal thought levels that are used musicians, composers, artists, directors, sculptors, perfumers for highly specialized thinking but these levels can be used as full-fledged "intellects" for solving not only direct tasks, but also all life tasks. These are complete, but not verbal "Intellects".

As in the case of Hadamard, who used the spatial imaginative thinking is not for building ordinary sculptures (like Michelangelo), and to build some mathematical theories. What could be more absurd than using a rainbow of colors (paints) solve an example or carry out color calculations a symphony? But people with such thinking are well-known “counters” and even some famous mathematicians and sometimes famous physics like A. Einstein.

### 3.2.1 Changes in Brainwave Patterns with Age

If viewed in perspective, the levels of thinking are not appearing just like that. Today is the undisputed scientific fact confirmed in most countries on the basis of a large the amount of research that brainwave types alternate in humans for the childhood and adulthood.

The picture looks about so: although the baby sleeps more, but in the waking state it is dominated by delta waves. Later they are added to the thawing waves and manifestations of other types of waves, but up to 3 months (some studies increase the gap to 14 months, some narrow to 3-4 months or 6 months, and some even increase up to 4 years depending on the research methodology, types of treatment and what is called "dominance") is precisely the delta wave remain dominant on the EEG frequency response diagram in the amplitude, density, representation of the range.

At least it's typical of European culture, our type of education (some authors’ time boundaries are quite different - perhaps this different interpretations of experiments).

Many researchers indicate to change brain rhythms from delta to theta, theta to alpha and alpha to beta (the time frame of the changes does not always coincide from different authors). The relationship of these changes with morphological reorganization of the brain was supposed.

The dominance of the alpha rhythm in the area from 6 to 12 years old in a different measure was noted by most researchers and theorists. The time frame of the domination of certain waves can differ, but the dominant movement is mentioned by all serious authors' generalizations. Discrepancies are most likely related to the difference sensitivity of instruments depending on the year of experiments (the sensitivity of the devices is constantly growing), the nature of processing EEG, rhythms in different areas of the brain, different understanding of the term dominant, cultural characteristics, sexual characteristics, the difference in the duration of research (30 minutes, a few minutes or a day, continuously or weekly, in just awake or when solving some tasks, whether it is caused by potentials or real-time observations).

The difference in the formulation of experiments was the typical thinking or state of rest, etc., lack of samples, medical features, etc. Various authors confidently claim different numbers, and most often they have a different statement experiments, different equipment, different processing schemes and different approaches to what is considered dominant.

About half a year (four is a given number it is doubtful, but he has defenders) up to 5–7 years (according to other data from 3–6 months to 5–6 years) theta waves dominate, although other waves appear. But on the spectral response characteristic EEG is usually traced dominant theta waves, as while thinking on theta level.

From about 3 (6) to 14 years old, this is strong depend on the culture, about the child can be said that he is in alpha state, although dominance is already ten years old beta waves with active verbal thinking. But massively in this period, as written by different authors, the dominant frequency of work brain in the alpha range of 9-13 (14) Hz (as when solving problems on pure alpha level in A. Wise).

At least many authors write about it. From twelve to fourteen may occur amplification of theta waves (relative SP), most likely associated with beginning love. Recall that the dominant brain waves can change even for a few minutes. It is about the long states of the dominant.

And finally from about the beginning of puberty, from the age of 14, domination, probably goes to beta waves of the brain 14-21 Hz (they start to be registered from one and a half years and earlier). But this change is not end - approximately with the onset of sexual activity, usually after some time after its beginning (love gives outbreak of delta and theta waves directed mainly at love object when thinking or contemplating) is thought to be not just the dominance of beta waves, but almost complete weakening of other types of brain waves in the waking state while thinking, that is, the thinking of an ordinary person is already happening on a pure beta level [17]. It is very likely that this is due to transition to verbal thinking and is observed in full only people with verbal thinking in adulthood.

The amplitude-frequency characteristic (AFC) is filmed in real time with using EEG monitor getting the simplest graph of amplitude versus frequency, adjacent for each hemisphere in the mirror mapping for better visual comparison. The indicated frequency ranges for:

- delta (0–4 Hz),
- theta (4–8 Hz),
- alpha (8–14 Hz),
- beta (14–30 Hz) and
- gamma levels (30-500 Hz)

are somewhat different from each other. Density optional one can add color in amplitude.

With the age and termination of sexual activity picture of the brain waves change again - available data from various scientists show that in old age a person again has delta waves, and in some cases even return to their dominance (Alzheimer's disease, for example).

Accurate statistics on broad samples for all ages, taking into account the basic type of thinking when problem solving has not yet gathered, but the spontaneous appearance of delta waves in waking state, most often leading to disturbances thinking (remembers childhood, as in hypermnesia, but loses time sensation as autistic or infant) in old age statistically significantly more often.

Studies show that with forty-five (fifty) years the dominant frequency of brain waves in masses begin to decline. In many papers, an increase in delta and theta activity in elderly age was reliably shown.

### 3.2.2 Spectrum-Power in Brainwave Patterns

The total absolute spectrum-power of all ranges in the period of 50–60 years at rest increases significantly (according to Ostrova [18]) 4 times compared with the norm: the total absolute spectral power (AFM) of the norm of AFM $\approx 5\ \mu V/Hz^{-2}$ (5.1 right semi-sphere, 4.78 left semi-sphere), for age 50–60 years AFM $\approx 20\ \mu V/Hz^{-2}$; for the age of 61–70 years, AFM $\approx 18\ \mu V/Hz^{-2}$ (18.9 right semi-sphere, 16.35 left semi-sphere, according to the submitted by V. Ostrova sampling). And this means that brain activity in 50–70 years is GROWING [15, p. 48]!

Possibly the Indian term "rebirth", through which symbolically passes a yogi or brahmin has a physiological basis and is connected with

hyperactivity of the "infant" wave bands in the elderly and old age. Spontaneous delta and theta levels hyper activation, mistaken for pathological, most likely, is possible at any age. Circle delta, theta, alpha, beta waves, passed from birth until maturity, as it closes and starts to go in reverse direction. The person as if "falls into the childhood". At least, decrease in the frequency of brain waves (Hz) among the masses of people not associated with mental activity is observed by many scientists.

A separately should be noted about creative people and scientists, and yogis - up to 14, they develop like everyone else, although there is possible pathology delay dominant in the alpha range or even in delta theta range. Many of them, even after 14, decide tasks at levels alpha, rarely theta and very rarely delta. But now in maturity their thinking is different from most.

At works by A. Wise, who has achieved success in creative areas there is a reduction of the remaining brain waves after sexual maturity, and there is a uniform activity of all types' brain waves during the creative activity or state inspiration. That is, they are active not only beta or even alpha, as in people with a sensory type of thinking (figurative, spatial, sound, etc.), and all types of brain waves simultaneously - beta, alpha, theta and delta waves together or interspersed usually with a slight dominant of alpha waves. Max Cade called this state "active intelligence" and asserts that this is exactly the scheme that the experimental described as "inspiration" [18].

People with creative mental activity have no reduction other types of brain waves in maturity, like ordinary people. Moreover, the dominant level of creators is often not the beta level. The creators have uniformly all types of brain waves activated and controlled; although slightly dominant is alpha level usually [18].

#### 3.3.2 The Main Types of Thinking

Consistent movement of brain wave dominant from delta to beta, from integrity to sequential unit thinking, and back from beta to delta, from sequential managed thinking to managed holistic thinking, exists as a natural mechanism for mastering your thinking. To sum up the discoveries of yogis, thinking should move towards top, not degradation.

The experiments of J.J. Kamiya [19], N.P. Bekhtereva and employees, M.B. Stark, M. Cade, A. Wise [18] and others have shown that through feedback and also using different methods workouts, one can learn how to manage brain waves, particular activation and quenching of the delta and theta ranges as it is done by yoga, controlling at will types of thinking. Based on the foregoing, we specify the main types of thinking, but just add to them the brainwave patterns:

- holistic (delta waves dominate);
- sensual (theta waves, pure or dominate);
- figurative (alpha waves dominate), represents a mixture of thinking with combinations of sense organs: figurative, spatial, sound, aromatic, taste, tactile - all these are images and their mixtures;
- consecutive, most often verbal-logical (beta waves dominate);
- corporal, skill, super-concentration on action (gamma waves);
- insight (flash of all types of brainwave with mandatory severe hyper activation of delta, theta, alpha waves);
- inspiration or working intelligence (constant hyper activation of all types of brain waves, except gamma and high beta).

### 3.3 Long-life working early years' experience

#### 3.3.1 Own early school case

This story I tell the students as an example of the usefulness of difficult tasks in childhood to believe in ourselves.

Once in 1964, I was in the 4th grade, my dad, his nephew Ivan (just a year younger), and his nephew Nick (recently graduated the secondary school), sat in the evening for dinner. Ivan studied at night school and told everyone that the textbook for grade 4, contains the tasks, marked with an asterisk, which are difficult to solve even for the graduates. I was immediately given a command and I brought a textbook. Ivan pointed out one of these tasks and Nick looked and said that he really didn't immediately see how to solve it. And then my dad confidently issued: "And Vanya will solve it!"

How was I tormented in another room for 3 hours while they were sitting? Mom with her 5 classes (before the 2nd WW) tried to help, but only encouraged me a little and tried to direct me somehow. How proud I was when finally I successfully found the solution! And my father was not disappointed by me. Such moments inspire confidence and somehow even influence the subsequent profession.

#### 3.3.3 Advanced Distant Mathematical School by Lomonosov Moscow State University

In the spring of 1968, a contest for admission to the Advanced Distant Mathematical School by Lomonosov Moscow State University was announced in a Soviet newspaper for young people. It was requested to solve a number (more than a half) from the stated 20 non-standard hard tasks.

I was dominated by an analytical mindset (equations, transformations, etc.), and he had better developed spatial imagination. With great difficulty, I solved several problems, he also solved several, moreover, we solved approximately 2 different tasks and we explained them to each other, including 2 tasks in addition in this way.

None of our school teachers and friends of our parents with higher education could help in solving these problems. We solved one problem for the geometric locus of points in completely different ways: I did analytically, he did geometrically. And the found sets of points were not only different, but not intersecting. We were very puzzled and realized that each of us found a particular solution. We began to search for a more general approach to solving the problem and found it. This was our methodical discovery, which opened the way to solve the task in general!

### 3.4 CompEduHPT

Except many best collected educational materials presented during the years by universities participating the claster, The CompEduHPT of the Prof. T.H. Fransson (KTH, Stockholm) has many above-considered methodical achievements, which were gradually introduced in the system.

For example, many discoveries of Shatalov from above were independently done by developers of the CompEdu: amazing flexibility, when student can possibility to arrange educational material in different ways he likes; the “Reference Signals” are present in short main pages of CompEdu (e.g. see Fig. 4); the “Pulsating Knowledge Process” is done individually by the student in his play with the material in the own way.

There also a lot of exercises, tests for self-control and many other possibilities.

## 4 Conclusion

Some methodological basics of the Interactive Teaching-Learning were considered in the paper. This type of interactive educational platform can hopefully serve as a base for a better teaching-learning environment in a global life-long education. It is implemented at KTH and in some parts also at many other universities and companies, and it is developed towards improvement both the programming platform/tools, as well as quality and quantity of the books and chapters.

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