

# PEDAGOGICAL ASPECTS IN FLIGHT INSTRUCTION

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## 1. PRELIMINARY REMARKS

In the beginning, I would like to give a disclaimer warning: This is not intended as rules—only suggestions!

In contrast to most other lectures of this Congress, the subject of this paper is of a different nature. The distinction is above all found in the fact that concrete answers or aids to solving problems can normally be given to questions or problems of a technical or physical nature, but this is not so in pedagogy. So, you should expect neither ready-made

proposals for solutions nor universal recipes. It was a conscious decision to address only pedagogical issues in the title, which are to be considered in detail in this talk.

Don't worry, the treatment of pedagogical issues in flight instruction should not be lost by such a general view. I hope I can show some findings of research, which will be able to help in solving problems in the classroom or on the airfield, but I cannot deliver ready-made schemata for the solving of those problems.

To become rather concrete in the given frame of time, I will restrict my lecture to some results of research into learning. Other pedagogical issues have been deliberately left out.

Figure 1 shows the average level of performance of a human being in the course of one whole day. The organism is in alternative phases of tension and relaxation. Your level of interest in the following report is thus dependant on this phenomenon.

In practical training, we also have to consider this aspect. For the first solo flights we normally wait for calm hours in the evening, a time in which the performance capabilities of the pupil have risen again.

In this connection, we also have to mention short term fluctuations in performance. Our brain tires rather quickly in times of mental exertion and must regenerate in breaks by absorbing fresh metabolic products, above all of oxygen.

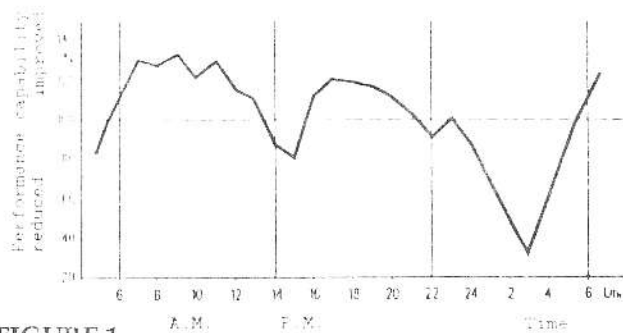


FIGURE 1.

The established progression of those fluctuations in performance you can see in Figure 2.

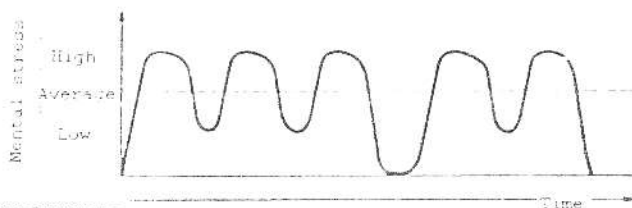


FIGURE 2.

The duration of each maximum is between 10 and 20 minutes. Thereafter, there need not be a break in the literal sense; it is enough to lower the level of difficulty of the lesson. At such points one can, for example, revise the material, provide opportunities for questions or for note taking and such.

After two or three such breaks a period of movement is necessary.

This is not only advice for the administration of theoretical teaching, but should also be noticed in practical flight instruction: During longer flights, which make considerable demands on the beginner, it is a good idea to take over the controls in the stages mentioned above and to assign other tasks (for example, observation of the airspace) to the pupil.

## 2. LEARNING AS ALTERATION OF BEHAVIOR

We are teachers who are supposed to "pass on something." That is the trivial description of our activity. I much prefer the scientific formulation that teachers should "initiate learning processes."

It is the better formulation because learning always has to be an active process on the part of the learner. Without his cooperation, without his will, nothing would happen. The widespread formulation "to pass on something" seeks in such a case to blame the teacher, sometimes with little hesitation, but nevertheless unjustly.

As a rule, we must not fear that a pupil struggles against being taught flying. He really wants to learn, the teacher only has to initiate the learning processes, which means: initiating, stimulating, supporting, reinforcing,... if the pupil, nevertheless, doesn't learn, then the teacher has to ask whether he has given correct and sufficient impulses.

To be able to give correct impulses, the teacher must be informed about the learning process, about learning in general.

The aim of the lecture is:

- to inform about the general conditions of learning,
- to show some basic findings of scientific research, and
- to show results of research into the biology of learning and to discuss possible applications in flight instruction.

Before we can talk about "learning," we have to define what learning is. What is your definition of "learning?" What should happen before we can call it a successful learning process?

The newer biologically orientated pedagogy defines learning as a change in someone's behavior which ensues from active perception or intake of information. Important is the condition of the active perception: When a boy's voice breaks it will also be a change in his behavior; of course, it is not due to active perception but it is caused by biological processes of maturation. Nobody would ever talk of learning in this case.

When the same boy can ride a bike, he has had to learn it. Nobody has a genetic program which suddenly enables him to ride a bike. The alteration in behavior becomes distinct in that he can remain on the bicycle; before he would have fallen off.

## 3. CONDITIONS OF PERCEPTION IN HUMAN BEINGS

After having emphasized the act of perception, we should take a closer look at the basic conditions of human perception, which means taking in stimuli from the environment with our sense organs.

These altogether contain some  $10^9$  receptors and every receptor can transmit presumably about 100 bits (unit of information) per second, all organs of sense together are capable to take in about  $10^{11}$  bits per second. Due to psychophysical limitation of the performance capabilities of our sense organs (absolute threshold, differentiation thresholds, spatial and temporal powers of resolution,...) only a fraction of this information, about  $10^7$  bits per second, is perceived and transferred into the centers of projection, where a conscious selection takes place.

About 90% of the total resources of sensory stimuli come through the optical channel, which is ten times more than through the auditory channel. The necessity of diagrams, figures and models for instruction derives from this fact.

By focusing our attention we can select from the supply of information which has been transferred into the centers of projection. This conscious selection is called apperception. For the quantity of information that can be selected and, thus, consciously perceived from the  $10^7$  units of information supplied, a definite limitation has been ascertained through research.

This limit which represents the capacity of comprehension of our consciousness, is dependent on two factors:

First, we have the so called "subjective temporal quantum" (STQ), which specifies the maximum of speed information can be consciously perceived. This maximum rate of apperception is dependent on age. It is about 16 bits/sec for young adults and decreases with the advance in years. See Figure 3.

This subjective temporal quantum can be verified by some facts, which we experience daily. Without this limit, movie and television would not be possible as they are today. As you know, moving pictures are produced by the rapid transposition of single images over each other. In movie and television, a frequency is used which is slightly more than 20 pictures per second. If we slowly reduce the film speed, we will soon reach a point when continuous motions change into an intermittent sequence. This is the case with picture frequencies of less than 16 pictures per second. Interestingly, the lowest amplitude that we can perceive is also in the region of 16 Hertz.

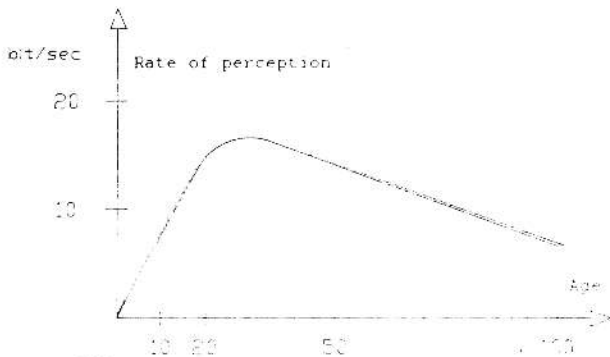


FIGURE 3.

Let us remember, that we can consciously perceive (apperceive) only 16 bits per second, at best. The perception of more complex information is made possible by the memory function of the immediate memory span. This is the space of time between future and past, in which received signals can "resound" before they escape again out of immediate recollection. This span of retention lasts ten seconds at most, and is also dependant on age, see Figure 4.

We have all been made conscious of this function of our memories every day too. We can still clearly hear the chimes of a clock or see the number-plate of a car though the real stimuli are no longer present.

We should pay attention to the age dependence of the span of retention in training young pupils. We can see from the curve, that a fourteen year-old has only half the memory span of an adult. Therefore, we have to make concessions in speaking to such young pupils: Long and complex sentences

and a flood of information in a short interval of time can not be completely understood, in spite of greatest attention.

Now we have to calculate: at most 16 information-units per second times at most ten seconds of duration makes at best 160 information-units. Therefore, the consciousness is also called ultra-short term memory (USM).

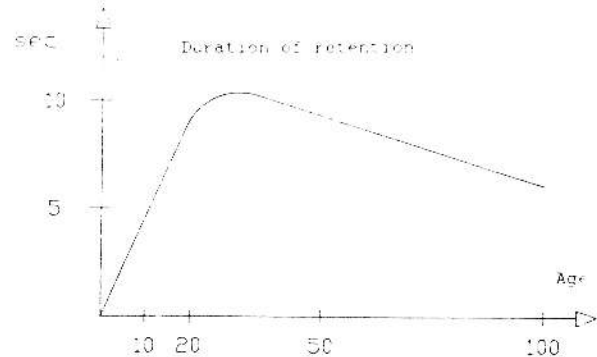


FIGURE 4.

#### 4. CONSEQUENCES OF THE LIMITATIONS OF CONSCIOUSNESS

This consciousness with its low capacity is our only access to the environment. Only if we know about the narrowness of this gate to our environment, can we understand the importance of continuous directing of the attention of a pupil towards matters of current importance. We really have to focus his attention, because a novice will never be able to pick up important information out of the great amount of information pouring in.

When being bombarded with a great deal of new information, the consciousness cannot fall back upon already store information or push aside as redundant what is already known. Therefore, new information should be offered in a structured way and in small packages suitable for the capacity of the mind. Such a structure is helpful for quick arrangement in our memory, because structured new information could easily be connected to already present contents.

As a basic principle, it should always be attempted to link new information to old. Either new content can be offered in old packages or similarities to what is already known are pointed out explicitly. This lecture also points back to things which are adequately known and which you have, perhaps, already been practicing for a long time. The really new information can be comfortably linked to knowledge that is already present. This is known as the redundancy principle of learning.

Through the access of consciousness to the content of memory, the capacity of the ultra-short term memory can under certain circumstances be put to considerable strain, so that only a little part is available for actual perception; we are "lost in thought." We often screw our eyes up, cutting out stimulation from our environment to have the whole capacity of our consciousness available for the power of recollection. In turn, we can leave the pupils whole capacity of consciousness if we keep away memory processes from him.

Flying a turn may be a good example: Which of us can say at once and without reflection, what we do when in a right turn the thread goes to the left? Our reaction in flight ensues automatically. A pupil who does not yet naturally have those automatic movements, must rummage around in his mind. During this time, his consciousness can hardly apperceive new stimulations, he can not notice further changes in the flying situation. By the time the right reaction is "ready," the situation has already changed.

A short hint: "More rudder" can relieve the pupil.

In situations of fear or stress, the gate of consciousness becomes so narrow that normal conscious perception becomes almost impossible. An analysis of accidents clearly verifies this assertion.

These days, nearly every glider is radio equipped. If something were to happen, we could call the pupil down, or so you think. At the latest after a critical final approach of your protegee, when you have screamed into the mike in such a manner that your instructions could also have been understood without the radio, when afterwards the pupil comes out as white as a sheet and trembling, and when he stubbornly insists that he really didn't hear anything, you will remember the frame of consciousness. He really couldn't hear anything at all. The situation of stress in which he had narrowed his consciousness to such a degree that stimulations of the environment could hardly be perceived. In addition, we are primarily visually orientated; if we can perceive any information at all, it will be visual information and not acoustic.

The radio equipment is of hardly any use in such a situation. Nevertheless, in precarious situations instructions must be given by radio, we should talk with the pupil as early as possible. He will then not get into stress or the auditory channel will be opened as long as is possible.

Only 0.7 bits per second can be transferred from the ultra-short term memory into the real memory which has the great capacity of storage of  $10^6$  bits. It is not intended to explain the structure of this long-term memory, only one remark should be made:

A great deal of what is transferred into the memory depends on interest. An interesting presentation of new material means an increase of the likelihood of retention.

This short survey of the conditions of human perception should have shown that our consciousness is only a very narrow gate through which we can perceive our environment.

## 5. BASIC PRINCIPLES OF TEACHING

The knowledge of this gate and our definition of learning provide some important principles of teaching:

- The teacher has to direct the learner's attention from the great flow of information towards the essentials! Such concentration can take place through goal-oriented directions and clearly specified learning instructions.
- Guidance of consciousness is also possible by directing interest towards particular facts; in pedagogy, also called motivation.
- Aids for the guidance of consciousness are media of any type which will focus the learners' attention and with it their

consciousness towards themselves.

Motivation and media are subjects suitable for a whole series of lectures. Therefore, we will restrict the discussion to some essential aspects.

Normally, we won't have any problems with motivation. Our pupils come spontaneously and full of enthusiasm to the airfield. What is valid for practical training need not be valid also for theoretical instruction which often seems to be a necessary evil. What they need for the exams they have on tap, but so many licensed pilots would fail the same exam. The high failure rate in aviation instructor selection examinations verifies this assertion. It can hardly be true that the necessary motivation, for long-term memory also, is present here.

Therefore, it is a task of the flight instructor to expand the pupils' motivation for practical training into theoretical learning. Some possibilities will be indicated later.

On the subject of the media, it is only intended here to point to their necessity and to their support of learning. Although human language is a carrier of information and, therefore, a medium, human beings are primarily visually orientated and optical information is much more helpful. In this way, pencil and paper for outlining any facts should be self-evident on the airfield. Also, a little glider model with movable control surfaces to demonstrate cause and effect of moving them should be an indispensable component of flight instruction.

At the latest when one remembers blackboards full of random scribbles and illegible OHP transparencies, it becomes clear that such commonplace media are also subject to their own laws, which is something that one should make clear to oneself.

As learning should cause a durable change in behavior, the information taken in has to be transferred into the long-term memory. Because the channels of information become more and more narrow, this will be a long-term process which, in turn, should be supported by the teacher.

Only what is interesting will be retained. The process of retention can similarly be supported by directing interest, by motivation. The above-mentioned exploitation of "practical" motivation to the theory without practice could be achieved by an ingenious combination of theory and practice. Who has ever applied the unloved theory of aviation law to practical activities with the pupil in the air? Who has ever checked calculated courses and flying timetables in the glider? Who has ever really tried to fly a coupling navigation?

This concatenation of theory and practice points to the field of multi-channel learning. As you know, the human brain has different areas for different ways of perception. There are areas of the brain, which are stimulated by theoretical knowledge, others by emotions and feelings. If we can achieve a transfer of information not only into one area, but also into further regions, the probability of retention becomes incomparably greater.

Our aides-memoire are to be seen from this point of view. "Thirty days has September, April, June and November" stimulates an area of the brain which is "competent" for rhythm and rhyme. Pure information is not merely stored in the "center of knowledge," and for that reason it will be well retained.

This leads on to learning by example. In flight instruction "example" is a synonym for "model." An instructor should always be aware of his function of a model, there cannot be any exceptions for defied flight instructors. Every instructor is untrustworthy when he teaches correct approaches in the classroom and demands the same of his pupil, but then in the final approach curve rides a thermal again and calls back from a flashy flight over the airfield.

## 6. THE PROBLEM OF FORGETTING

Even when we have learned some facts and stored them in our long-term memory, we have the problem of forgetting. What we do not practice, we will forget. There are clear-cut points of time for exercise and training. See Figure 5.

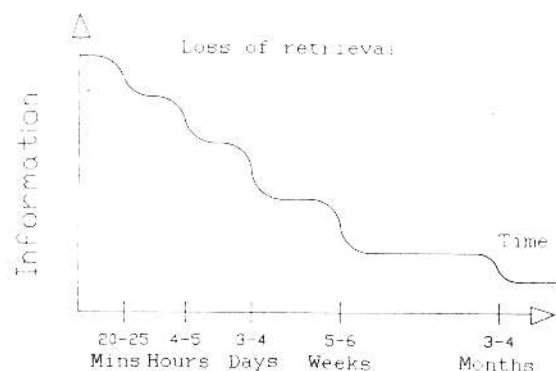


FIGURE 5.

The research into learning has found that forgetting is not a continuous process, but happens in stages. From a quantum of information which is stored in our memory at the moment, we have already forgotten the first portion 20-25 minutes later. Other parts of the remaining knowledge will disappear respectively after 4-5 hours, 3-4 days, 5-6 weeks and 3-4 months.

Under these circumstances, a revision during a lesson or a discussion following a flight may help to avoid forgetting.

Likewise, a review in the evening can counteract a phase of forgetting. There is then no need for surprise if a pupil has forgotten a week later most of what had been learned. In the meantime, he has had to pass through three stages of forgetting. Our 90-days-regulation should be seen under this aspect too.

Also, this lecture will fall into oblivion. To counteract the first stage of forgetting, let me repeat some catch words:

-Learning is a change in someone's behaviour due to active perception.

-Our apperception is limited by the narrowness of our consciousness. The immediate memory span and the subjective temporal quantum will restrict our perception.

-Therefore, a teacher has to direct the learner's consciousness towards essential matters.

-Learning will be supported by motivation and a considered use of media.

-Well-timed repetition will counteract the stages of forgetting.

My talk has now reached the point of decline as far as the performance curve is concerned, and I would like to grant you your deserved break after my closing words.

Now, it is time for questions or criticism. To weaken the criticism and to put into practice the good teaching principle of rounding off, I will remind you of my warning. The point of this article has not been any universal recipes. That is impossible and not necessary for tried and tested flight instructors.

We also have to be aware that it has only been possible at best to touch upon an immense topic within the time available. Nevertheless, I hope according to my central point, a teacher should initiate learning processes, that I could stimulate some reflection. If I have succeeded in doing this, I have achieved my aim. For the future, I wish you many happy landings and success in flight instruction.

## 7. REFERENCES

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