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Excerpt of Study  
on the Educational Efficiency of  
Multimedia Based Training Programmes (MBT)  
created by infoWERK GmbH, Austria

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## Imprint

Study of the Educational Efficiency of Multimedia Based Training Programmes (MBT)  
created by infoWERK GmbH, Austria

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## 1 Assessing the Educational Efficiency of MBT

The catalog for the assessment of the educational effectiveness of MBT in comparison to traditional classroom training programs, organizes the criteria along didactic dimensions. These stem from relevant national and international studies, where they have been emphasized. The didactic considerations in question are drawn upon by the Fraunhofer-Society itself in the development of knowledge products for commercial use:

- Choice of contents in accord with lesson objectives and appropriateness for the target group
- Conceiving the MBT-Learning Process in accord with target groups, contents, training location
- Variety, Appropriateness of the Interaction possibilities between the User (Learner, Trainee) and MBT
- Multimediality with reference to the types, extent and quality of the media used
- Learning Time (Completion of the Learning Module by free choice of learning times and with reference to a defined given time
- Performance Support on the job and with real problems
- Measurement and Assessment of Learning Success by the individual as well as the Use of MBT by groups of co-workers.
- Creation of Exercise Segments with reference to Form, Variety, Contents, appropriateness to the individual target
- Personalization, above all the modification of the training location and the choice of modules dependent on the individual and/or the degree of qualification of co-worker groups; reference to organizational requirements
- Trainee Motivation through encouragement to learn as immanent in the MBT Structure and Tutoring

Each presentation of study findings in connection with the various didactic considerations is preceded by a short summary of the criteria underlying the training goal defined in the catalog. There follows a brief survey of the most important findings, outlining the realization of the training goal as demonstrated by the infoWERK MBT. An evaluation of the comparison between the training goal and the degree of achievement of that goal makes it possible to draw conclusions as to the effectiveness of the MBT.

### 1.1 ***Choice of Contents suitable respectively to educational goals and target groups. Modularization of the subject matter for MBT- Contents***

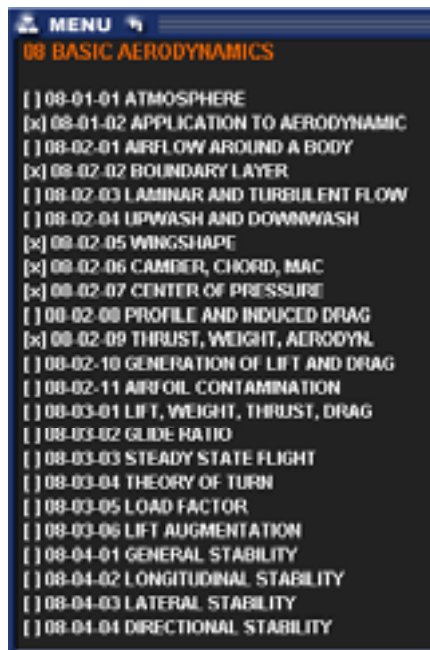
At the moment, advanced training programmes (whether available in the Internet or in the so-called offline-media, such as CD-Rom) reflect no particular target group or, at best, a very loose concept of the same. Frequently, this is a result of the offering companies desiring to appeal to the largest possible segment of the market. It's from this standpoint that the aspect *Choosing Contents and Planning Modularization of the MBT in Accordance with Learning Objectives and the Needs of Target Groups* plays a key role in comparing the study with traditional class room training programmes.

The criteria that best illustrate this key role are the questions concerning the target groups aimed at by the MBT, their level of prequalification, and the additional qualification that is meant to be achieved or stabilized. The following criteria will be drawn on to evaluate the suitability of the presentation/treatment of the contents: Are the contents modularized? Do

contents and didactic considerations require that there be clear-cut methodological and subject-matter boundaries between the modules, while at the same time they relate to each other? How can the relationships between the various modules best be characterized from the standpoint of contents and seen in a didactic light?

On the basis of these questions, it can be stated that four of the infoWERK MBT examined in the study (Maintenance Training für Fairchild Dornier 328 Jet, JAR 66 Module 8, Embraer 145 Honeywell FMS, Augsburg Airways Dash 8-300) are consistently oriented, at various levels, to a largely uniform concept of the target groups maintenance personnel and pilots. These target groups are seen as highly qualified, certified specialists trained on the basis of the governing aviation regulations.

The MBT *De-Ice* (German, English) is laid out for the advanced training of technical personnel already in possession of professional qualification for the de-icing of aircraft and with a command of the accompanying regulations. The level of specialized presentation, however, exceeds the above said MBTs in the areas of grasping, understanding and consolidating knowledge of the interdependence of the natural sciences and technology



Picture 1: Explorer structure of the MBT Modularization

All MBT have a systematic and universal modular structure. The modules (building blocks of knowledge) are sensibly self-contained, both didactically and in their contents. That is to say, they are completely separate and at the same time form building blocks for each other. They introduce subject matter in the form of elements (graphics, pictures, animations, speech and sound, and videos) or as an indivisible combination of these elements. The presentation of the modularization (see picture 1) follows in all cases the well-known Explorer structure, thus making it visually graspable for the trainee. However, the modularization or individual MBTs (for example Augsburg Airways Dash 8-300 and Fairchild Dornier 328 Jet) is not always immediately evident, because the modules are not always designated by title, but rather with a number (the reason for which may not be immediately clear to the trainee).

Comparing the desired level of achievement in the catalog of criteria with the realization of the same through infoWERK, it must be emphasized that the afforded requirements have been systematically and universally fulfilled on the basis of a clearly defined target-group concept. The contents also take into account the provisions set forth in the relevant aviation regulation requirements of, for ex., JAR 66 and ZLPV. The fact that the modules are completely separate didactically and in substance and at the same time progressively related to each other, makes the system especially equipped to promote creative problem-solving processes, based on technical know-how, professional skills and corresponding professional experience.

This didactic organization with its emphasis on the trainee's independently mastering didactically processed knowledge leads the user step-wise to a deepened understanding of complicated relationships, enlarging his problem-solving capacity. It is this didactic disposition coupled with the systematic modularization of subject matter which distinguishes the MBT from traditional trainer-dominant classroom training methods. One possibility for improvement concerns the easy surveying of the organization of the modules. The organization of the separate models by title according to subject matter appears to facilitate the user's orientation within the MBT.

### **1.2 Conceptualization of MBT educational procedures in accordance with target groups, contents, and training locations**

The didactical dimension *Conceptualization of Educational Processes* initiated by MBT addresses in particular the relationships between target groups, contents, and training locations. The coverage of these relationships is especially important, since not every training location is equally suitable for the communication of specified knowledge to specified target groups. These relationships can best be disclosed by means of the following considerations: *In which surroundings should the target group learn? Which key qualifications should the target group already possess? Should the learning process triggered by the MBT be of an individual or group nature? Should the trainee receive help and/or support in organizing the learning procedure? Should the MBT enable independent, self-regulated, practice-oriented learning? Should reports on learning progress/success be designed to motivate the trainee?*

All MBT have been created for the individual online training of highly qualified technical personnel. The training location is the Internet, accessed by a computer. The individual MBTs are distinguished by various training levels, recognizable by the language used to create the contents. In the MBT *De Ice*, simple language with basic technical terms is used when speaking to the target group as well as in the presentation of the subject matter. In the following MBTs the language used is designed to lead the trainees to the theoretical and practical understanding of complex relationships (see picture 2) typical for the piloting and maintenance of aircraft. The example of the MBT JAR 66, Module 8, shows especially clearly (as has been verified in interviews with trainers) that training at a computer, via Internet, must be supplemented by traditional class-room training and a variety of guided practical training if the required AMC 66.25-specified basic knowledge is to be attained at the following specific levels:

- Level 1A: *Acquaintance with the principal elements of a topic*
- Level 2A: *Competence in applying the acquired knowledge*
- Level 3A: *Ability to understand, combine, and apply acquired knowledge in a logical and conclusive manner*

A prerequisite is that the target group(s) to which the MBTs is/are geared possess a solid (that is, theoretical, through professional practice well-founded) practice-oriented technical knowledge in the knowledge- and operations sectors covered by the MBT. In addition, these target groups must have the prerequisite abilities and skills at their disposal. Also prerequisite are key qualifications such as the ability to learn independently at a self-controlled rate; the ability to think analytically; a basic mastery of the English language and of technical English; and an over-all ability to learn with the computer.



Picture 2: Transmission of complex knowledge, using the hydraulic system as an example

From this standpoint, the level of desired achievement set out in the catalog of criteria is completely realized by the infoWERK MBT under study, taking into full consideration the varying levels of qualification of the target groups. Above all, the supplementary concept of trainer, guided classroom- and practical training as developed for the MBT JAR 66, Module 8 seems especially suitable for increasing the effectiveness of advanced vocational training for maintenance personnel, given certified primary professional training and the appropriate special training for the specific type of aircraft.

Thus, in developing and producing further MBT, the division of labor between the various training sites (trainer-, classroom-, practical training, MBT) should be more carefully looked at from a didactical standpoint, posing the question of which subject matter can best be transmitted/learned independently in which training situation. This is also true for the choice of subject matter as well as for its (above-mentioned) multimedia presentation. If the goal is increased practically-oriented learning/teaching through the use of MBT, then those elements which the trainee can personally control through individual input (animations, for ex.) should be given more consideration in MBT development.

An increase in efficiency may also be expected as soon as the trainee is better informed through feedback as to his individual progress, as well as when his personal level of qualification – both at the onset and during the work with the MBT – can be better diagnosed. This is especially true if, as with the MBT, a high degree of key qualification is presupposed, although it is not necessarily true that every trainee possesses the required qualifications in every case. In addition, it should be remembered that every trainee grasps complex technical

material individually, depending on his personal capabilities. That is, the MBT should be more closely geared to allowing that target groups with mainly practical abilities be given greater freedom to take a practical approach to the subject matter.

In order to reach this goal, the trainee can also receive the necessary help and support from a tutor. That tutor can be addressed through the platform on which the infoWERK MBTs are placed. However, an assessment of the quality of this tutorial feedback – in respect to contents, adjustment to the individual, reaction time, etc. – could not be included in this study. It must be taken for granted that this feedback is indispensable in cases where problems are to be solved directly through the use of MBT, information exchanged, questions relating to the contents answered, and/or possible misunderstandings cleared up. Results leading to a high increase in effectiveness follow directly from this feedback, which, in its turn, relies not only on the technical, but also on the didactic, media-pedagogical- and psychological training of the tutors. The high increase in effectiveness is a direct result of the fact that the above-related combination of MBT and trainer organically combines the elements and levels of traditional training with professional advanced training through the use of MBT.

### **1.3 Variety and Suitability of Possibilities for Interactivity between the User and MBT**

Directly related to the didactic dimension *Variety and Suitability of Possibilities for Interactivity between the User and MBT* are the following questions, which are of great importance for the assessment of educational efficiency:

- Whether the use of MBT yields increased possibilities for the organic connection of systematic technical training with the development of the corresponding professional practice and skills, resulting in
- The trainee being given more opportunity for self-controlled, responsible dealing with the subject matter to be learned.

The comparison with other educational products that are offered as eLearning through the Internet indicates the great need on the market for a product which has been conceived with reference to contents, variety of presentation, and target-group orientation in the planning of interaction. The questions which arise here are related to the following criteria in the catalog: *Should the MBT enable the user to control the learning process according to his won knowledge level and capabilities? Which kinds of interaction should the MBT place at the user's disposal? To what degree should the user be expected to give individual, open answers? Does the MBT react to open answers without danger of termination, and with meaningful feedback?*

Trainee control of the learning process has been implemented into all of the infoWERK MBT under study. The tools foreseen for this are practically identical in all MBT and essentially can be reduced to the following three: multiple choice (MC), tutorial feedback, dad-elements (see 1.2) and a glossary.

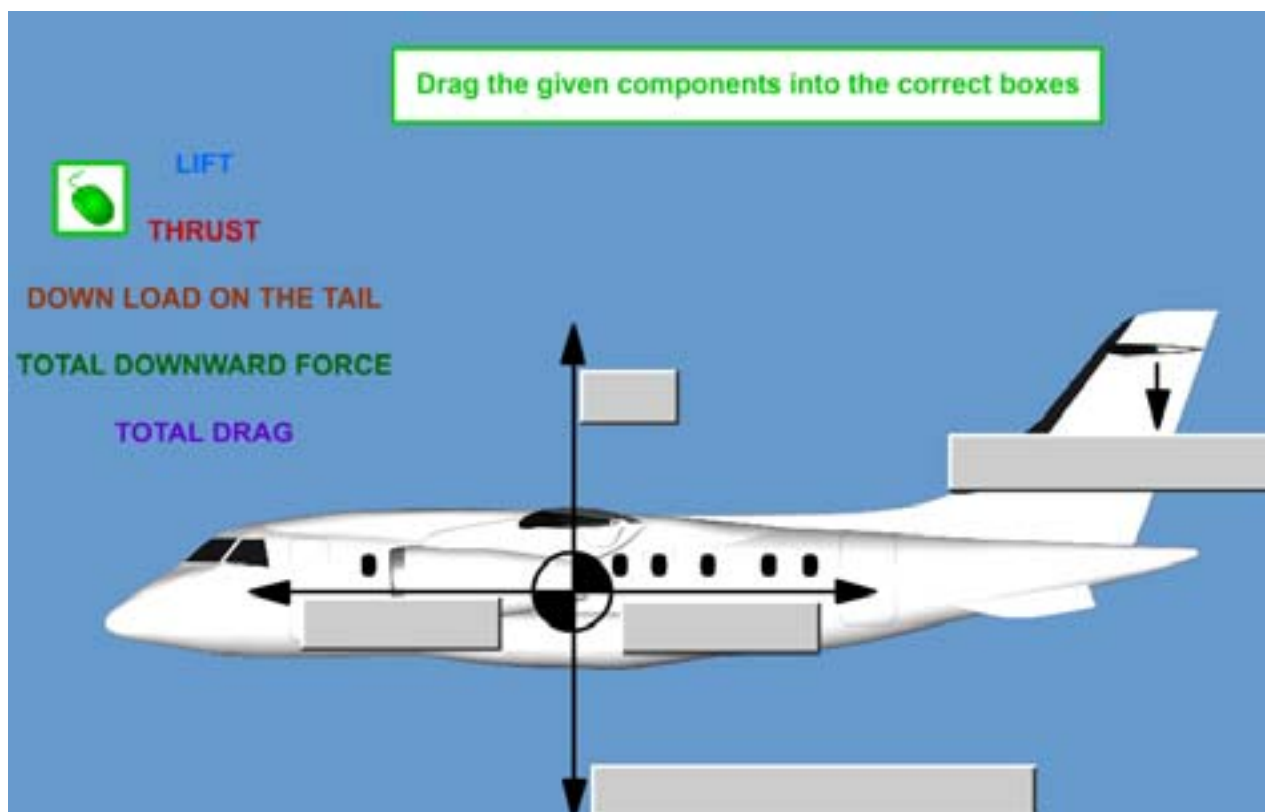
In contrast to classroom training, MC in the MBT are used almost exclusively to test factual knowledge and –associations. The trainee may choose from a series of alternative answers that well cover, seen together, the main body of facts pertaining to a technical case or – relationship.

The suggested alternative answers differ convincingly from each other and the right answers are so worded that they do not draw undue attention to themselves. The answers are generally made with yes-no or right-wrong sets as well as with dad-elements.

In addition, diverse reports through the learning platform offer both the trainee and the tutor specific information about the learner's progress – among others, the name of the test, the number of attempts necessary, duration of the test and the average (in percentage) number of questions answered correctly.

Tutorial feedback is another thing that is offered the trainee through the platform, rather than directly from the MBT. The tutor thus has the possibility to answer the questions of all trainees online. Further, a message function enables direct communication between the tutor and the trainee. Messages sent with this function appear directly on the trainee's display. For reasons of data privacy, these messages are not archived.

All MBTs under study provide an integrated glossary. This is not a dictionary in the classical sense, and there are no explanations of terms or cross-references to additional information. Rather, the glossary has an index/search function. After introducing a sought term or phrase, the trainee is referred to the MBT modules that contain that word or phrase, thus urging him to delve more deeply into these blocks of knowledge or to repeat them.



Picture 3: Example illustrating interactive procedures in the MBT

The above-mentioned possibilities for interaction indicate that all MBTs under study are targeted for individual, tutor-supported self-learning on the infoWERK educational platform. Learning environments may include the work place, educational and advanced-training centers, private and borrowed PCs and notebooks. There must be access to the Internet. This means literal independence of time and place, with the learner having free choice as to when and where he decides to take advantage of advanced vocational training. This independence of place and time as well as the freedom to learn individually are especially important for pilots and other flight personnel and have a positive effect on the educational effectiveness of MBT in comparison to traditional classroom training.

The interaction possibilities offered in the MBT clearly lie above the standard usually encountered at the present in the Internet. These give the trainee the possibility to actively and individually interact with the subject matter, leading to an increase in the educational efficiency of the training program (see picture 3).

Connecting the various tutorial supports to the educational platform is common practice, based on the assumption that all platforms offer the trainee identical or similar services. An inquiry should be made as to whether those using MBT could have these supports available as an integrated element of the MBT. It should also be asked how this could be done.

Promising developments and improvements include the increased inclusion of animations and simulations, multimedia-designed exercises, and learning-through-discovery components (for ex. Games that the learner controls himself and which he can influence through individual input). Nonetheless, no matter how successful an animation or simulation is, no matter how demanding an exercise on the PC seems to be, nothing can replace practical training. This fact emphasizes once again the significance of a „division of labor“ between the various members cast (trainee, trainer, tutor, MBT, learning platform, etc.) and the sites of the training, the learning environment. This „division of labor“ is one of the decisive factors which can lead to heightened educational effectiveness when the MBT is used for advanced vocational training by airline companies or in development-, production- and professional maintenance operations.

#### **1.4 Time spent Learning (Completion of Lesson Modules by Individual Time Allotment as well as According to Specified Time Allowances)**

The significance of time allotment in connection with the didactic dimension *Variety and Suitability of Possibilities for Interactivity* between the User and MBT (see 3.3.) has already been mentioned. The fact that the trainee is free to organize his own time plan when using MBT has been shown to increase the educational efficiency of the program, when compared to traditional classroom training. The problem of time allotment is taken up once again in the catalog under the aspect of modularization: should modules/sequences function completely automatically, or should they be segmented during the repetition? Should the trainee be able to repeat them at will? Should there be a time limit for their completion?

Going on these criteria, the user behavior of 39 trainees was studied with special focus on time parameters. The basis for the study was the MBT *AUA De-Ice* (English), using nameless course reports that also carried information about the test results. The reports were generated out of the education platform by infoWERK.

The detailed course reports allow statements about each trainee concerning the

- Degree of completion of the module. The degree of completion for each module and each user is shown in the reports as complete, incomplete or not yet used. According to the reports, 100% of the users completed the module Test whereas 87,5% of the 35 trainees using module 06-04 did not complete chapter 6, *Inspection by Aircraft De-icing*. There was no module that none of the trainees worked on. Some of the total 192 modules (including the introduction and a test), however, were not used by all trainees.
- Time used for completion. As an average for the entire MBT, the time used for completion lies by 2 hours, 53 minutes and 33 seconds. The longest length of user time, needed by one trainee, was 6 hours, 9 minutes and 26 seconds; the shortest, by contrast, was 15 minutes and 14 seconds for the entire MBT. This last user, however, only worked on 6,77% of the contents of the entire MBT. The module 03-07 4 has the longest user time (1 hr, 41 minutes and 25 seconds), whereas five modules share the shortest user time (04-01 2, 06-05 2, 03-07 4, 03-07 6, 03-08 3). Several users needed no more than one second. The table (see Appendix 2) shows the distribution of the user times (times needed) over the various pieces of course-ware of the MBT.
- The relationship between user time and learning success. Success in learning was determined according to the number of points that the trainee was awarded for completing the tests. That is, the higher the number of points, the greater the success in learning. Ten trainees (25,64% of the total) received the maximum of 100 points each. One of these trainees needed eight minutes and six seconds to complete the test. Among those who took the longest, the slowest trainee needed 55 minutes and 36 seconds for the 100 points. 51,28% of the trainees earned 90 points each, seven (17,95%) 80 points, and two (2,56%) earned 60 and 70 points respectively (see Appendix 2).

Evaluation summary: the majority of the trainees is capable of handling open user times and utilizing the opportunity to work at his own individual rate. It is apparent that successful learning, as measured by points achieved in the tests, is in no way negatively influenced if the user takes advantage of this freedom.

The established times were purposely called user- rather than learning times. Whether a trainee has actually learned while using the MBT, or just taken a mental walk, cannot be determined by the facts at hand, since we have no statistics on the individual user's qualification level prior to successful completion of the training.

This, however, again points to that which was stated above (see 1): time alone is a poor means of evaluating learning effectiveness. On the other hand, it can be assumed that determination of prior qualification is a suitable means of further increasing the efficiency of in-depth individually organized advanced vocational training. This increase in efficiency results when contents correspond to individual levels of qualification.

### **1.5 Performance Support on the Job and with Problems as they Arise**

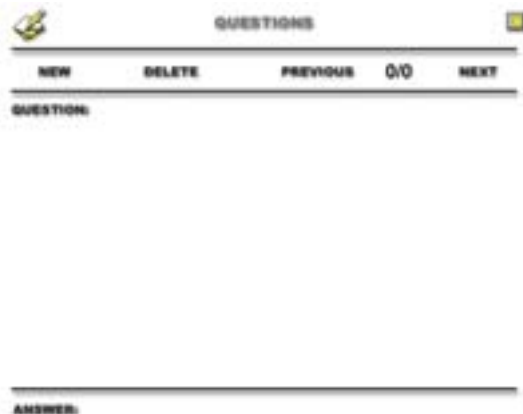
Contrary to tutor-based training forms, such as traditional classroom training, the emphasis in MBT learning is on the individual's active dealing with the subject matter rather than on the trainer's. Personal learning activity is at the core of the MBT philosophy.

At the same time, it cannot be assumed that this form of vocational training can succeed without a trainer. This trainer - perhaps an employee at an airlines or himself an aircraft

manufacturer, would, as an expert in development, production and maintenance operations or, perhaps, as a media producer at infoWERK – has pre-structured the MBT contents intellectually and pedagogically in a multiplicity of ways. He presents himself to the trainer as a virtual partner in the learning process by way of the goals, learning contents and multimedia-didactic design of the program.

Further, the trainee needs direct social contact rather than social isolation while learning with the MBT on the PC. This social contact, indeed, has a positive effect on his motivation to learn. In our case, heightened motivation during the learning with MBT is thought to be achieved through the tutorial assistance offered over the platform.

Tutorial accompaniment is a very decisive factor that appears to have direct influence on the efficiency of MBT professional advanced training. This issue should be addressed in the catalog of criteria, especially with questions as to which assistance functions should be offered, and to what extent those functions offered should be suitable to the target groups in question.



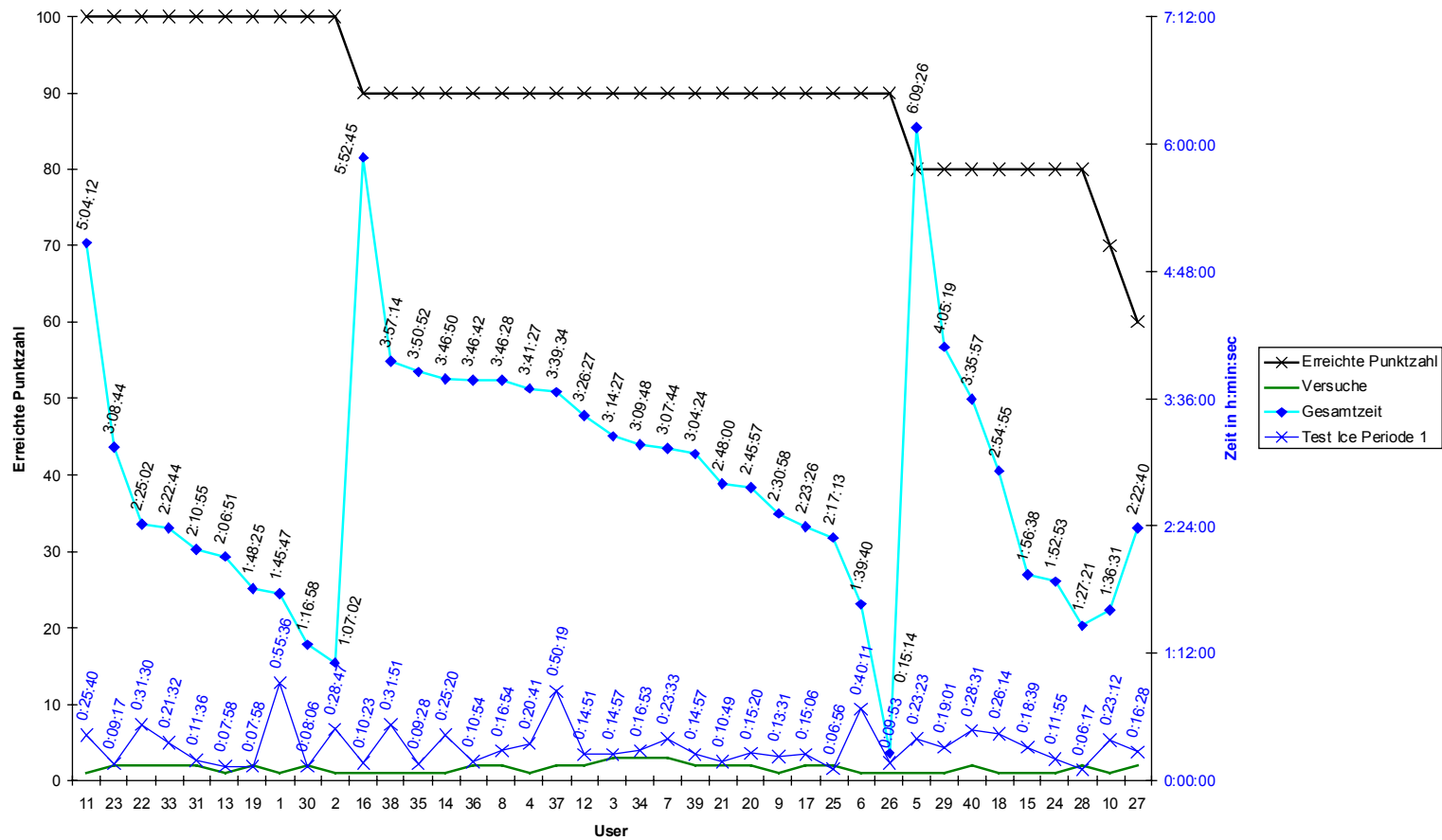
Picture 5: A window in the menu for editing questions and answers

The types of tutorial assistance offered have already been thoroughly described in another context (see 3.3.), so that they don't need to be listed again. In addition, it should be mentioned that, for ex., in the MBT *AUA De-Ice* a special module is available which interactively and comprehensively introduces the trainee to the operation of the MBT, helping him to become familiar with the procedures. Over and above this supplement and the tutorial services, special assistance functions are available in all MBT (see picture 5).

The variety of these services and assistance available for use by the trainee directly from the infoWERK MBT - or through the learning platform - (particularly direct support for the learning process and assessment of learning success, but also technical support and many other functions) contribute substantially to heightened educational efficiency. Educational efficiency is an outcome of the personal confidence which grows during individual achievement of higher qualification, and of the corresponding increase in motivation. Nonetheless, it is certain that again in this sector further improvements are possible and that they will, in fact, prove necessary. This seems especially true when the trainee is given the opportunity to make external contacts with experts, or to create learning management directly out of the MBT, organized over the learning platform – through chat-, newsgroup- or Hotline applications.

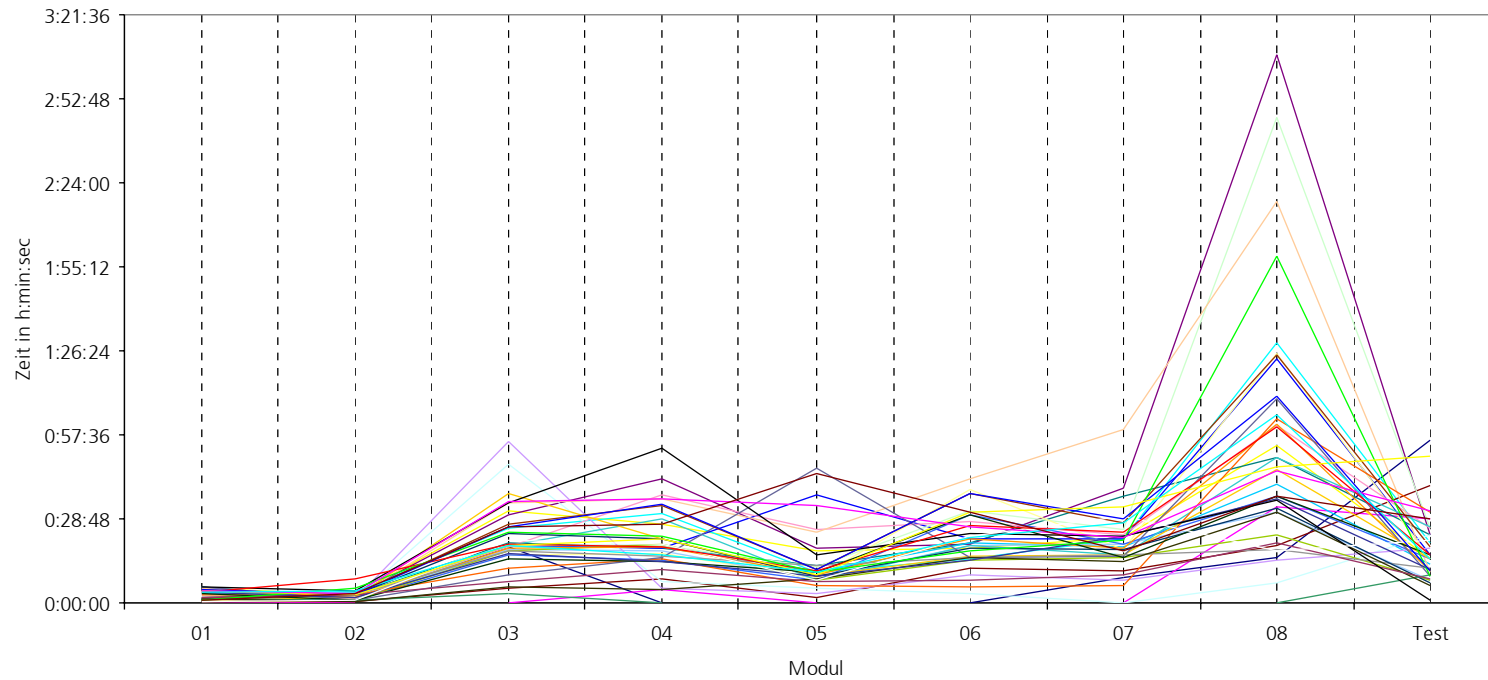


MBT AUA De-Ice English: Korrelation Übungszeit/Lernerfolg



MBT AUA De-Ice English: Correlation processing time – test score

MBT AUA De-Ice English: Nutzungszeit/Modul - Alle User



MBT AUA De-Ice English: Total time per module – All Users

## 2 Conclusion: Considerations concerning the teaching effectiveness of MBT

As a result of the study, we establish that the teaching effectiveness of MBT shows an increase and further development in comparison to traditional classroom training programs in the following aspects:

- Consequent orientation with content distinction according to various levels as well as a generally conform picture of the target groups aircraft maintenance crews and pilots as highly-qualified personnel trained and licensed according to the standards of international aviation.
- Modularization of the teaching material in self-contained units according to the subject matter and didactic considerations on the one hand, and according to a progressive order of the modules on the other. This media-didactic orientation leads the trainee step by step to a deeper understanding of complicated correlations and strengthens his ability to solve problems. In the future greater emphasis should be given to the question of which contents should be taught by which mediums in which places, as opposed to which contents can be learned by the trainee without assistance.

The interaction options in the MBT make reference to individual, tutor-supported self-learning on the learning platform. Places of learning can be the working place, training- and advanced-training centers, individual and borrowed PCs and Notebooks. The only criteria is that these options have access to the Internet. In this way independence of time and place is achieved. The Trainees are free to choose when and where they want to take advantage of professional advanced training. This independence of time and place and the freedom of individual choice are as important as the tutorial support and have a lasting influence on teaching and learning effectiveness.

The MBT are characterized by a wide variety of multimedia options. Throughout the programs there are combinations of text, photos, dynamic graphics as well as animations. There are also easy-to-grasp explanations beneath the illustrations. The MBT multimedia design is characterized by a high level of quality. It must be especially emphasized that the underlying orientation of the programs remains throughout the goals, contents and high standards of official security regulations.

The majority of the trainees is obviously capable of taking advantage of the freedom to individually choose learning times. The suggested learning times for the individual units have been purposely marked as „time of use“ rather than „time needed to learn“. This indicates that the time factor alone is a poor measurement of learning efficiency. On the other hand, it may be assumed that a „sizing up“ of the pre-qualification of the trainee is a sensible method for organizing the MBT contents: organization of contents depending on individual qualification can increase the efficiency of heightened, individually determined advanced training

The wide variety of these services and assistances that the trainee can take advantage of over the platform - especially the direct support of the learning process and the evaluation of learning success, but also the technical support and many other functions – contribute decidedly, through the promotion of personal competence and motivational reinforcement, to heightened learning efficiency.

Because the MBT is a relatively new learning medium, in which its usefulness for advanced training in the aviation sector depends on very high professional standards, the demands on

the multimedia-design are sharply increased. For this reason, it must be questioned whether the subject matter, as artifacts for the trainees with which they carry out active learning procedures, should not be more highly animated. This of course cannot replace experiences and observations made in reality, but animations do approach reality and can thus bring together technical conveyance of knowledge with the development of skills in the learning process. This would be an additional contribution to learning efficiency.

There are a whole set of different tools in connection with MBT as well as in connection with the learning platform that allow an assessment of learning success. These should be more strongly taken into account, not only for the establishment of learning success in the eyes of the trainees and of the tutors, but also as a means of increasing the efficiency of learning with MBT. The enjoyment that an individual User may find in the learning process is not enough to increase learning efficiency by itself.

The MBT under study and the learning platform allow the trainees too little possibility for personal identification. Related to learning with MBT or on a platform, this means that the user must have the opportunity to personalize both according to his individual requirements on comfort and expediency. These are two indispensable psychological and physical factors determining learning efficiency.

Again: Motivational effects resulting from the use of MBT from infoWERK are especially a product of the consequent modularization of the contents, which are both free to use in individually chosen sequence and at the trainees personal rate of speed according to his personal goals. High motivational affects also result from the multimedia design, that is, from the successful combination of a variety of media. The animations in these media and the easy-to-grasp comments under the illustrations are designed to heighten the qualification standards of the target groups – this consistently, and in all MBT.

In summary, it can be assumed that the results of this study are more than in indication – that, in fact, the use of MBT as a tool in professional advanced training can considerably heighten learning and teaching efficiency, if MBT is seen not as a substitute, but rather as a supplement to classical advanced training methods and elements.