Developing digital competence - learning, teaching and supporting use of information technology

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Ten golden rules for improving IT users' competence

1. **Organise training at the same time as the system is installed.**
2. **Provide users with detailed documentation during training.**
3. **Train users so that they understand IT concepts.**
4. **Train users so that they understand the usefulness of the IT.**
5. **Train users so that they can learn on their own.**
6. **Provide a variety of learning material.**
7. **Identify, organise, authorise and cultivate superusers.**
8. **Include IT, information and use competence.**
9. **Provide a variety of support channels and frequency.**
10. **Train local groups of users, not only individuals.**

Chapter 1. Introduction

1.1. Motivation and target groups

1.2. Aims

1.3. Related areas

Part I. Activities for learning IT

The learning aim of Part I is:

To be able to train IT users so that the users can apply their competence learnt at a course when they return to work or other activities.

The chapters in this part will present approaches for teaching the use of IT. These approaches will constitute the structure which the topics of Part II will feed into.

Part I will take on a training view of developing IT user competence. This means that we consider the development of IT user competence which takes place in some training activity, and thereafter the competence learnt is transferred to the tasks to be utilised. This could be in a work place or in an educational setting or for leisure.

Seen from the training perspective, learners have some competence when starting up, and hopefully a bit more when completing. This new competence is what the learners will bring back to the tasks. We can illustrate the process as in Figure 1.

This sequence may give the impression that new competence learnt during a training course is used automatically in the later tasks. However, transfer of competence from one setting to another will only take place when the settings are similar, and a course setting will often differ a lot from the tasks to be carried out afterwards. Therefore, often only a small part of the

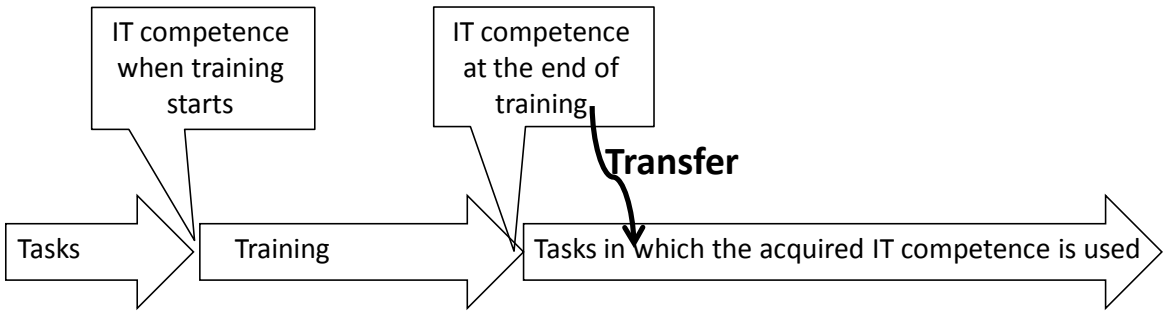

Figure 1. A transfer model of training. Competence is learnt in a course and transferred to work or other settings.

acquired competence from a training course is actually transferred and be put into play.

Timing of training is possibly the most important factor to succeed transfer. If training is provided weeks before the IT system is put into operation, the users will forget much of their new competence, so the possibility for transfer has decreased seriously. On the other hand, if training is provided long after a new system is installed, the users may say

Why training this late? The system has been up for ages, but nobody knows how to use it. The management is not giving appropriate attention to this change.

Users will bring this negative attitude to the training session and blame the trainer for the delay and mismanagement. Less motivation for learning and a bad atmosphere will impact the course.

The first golden rule for user learning is therefore:

1. **Organise training at the same time as the system is installed.**

The trainer needs to identify the start and ending level of competence for the training. Determining the beginning level serves two purposes. The trainer will know where to start, and also, the trainer can relate new topics to what the learners are familiar with already.

Part I will in particular address the issue of transfer. We will describe two types of teaching, each of them having particular qualities concerning transfer of the learning outcome. The last chapter of Part I will consider evaluation of training, also related to the transfer issue.

Chapter 2. Training for transfer of subject matter competence

The learning aim of this chapter is to be able to design a training session which maximises the possibility of the learners for transferring of the competence they acquired into where they will use it.

First, a common training method, which does not support transfer well, is presented. Thereafter, this method is contrasted to a way of training which makes transfer more likely to happen.

2.1. Repeat-after-me training

User training is most likely to be carried out as followed. Each student has a computer, and the teacher uses a video projector. For each topic, the teacher first demonstrates how to carry out a task at the computer. The teacher tells what keys to pushes on the computer, and its screen image is being projected onto the wall. The learners try to remember the keys and repeat the operations being carried out. The teacher then hands out some exercises supposed to exemplify the topic and the students try to remember what the teacher actually did when they do the exercises on their own. Often they have forgotten, so the teacher has to run between the desks to help out. After a while, some learners have long completed while others are still confused, waiting for the teacher.

Since the learners try to mimic the teacher, this way of training can be called the parrot style. After many hours of training, the learners might have developed sophisticated skills repeating what happens on a big screen.

Comparing this training setting with the user's work, there are two obvious differences. First, there is no teacher with a projector at the work place, and also, there is no teacher running between the desks helping out with forgotten details. Instead, the users may face the challenge of working on their own most of the time, with the aid of tooltips and an online manual and a helpful colleague understanding more of the system to be used.

Demonstrating software on a projector may provide useful motivation for the functionality of a software package, but a pure demonstration does not include the audience trying to do the same operations on their computers. Therefore, demonstrations should not be confused with parrot training.

Also, demonstrating computer operations by means of a video controlled by the user also differs from the parrot style in two important ways. First, the video can be brought to the tasks where the IT is going to be used. This will differ a lot from having to wait for the teacher to come along. Second, the user can stop, start and replay the video so it is possible to follow in a speed that allows repeating after the video instructions. Videos for repeat-after-me therefore

avoid the pitfalls which make parrot training unsuitable for transfer. We will therefore return to video productions in Chapter 9.

2.2. Conceptual-practical training

The alternative to repeat-after-me training is a sequence of instructional events which aims for meeting a variety of conditions for learning. These sequences also address transfer specifically. Based on research on teaching and learning, Gagné and Briggs (1974) proposed a nine step model which in general would be the best design of a training session, see Table 1.

Table 1. Gagné-Briggs sequence of instructional events.

Instructional event	**Purpose for the learner**
1. Gain attention	Focus on trainer
2. Inform the learner of the objective	Focus on the learning goal and the usefulness of this goal
3. Stimulate recall of prerequisite competence	Retrieve prior learning
4. Present material	Perceive essential elements
5. Provide guidance to the learner	Perceive how the elements can be operationalised
6. Elicit performance	Develop basic skills through own actions
7. Provide feedback	Reinforce adequate behaviour and correct the inadequate
8. Assess performance	Rehearsals for enhancing skills
9. Enhance retention and transfer	Combine usefulness, essential elements, and skills

Although this sequence is designed to be generally optimal, the actual subject to be learnt, the learners and the setting, may call for different events and sequences. Concerning IT user training, the only instance of instructional development documented is found in (Herskin, 2006). Although Herskin's book does not provide references, the sequence of instruction presented follows the Gagné-Briggs model.

Herskin's model has not been scientifically tested, but based on learners' feedback. The book claims that this sequence improves understanding of the IT concepts, compared to the repeat-after-me training model. Understanding concepts and principles is known to enhance transfer of competence from courses to work (Bransford, 2000, p. 9). The benefit of conceptual knowledge for transfer has also been demonstrated in research on computer training (Yi & Davis, 2003). This is an additional argument for adopting the Gagné-Briggs model for training of IT use.

The model separates five different types of capabilities, intellectual skill, cognitive strategy, information, attitude and motor skill. Correspondingly it shows us five different types of each of the nine instructional events. Cognitive strategy concerns problem solving, and this will be addressed in Chapter 8.

Use of IT tools requires some motor skills like typing on qwerty keyboards and mobile phones, hand-eye coordination, changing toners in printers, as well as specialised skills for other input or output devices. This book will not address motor skills. Use of IT is primarily an intellectual skill. Therefore the sequence of instruction presented in this chapter will mainly be built out from this. Also the attitude towards the information technology is important for the ability to transfer intellectual skills from courses to work. This will be included specifically in events no 2 and 9.

Information capacity in Gagné-Briggs's sense concerns the learning of facts. Knowing some of these is also useful for transfer. The learning of simple facts will be included in the skills practice in event no 6. Information competence, in the sense of the ability to interpret and present information, will be considered in Chapter 6. Beware that this is rather a refinement of intellectual skills than information capability.

Table 2 shows a sequence of instructions for teaching one IT topic to a class. The sequence should last 30-60 minutes, and the practicals, events 6-8, should make up for at least half of the time. Event 1 necessarily comes first, and event 5 links the theory to the hands-on activity. Therefore this should be the last event in the introduction. The contents of events 2-4 may change order, depending on the teaching topic. Event 6 introduces the practical training, while the invocation of events 7 and 8 is determined by the individual or small group initiative and progress.

Table 2. Conceptual-practical training for IT users. Coding: C – concept, U – usefulness, S – skills.

	Instructional event	**Teaching use of IT**	**Example – Import by link**
Introduction. Presentation and discussion with the whole class	1. Gain attention	Any quick action which draws the learners' attention to the teacher. Not necessarily IT related.	Clapping hands.
	2. Inform the learner of the objective	C1. Explain the IT concept / idea / principle to be learnt. U1. Explain the usefulness of this idea for the tasks in which the IT is going to be used.	C1. Explain import spreadsheet by link into a document. Explain that when data needs to be changed, updating the spreadsheet is enough, inconsistencies are avoided. U1. Present an example where a report under preparation contains a table of figures and calculations, and that the figures are not complete yet.

	Instructional event	Teaching use of IT	Example – Import by link
	3. Stimulate recall of prerequisite competence	C2. Compare the new IT idea / principle / concept with previous ones. C3. Compare also with experience from phenomena outside IT.	C2. Present how import by link differs from copy and paste, how it is similar to hyperlinks, and C3. How it differs from the copier machine, and ask learners for other comparisons.
	4. Present material	C4. Explain the principles of how the data is stored and processed by the computer	C4. Explain how import by link is stored in the hard disk.
	5. Provide guidance to the learner	C5. Present steps with observable results in the procedure for carrying out the operation.	C5. Present the steps in the procedure for importing by link.
Practical. Guiding learners who practice hands-on	6. Elicit performance	S1. Develop basic skills through own actions	S1. Give the learners an instruction sheet with the detailed prescription of how to carry out the operation on the computer.
	7. Provide feedback	S2. Guide learners who face problems and confirm correct results	S2. Guide learners who cannot follow the instructions. Confirm correct results.
	8. Assess performance	S3. Observe learners' progress of task. C6. Elicit their understanding by asking about the state of their data. S4. Ask them to repeat if necessary, possibly with small variations.	S3. Check whether the learners have identified the data and created a link. C6. Ask about where the data is located and which links they have created. S4. Ask them to repeat the operation if not carried out correctly

	Instructional event	Teaching use of IT	Example – Import by link
Summary. Discussion with the whole class	9. Enhance retention and transfer	Repeat and extend S5. skills, C7. data storage and processing, and C8. Concepts. C9. Combine the IT concepts with similar ideas / principles / concepts. U2. Repeat the usefulness with reference to tasks.	S5. Repeat the steps in the procedure and ask about other ways of doing it. C7. Repeat how the data is organised in the hard disk, and ask about how this can be observed. C8. Repeat that import by link is similar to hyperlinks, and C9. Introduce the principle of functional dependency as a more general concept. Ask for other instances of this concept. U2. Repeat that inconsistencies can be avoided and ask about work tasks where this may be advantageous

Compared to the Gagné-Briggs model, the IT training requires the attention of more elements in the events. Understanding the usefulness is an important motivator for learning. This is introduced in event 2 as U1 and repeated in event 9, see U2. Likewise, understanding the IT concept is essential and often non-trivial. Therefore this is treated nine times in six of the events. Teaching for learning skills is the third type of element here, S1 – S5, mainly addressed in the middle section, the hands-on part. The distinction between skills and understanding will be discussed in Part II.

Understanding the usefulness and the concept, increases the chances of transferring competence from course to work. The clue for transfer of skills lies in the instruction sheet in event 6. Based on Herskin's (2006) suggestion, an instruction sheet is a detailed prescription for what menu items to select and buttons to push, in order to bring out the operation being outlined in event 5. These instructions must be tailored to particular software brands and versions, since the learners have to use this during the practical part.

The instruction sheets serve two purposes which support transfer. First, during the hands-on part, the learners follow the instructions on the sheet, and the teacher does not display the software operation on the projector. The learners become accustomed to following a written instruction instead of repeating the teacher. Concerning transfer, the latter might be a dysfunctional habit, as discussed in Repeat-after-me training section. Second, the learners will bring the instruction sheets back to their workplace, and be able to operate the software in the same setting at work as in the course.

Training material for the example indicated in the rightmost column of Table 2 will be spelled out in the sequel. The material is annotated by double encircled codes U1, etc., in order to show which element in the instruction sequence the material is targeting.

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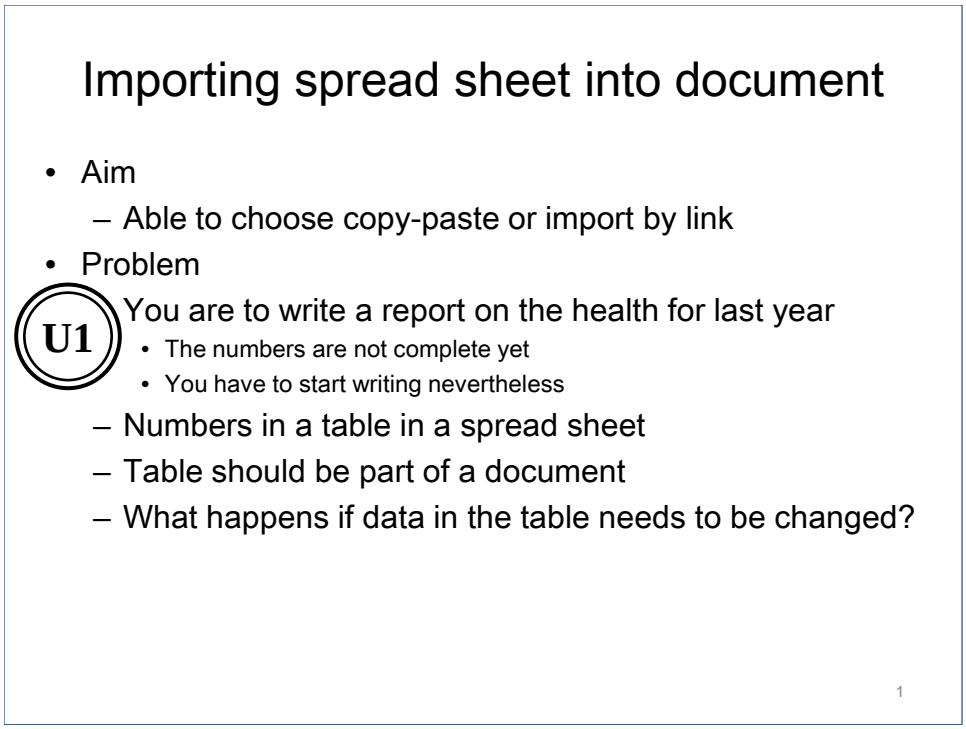


Figure 2. First slide for learning import by link. Emphasis on usefulness.

This introduction opens with presenting a case for which the operation can be useful, U1.

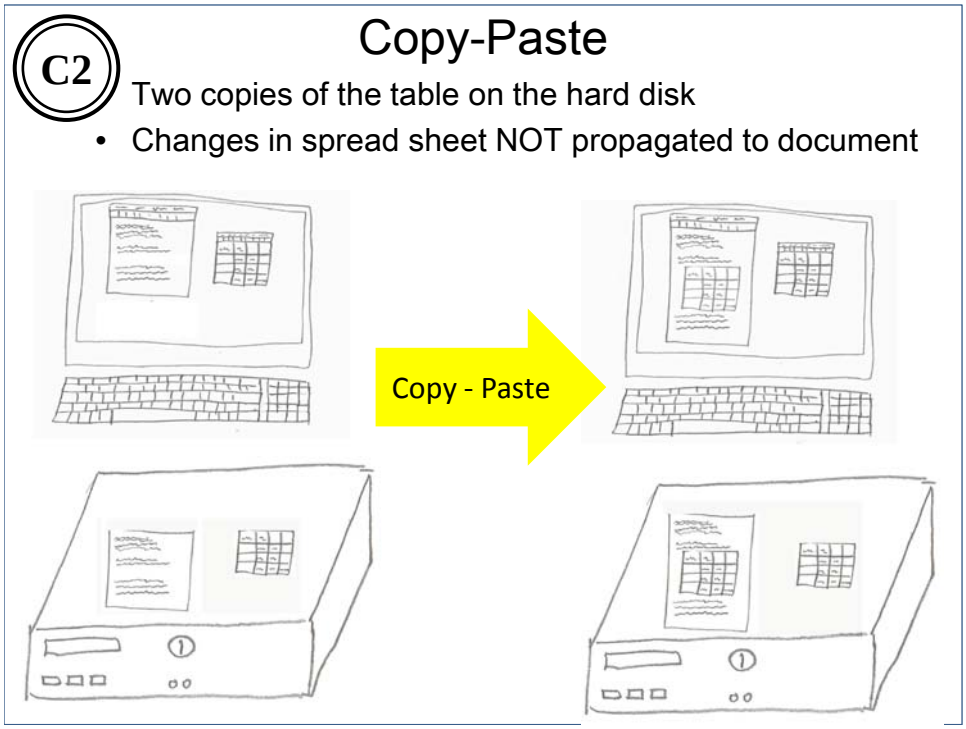


Figure 3. Repeating known principle. Illustrating the hidden data on the hard disk.

Instead of presenting the new concept first, this introduction starts out with what may go wrong with the operation already known by the learners. It also illustrates the relation between what is shown on the screen and the how the data is stored on the hard disk, see

Figure 3. The essence in this case is understanding how a new concept relates to one which is previously known, the copy-paste. The results of both operations look the same on the screen, but how it is stored on the hard disk differs. For supporting this understanding of hidden data structures, the relation to the visible is illustrated in Figure 4. Chapter 9 will provide guidance to the design of such kinds of illustrations.

In order to provide a concrete illustration of importing by a link, the teacher could present the dynamics that the link offers. The teacher could display an already prepared solution on a projector, and demonstrate that when changing a number in the spread sheet, the document is changed accordingly. The point of this demonstration is to show the benefits of the result; not to learn how to do it. The 'how-to' is for the practical part, to avoid the repeat-after-me style; the learners are not try to try repeating what is done, therefore the teacher is not to tell which buttons to push.

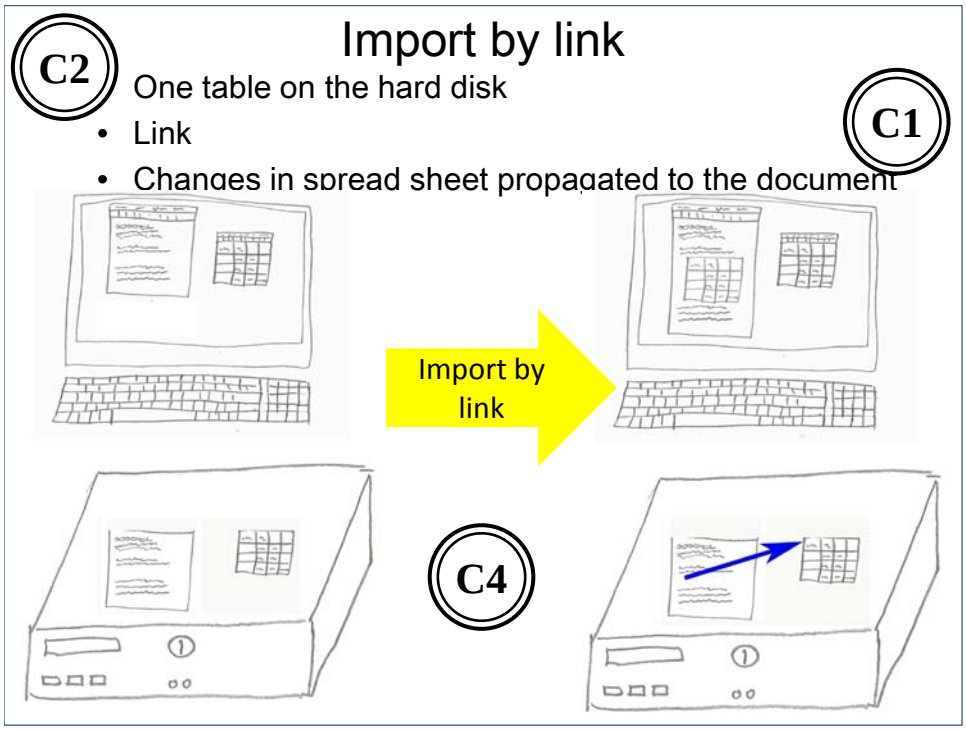


Figure 4. The way import by link is stored in the hard disk.

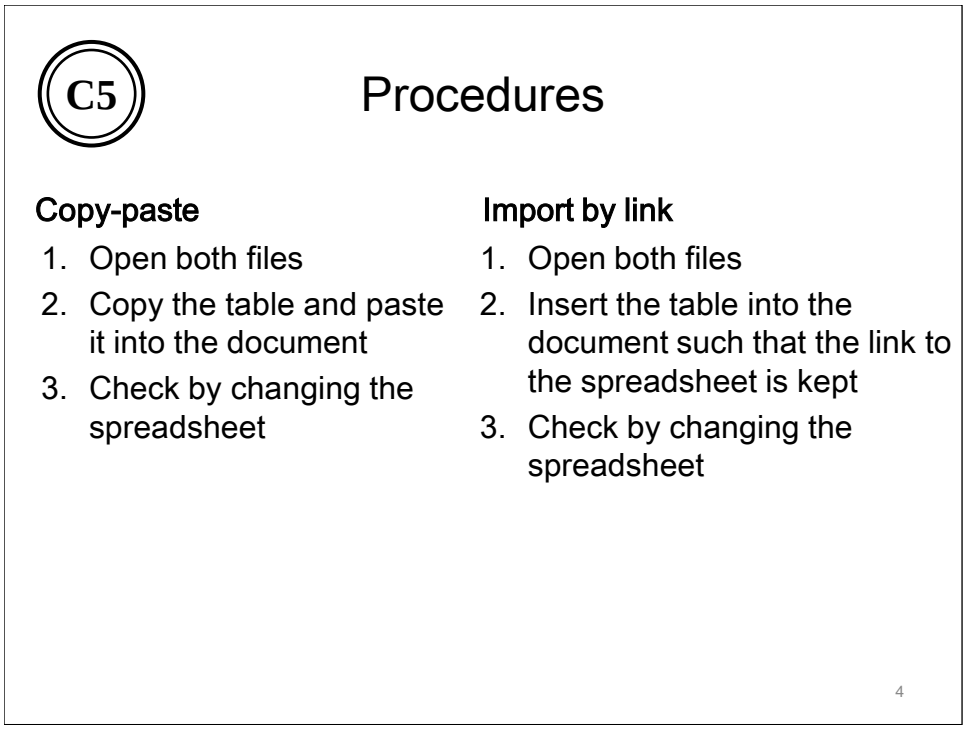


Figure 5. The procedure for the operations at the computer.

The procedure for carrying out the operations is divided into three steps (Figure 5). The separation follows the fixed rule that after a step, the learner may observe on the computer whether it has been successfully carried out. This will ensure the learner if being on the right track. If not, asking the teacher may be appropriate.

After the copy operation, the computer does not provide observable feedback about what has been copied. That is why copying alone does not constitute any step in the procedure.

In event 6, instruction sheets for OpenOffice (Figure 6) or Word (Figure 7) are handed out to the users, out from what software they are using. The sheets are tailored to their level, to assume that they are able to manage the normal menu operations. The specifics of the operation taught is illustrated in detail. The learners are supposed to follow the instructions without any oral teaching or projector guiding. With the level of details in these instruction sheets, most learners can do that.

When learners work on their own, the teacher can move around freely in the classroom to help out when needed. Experience shows that working with instruction sheets relieves the teacher from most of the requests that appear during hands-on training in the repeat-after-me style. The teacher is gaining time to respond to the questions from the learners. In the repeat-after-me training, time for responding becomes too short.

During introduction and summary, instructions for particular software installations are avoided in all written materials and presentations. There are three reasons. First, the introduction and summary should focus on understanding. Second, the strict separation allows learners using different versions of software to be taught, as long as the teacher has instruction

sheets for all versions. Third, a modularised design of training material is achieved. When a new software version appears, the material for introduction and summary can be kept untouched.

Instruction sheet

Table into document with OpenOffice Writer

Copy-paste

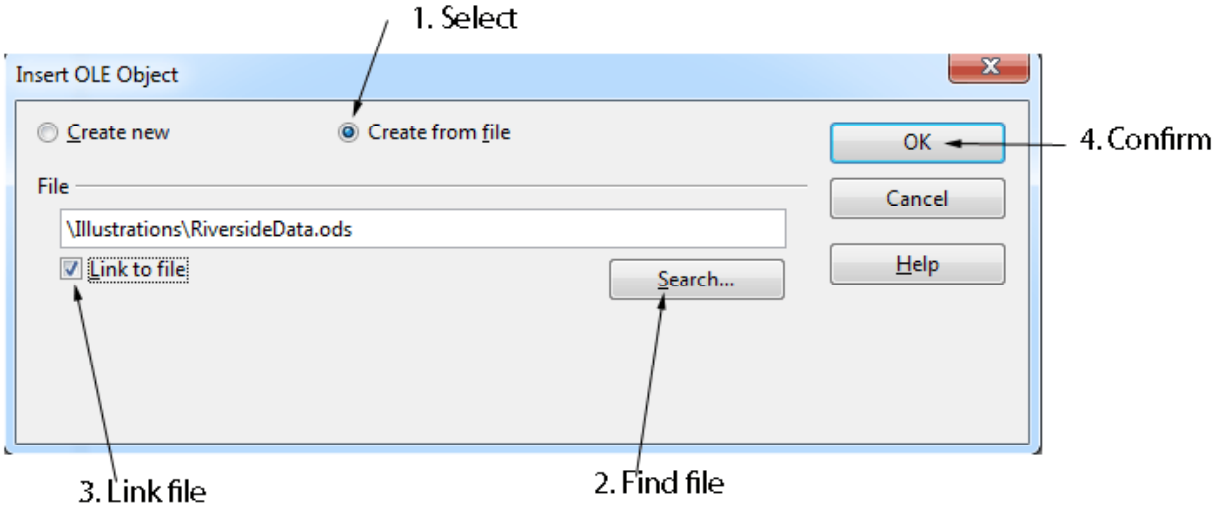
1. Open the file AnnualReport and the file RiversideData.
2. In RiversideData, mark the table you want to copy and select **Edit → Copy** .

   In AnnualReport, click where you want the table to appear, and then select **Edit → Paste**
3. In RiversideData, change Headcount for July to 503. Did it change in AnnualReport?

Import by link

1. Open the file AnnualReport.
2. Click where you want the table to appear, and then select **Insert → Object → OLE Object**

   Fill the dialogue box as follows.



3. Open RiversideData, change Nurse clinical work days for August to 43 and **Save** RiversideData.

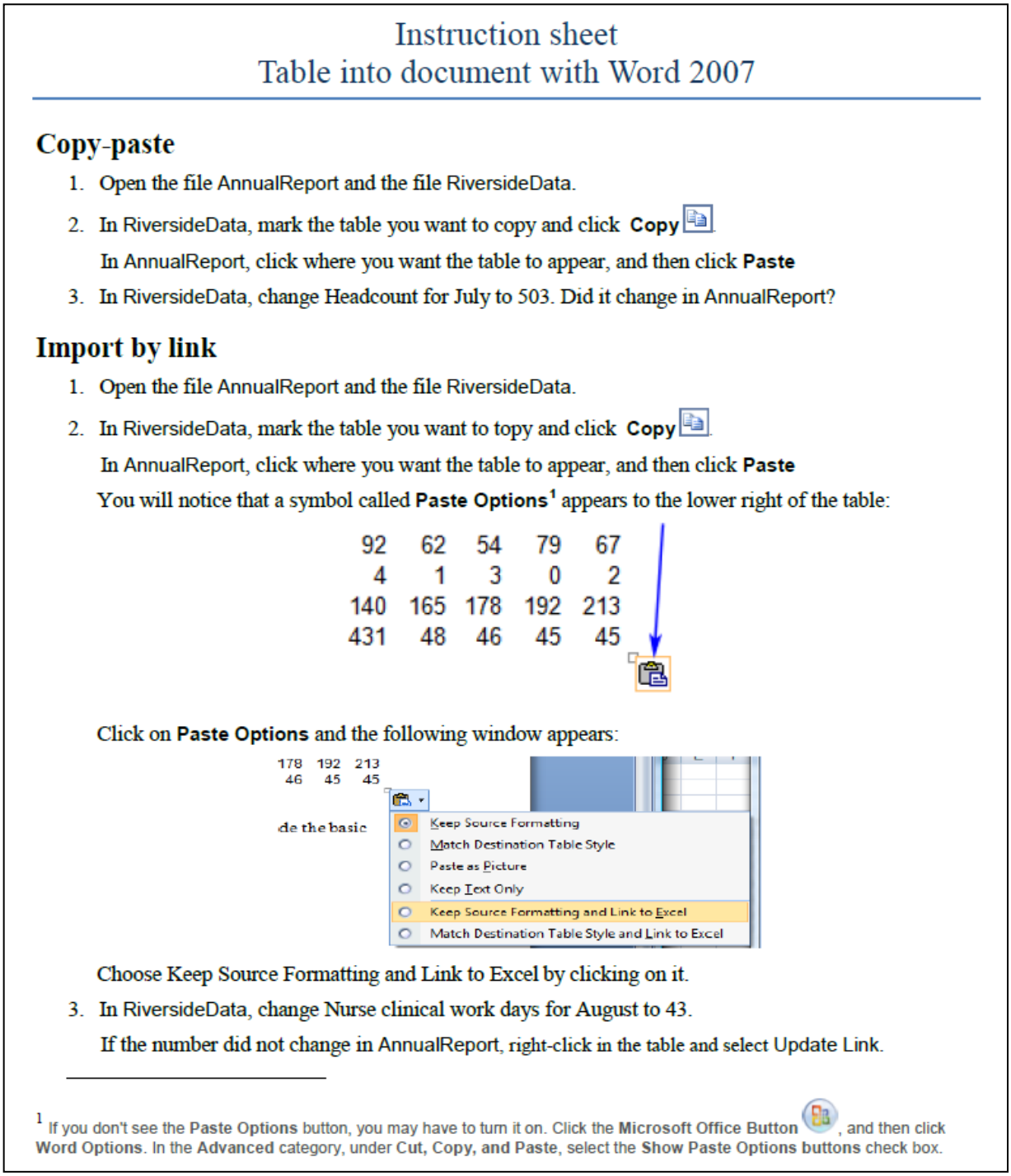
   In AnnualReport, select **Tools → Update → Update → Open Read Only.**

   Did it change in AnnualReport?

Figure 6. Instruction sheet for hands-on practice with OpenOffice.

Although the written material for the summary is without the technical details, asking the learners in the beginning of the summary about their practical experience serves two purposes. First, it is an opportunity to discuss other ways of carrying out the operation, for example by means of shortcuts. This might be a help for the whole class to pick up some details. Second, it forces the learners to talk about what they have done. Making experience explicit is a step towards understanding.

The slides for the summary focus on three topics. The concept of import by link, how this



Instruction sheet
Table into document with Word 2007

Copy-paste

1. Open the file AnnualReport and the file RiversideData.
2. In RiversideData, mark the table you want to copy and click **Copy**.
   In AnnualReport, click where you want the table to appear, and then click **Paste**
3. In RiversideData, change Headcount for July to 503. Did it change in AnnualReport?

Import by link

1. Open the file AnnualReport and the file RiversideData.
2. In RiversideData, mark the table you want to topy and click **Copy**.
   In AnnualReport, click where you want the table to appear, and then click **Paste**
   You will notice that a symbol called **Paste Options**[1] appears to the lower right of the table:

92	62	54	79	67
4	1	3	0	2
140	165	178	192	213
431	48	46	45	45

   Click on **Paste Options** and the following window appears:

178 192 213
46 45 45

de the basic

Keep Source Formatting
Match Destination Table Style
Paste as Picture
Keep Text Only
Keep Source Formatting and Link to Excel
Match Destination Table Style and Link to Excel

   Choose Keep Source Formatting and Link to Excel by clicking on it.
3. In RiversideData, change Nurse clinical work days for August to 43.
   If the number did not change in AnnualReport, right-click in the table and select Update Link.

[1] If you don't see the **Paste Options** button, you may have to turn it on. Click the **Microsoft Office Button**, and then click **Word Options**. In the **Advanced** category, under **Cut, Copy, and Paste**, select the **Show Paste Options buttons** check box.

Figure 7. Instruction sheet for hands-on practice with Word 2007.

concept is a special type of a more general type, and its usefulness.

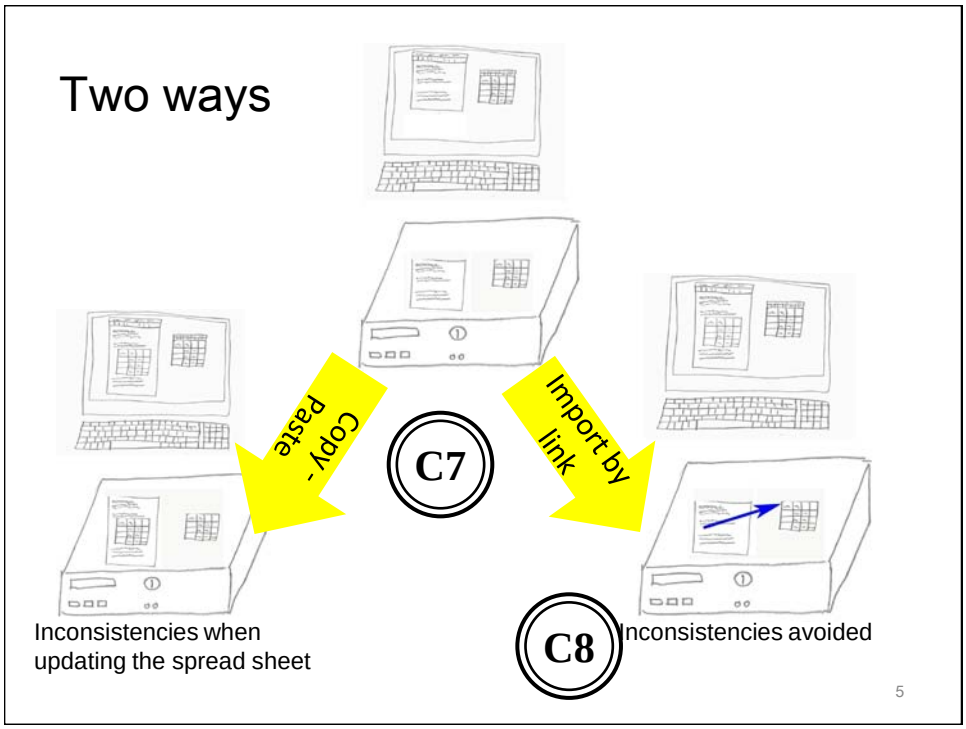


Figure 9. Repeating the difference between copy-paste and import by link in the summary.

The distinction between the concept of this session and the old one (copy-paste) is still emphasized, see Figure 8.

Then the topic is taken to a more abstract level. Import by link is compared to formulas in spreadsheets supposed to be known to the learners. Both are illustrated as examples of the functional dependency principle, Figure 9. Understanding similarities and more general concepts ease the learning of new concepts, which is why we should aim at more general understanding. These issues will be discussed thoroughly in the chapters “Competencies and learning” and “IT concepts.”

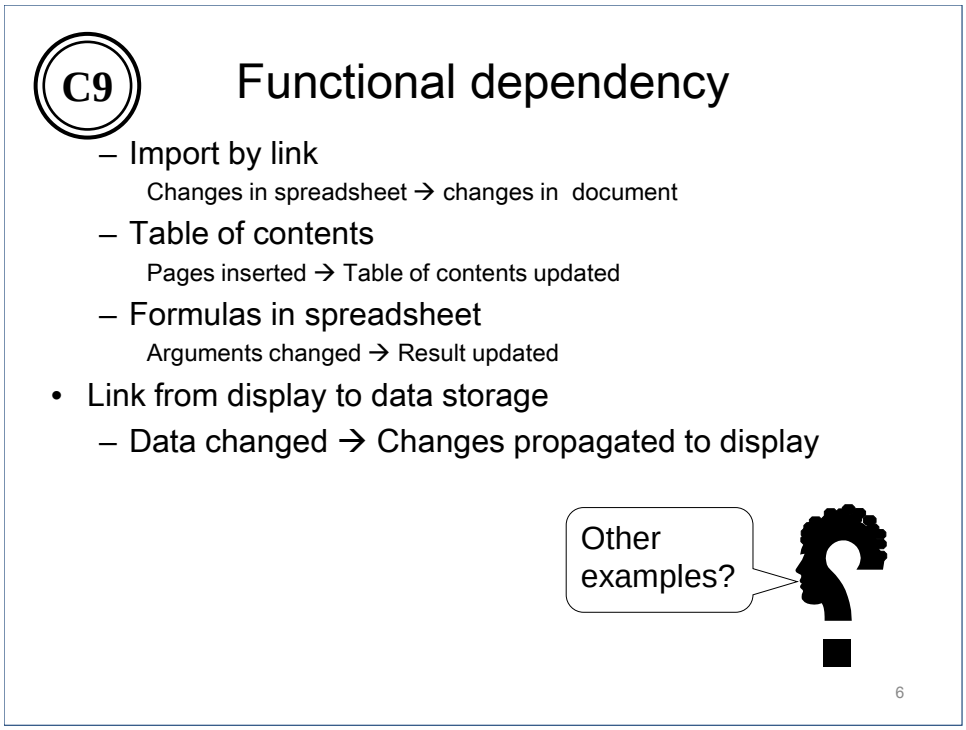


Figure 10. How import by link is a special instance of the functional dependency principle.

In order to improve the likelihood of transfer, tying the learnt concept to the users' future practice is repeated. Therefore, asking the learners about where import by link can be useful or disadvantageous concludes the summary, see Figure 10.

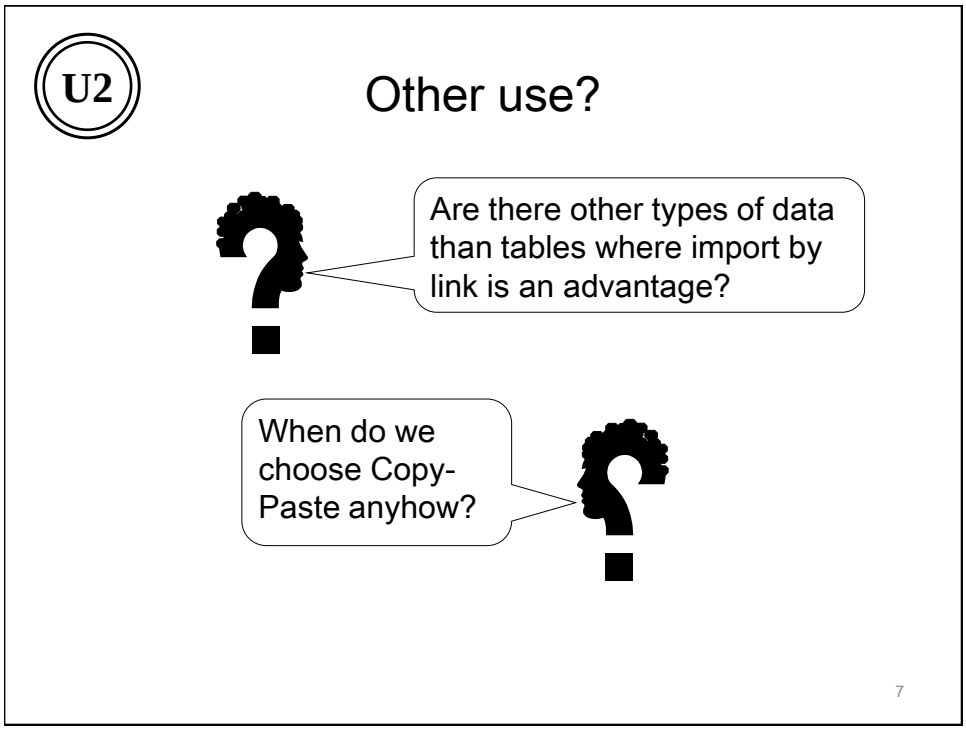


Figure 11. Last slide in summary, triggering discussion about usefulness.

2.3. Learner activity

The Conceptual-practical training model mainly addresses the contents of the session and the role of the teacher. Also the learners' activity is important for transfer, so we will point to ways to organise this.

During the introduction, making the learners to talk about cases where they have added spread sheet tables in documents, serve two purposes. First, it triggers the learners' attention to the current topic, and second, it informs the teacher about the learners' competence in this area and thus how to address the explanations.

During the practical, obviously the learners are busy on their computers. This is necessary for developing the initial skill. Since talking while doing contributes to understanding, it might be better if the learners were discussing while running the computer. This can be achieved through having two learners at each computer. One is operating the keyboard and mouse, while the other is making comments, asking questions, checking the documentation etc. Then the pair swap roles, so that both do the hands-on exercise. A laboratory study showed that learners operating in pairs outperformed individuals in their conceptual understanding. The pairs could explain more about how the software operated and they performed better in exercises which introduced some novel elements (Lim, Ward, & Benbasat, 1997).

Operation in pairs is known from computer science education as 'pair programming.' Several studies have been carried out, and pair programming has been proved more effective for bringing more students through exams than the individual programming (McDowell, Werner, Bullock, & Fernald, 2006). The lesson from learning of programming addresses learning goals of understanding and problem solving.

Motor skills were not considered, neither in the user learning nor the computer science cases. It would be reasonable to believe that learners, still struggling with the mouse and keyboard, should be practicing this as much as possible, while pair learning fits better for those above this level.

2.4. Summary

The Conceptual-practical training model emphasizes three important issues for transfer. These will be summarised as three Golden rules for user learning:

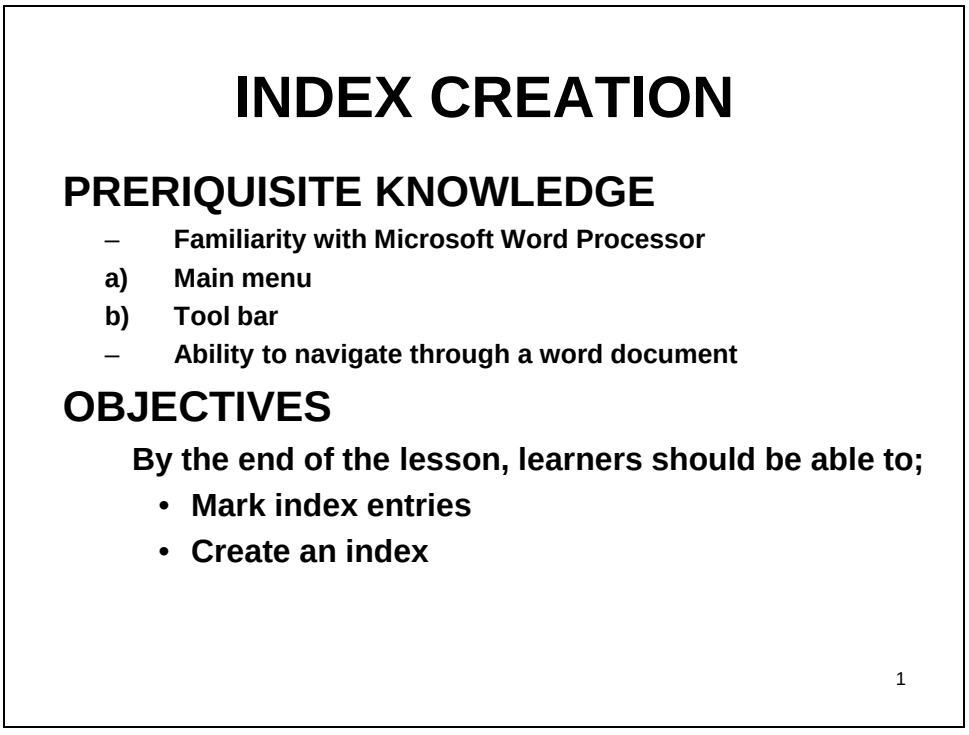
2. **Provide users with detailed documentation during training.**
3. **Train users so that they understand IT concepts.**
4. **Train users so that they understand the usefulness of the IT**

Exercises

1. Extend the case on import by link with two more exercises for the practice training, so that those who complete quickly can move on to the next one. Each of the additional exercises includes a small, new challenge.

2. Extend the case on import by link with two more examples for illustrating the usefulness of the concept.
3. Find two or three examples for usefulness of the topic to be included in a Conceptual-practical training for the following subjects:
    a. Table of contents in a document,
    b. Line graphs in spread sheets,
    c. URLs as displayed in hits from search engines.
4. Write explanations and make a drawing of
    a. Saving and finding files
    b. Cross references
    c. Playlists in music players

    Make sure that the explanation and drawing fit into one slide.
5. For the cases in the two exercises above,
    a. Identify an example from the world outside the computer which resembles the computer concept.
    b. What is the similarity?
    c. How does the computer concept differ?
    d. Express the similarity and difference on one slide, including a drawing.
6. The following slides are intended to cover the introduction part of a training session on indexes in documents, steps 1-5 in the Conceptual-practical training for IT users. Assess this introduction according to the principles presented in this chapter.



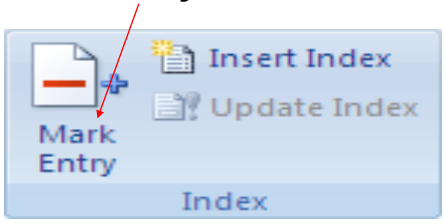
Definitions

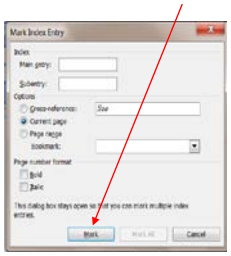
- **An index is a directory arranged alphabetically to guide on the location of key words or phrases in the document.**
- **Key words are core items that surrounds and best explain the main topic**

2

Mark index entries

- Highlight the key word or phrase then,
- On the menu bar, go to *"**Reference"*** then "***Mark entry"*** and on the other window "***Mark***"



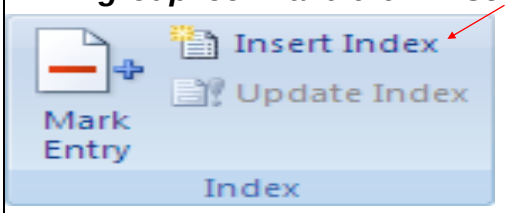


- **Click where you want your index to appear.**

3

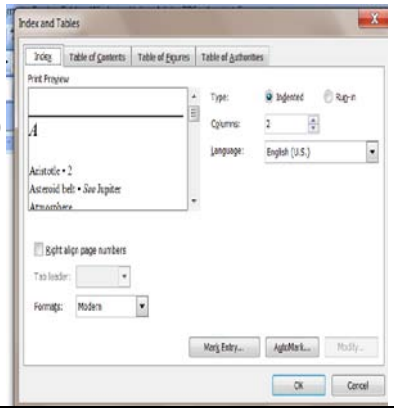
Create an index

- After all entries have been marked, then go to "***Index group icon"*** and click ***"Insert index"***



- This window will show, then do
  - Check Right align page numbers
  - Tab leader (select one)
  - Formats (select one)
  - Select type, Columns and
  - Language

  - Accept all by clicking "OK"



7. Construct an instruction sheet and example files which are appropriate for hands-on training of
   a. Table of contents
   b. Inserting pictures into documents
   c. Line graphs
8. Find other concepts/principles/ideas in the computer which are similar to
   a. Cross references
   b. Properties of a file in the file system
   c. Master slides

   For each of these cases, to which other general principles from computers would you relate them? Out of the possible ones, which principle would you use for explaining to users?
9. Design a first version of a Conceptual-practical training for learning
   a. Table of contents in a document
   b. Pivot tables in spreadsheets
   c. Download and install an application on a mobile phone.
10. Of from your experience, which computer topics do your friends, family or colleagues struggle to learn?
    a. What is difficult learning these topics?
    b. Does the difficulty concern usefulness, concept or skills?

Project

Design a first version of a Conceptual-practical training for learning one of the topics identified in the previous exercise.

Chapter 3. Evaluation of training

The learning aim of this chapter is to be able to design appropriate evaluations of training.

3.1. Evaluation of reaction to training

3.2. Evaluation of learning – assessing competence

3.3. Evaluation of behavioural change

3.4. Evaluation of result or outcome

Pedagogical theory – behaviourism

Within a training and transfer view of user competence, the outcome of the learning process which takes place during training is our focus. This view of learning is in accordance with the behaviourist approach, where learning is considered a relatively stable change of the potential for action. That means, after learning, the learners should be able to do things which they could not do before, and that this ability is not a random change. Being able to do something does not necessarily imply that it is done, since required conditions like time and money might not be present. The behaviourists only consider observable behaviour, meaning that what goes on in people's head is outside the area of interest.

The typical way of regarding learning in the behaviourist perspective is that a person is presented with a *stimulus* from the environment, for example Arja's computer displaying a spread sheet table and a document. Thereafter Arja responds to the stimulus, for instance by importing by a link. If this *response* was different from the previous ones, and also that Arja continues with this response more times when she is presented with the same stimulus, she has learnt a new behaviour.

After a response, the person can receive a new stimulus, which can reinforce the learning, for example that the numbers in the document are updated according to changes in the spread sheet. If seeing this makes her more inclined to import by link the next time she sees a spread sheet table and a document, then the updating constitutes a *reinforcement* for her learning.

Positive reinforcement like appraisals and negative reinforcements like the disappearance of an error message will both strengthen learning. Immediate reinforcements are better than delayed ones, and informative better than uninformative ones. For example, observing the change of numbers is an informative reinforcement. Repeated reinforcements at variable intervals are also more effective than only one reinforcement or repetitions at regular intervals.

Punishments weakens learning and are the opposite of reinforcements. For instance, after printing a file, the computer displays the message `Illegal user action! Printer damaged!` would for most users constitute a punishment, making them less likely to try the print command again. Also, lack of any new stimulus after response weakens learning, for example that the computer does not provide any feedback after the user issues a print command.