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MICROTEACHING: Effective Knowledge Transfer for Sustainable Technological Innovation

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Abstract:

Technology and innovation play important roles in the approaches to sustainability related problems. An increasing number of companies find Sustainable Development (SD) important; this is mainly due to the growing attention from politics and society. Exchanging of new knowledge and insight is therefore important. Daily practice proves that it is difficult for (small and medium sized) companies to regularly make time to transfer knowledge internally. Therefore it is necessary for companies to have a practical approach on improving the level of knowledge of Sustainable Technological Innovation (STI) within the organisation.

Microteaching STI offers a flexible and activating approach focussed on stimulating feedback, coupled on various learning styles and participants. In series of meetings of 15 to 30 minutes, related topics will be taught. The choice of topics covered will be determined by the knowledge requirements of both the employees and the company. The approach is developed and tested in collaboration with six companies in the Netherlands, Delft University of Technology and partners involved in training and Sustainable Development: Innovaders Amsterdam, in corporation with Beco Rotterdam. Learning goals of both participants and company are discussed. Mind maps have been used to indicate the attitude of the companies towards Sustainable Development. Brainstorm meetings with all partners and 'learning by doing' have resulted in a format to support an active learning approach. Other focus points are: Training of the (internal) trainer, choosing the correct active work form, using clear examples, paying attention to feedback, facilitating internal discussion and deepening of knowledge after the teaching.

Microteaching STI in the Netherlands is a Leonardo da Vinci EU sub-project, which started in October 2004 and will be finished in February 2007. Two sub-projects in Germany and a project in Slovakia deal with the employees' training in their respective fields, on an operational level. RWTH Aachen, Center for Learning and Knowledge Management and Department of Computer Sciences in Mechanical Engineering, is coordinator of the project. Knowledge of the approach will be transferred to Universitat Politècnica de Catalunya (UPC) Barcelona Spain and also to partners in Finland and Hungarian.

This paper describes experiences with the Microteaching STI approach in the Netherlands. Theory on active learning is combined with practical examples from Microteaching trainings offered.

1 WHY MICROTEACHING FOR SUSTAINABLE TECHNOLOGY

An increasing number of companies find Sustainable Development (SD) important, because of the growing attention from politics and society for this development in which technology and innovation play important roles. Most (small and medium sized) companies though focus on short term improvement like the fine tuning of operations such as quality management, maintenance, auditing and efficiency drives (see Figure 1). These can be seen as an essential first step, but to minimize conflicts and achieve trade-offs between economic, social and environmental goals, sustainability concerns have to be integrated into technology designs from the outset. Fundamental renewal of technologies and organisational arrangements can be reached only in long time-horizons. By breaking with past practice, it can deliver leaps in performance in relation to environmental efficiency. (Weaver, 2000).

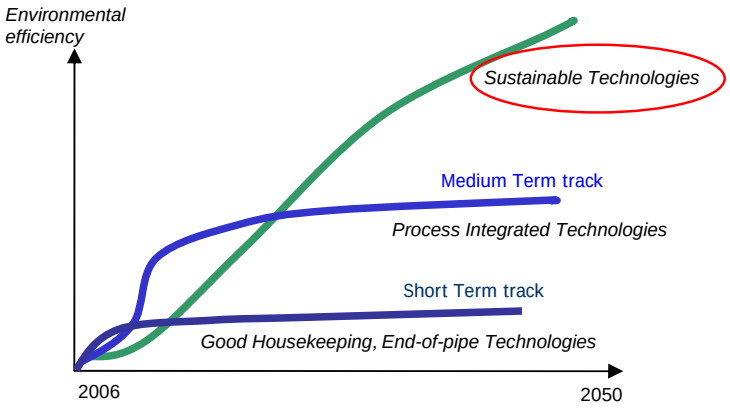


Figure 1: Towards sustainable technological innovation (based on Jansen, 1999)

In this process the transfer of new knowledge and insight are of vital importance. Managers and entrepreneurs within companies need to inform their employees about the latest developments, safety issues, new environmental regulations, new products, new techniques and new production methods etc. on a regular basis. Also for research and

development departments it is essential to share new ideas and insights. Therefore companies need to have a practical approach on improving the level of knowledge of Sustainable Technological Innovation (STI) within the organisation.

Knowledge transfer in (small and medium size) companies is especially difficult for people whose presence in the workplace is of vital importance for the primary business processes like in production, operations, and sales. The European Leonardo da Vinci Microteaching project (Microteaching, 2006) deals with this question for employees whose basic knowledge needs to be refreshed or improved and who need this information for immediate use in their daily practice. The time limit of 15 minutes of has been chosen as challenging goal.

Microteaching STI in the Netherlands is a sub project of the Leonardo initiative. This approach is developed and tested by the Delft University of Technolgy and Innovaders Amsterdam in close co-operation with six companies in the Netherlands and Beco Rotterdam. The project started in October 2004 and will be finished in February 2007. Two other sub projects in Germany and a sub project in Slovakia deal with employees' training in their respective fields, on an operational level. RWTH Aachen, Center for Learning and Knowledge Management and Department of Computer Sciences in Mechanical Engineering, is the overall project coordinator. Experiences with the approach have been transferred to the Universitat Politècnica de Catalunya (UPC) Barcelona Spain and will also be shared with partners in Finland and Hungary.

Content of this paper

The paper deals with the experiences of the Microteaching STI approach in the Netherlands. At first the analysis of the knowledge requirements of the companies will be described in paragraph 2. Paragraph 3 is about the development of the Microteaching approach. It includes a reflection on the theoretical knowledge for a better understanding of the choices made in the approach. Finally the conclusions and recommendations will be drawn in the last paragraph.

2 ANALYSES OF THE KNOWLEDGE NEEDS

Getting people into a classroom at the same time and the same place is often difficult. The problem is the lack of people (low manpower) to do the job, so there is no time left for education during working time. Also before or after working time it may be difficult, due to travel time, public transport and personal commitments. In practice finding time in the agenda of an expert/professional is also proven to be difficult. With six Dutch companies taking part, the Microteaching STI project has great possibilities for developing and testing the Microteaching approach to transfer knowledge to various target groups, working on several core businesses (see Figure 2). Would it be possible to meet the learning objectives of their employees within this project? Four of the companies are Small and Medium size, working in a production environment. Both the managers and entrepreneurs understand the need for knowledge transfer, but do not know how to organize such an event because of the tight daily working schedule.

Figure 2: Different target group: Draughts men and electricians, production employees and sea men.

At the first individual meeting with all the companies in November and December 2004 the managers and entrepreneurs, the future trainers participating in the project, were asked to develop a mind map related to the theme of the Microteaching sessions. We asked them to take only about five minutes time. The mind map (see Figure 3) was used as starting point for further discussion on sustainability and innovation in relation to the activities of the company.

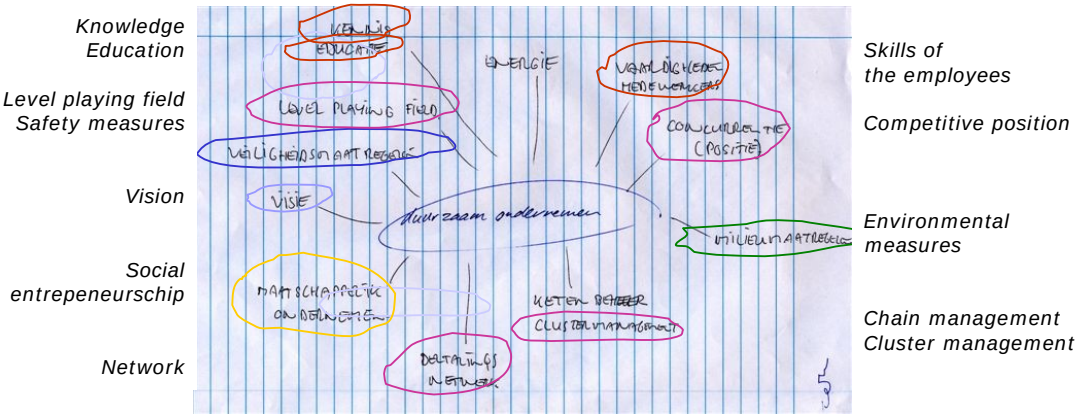


Figure 3: Example of a mind map on sustainable entrepreneurship

The mind maps were analysed on the categories Lourdel distinguishes (2004) to get an indication of the attitude towards sustainable entrepreneurship. Although some catchwords fit in more categories the outcome seems to be quite accurate (see Table 1).

Person	Social and cultural	Environmental	Economic scientific and technical	Procedural rationality and political	Principles of SD	Actors and stake-holders	Existential and philoso-phical	***Total***
1	0	5	2	0	1	0	0	**8**
2	5	2	3	0	2	3	1	**16**
3a	0	2	0	0	4	2	1	**9**
3b	0	0	4	0	1	4	0	**9**
3c	0	1	2	2	1	1	0	**7**
4a	2	1	3	2	3	3	1	**15**
4b	1	1	3	1	2	4	1	**13**
5	3	2	2	0	2	2	1	**12**
Total	**11**	**14**	**19**	**5**	**16**	**19**	**5**	

Table 1: Scores mind maps on sustainable entrepreneurship categorized according Lourdel (2004).

It is clear that employees with various responsibilities have a different focus on sustainable entrepreneurship. Table 1 shows for example that person 1, a Quality and Environment coordinator, focuses mainly on environmental issues and only little on SD principles. Director nr 2 is very much involved in regional social activities which correspond to his high score on the category 'social and cultural'. Person 3a is Environmental Coordinator. Her main focus is on environmental topics and on principles of SD. Plant manager 3b of the same company is most interested in economical issues and stakeholders. Persons 4a and 4b work for an intermediary organisation. Their focus stems from their specialismes.
Highest scores are in the categories "Economic, scientific and technical" and "Actors and stakeholders". We can also conclude that most respondents not only focus on environmental issues, but also on principles of SD.

During the first meeting with all companies we also discussed how the companies transfer knowledge to their employees (see Table 2). Common practice is a monthly "talk from the boss". Some companies were familiar with organising so called toolbox meetings on the job. This is an obligatory part of a Dutch safety certificate in the building and construction branches (VCA, 2006).

Lecture	• (Monthly) talk from the Director • (Lunch) lectures
Reading	• Leaflets and brochures • Posters in canteen • Presentations on 'Knowledge Website' • Sending sustainability messages by e-mail
Visuals	• Powerpoint presentations / CD-ROMs • Toolbox meetings (on the job) • Management training
Demonstration	• Setting an example of behavior (top-down) • Custom made training and courses
Discussion groups	• Exchange of experiences with other entrepreneurs
Practice by doing	• On the job: learning from each other • New employees have actual knowledge, older employees are more experienced
Teach others	• Immediate use of knowledge *(instructor learns)* • Guiding a tour through the factory

Table 2: Inventory: How do the companies learn now

In a second round of individual meetings with all companies in July and August 2005 one single topic was chosen from their short list of ideas as a start for developing and testing the Microteaching approach (see Table 3).

Company 1 - Installer of sustainable energy
• ***Involvement of employees on the topic SD*** • Inspiration for new activities • Information exchange (also with other entrepreneurs) about experiences
Company 2 - Collecting maritime waste
• Internalizing 'why Sustainable Development' – raising awareness • ***Why environmental law and regulation - raising awareness*** • Precautionary measure for maintenance
Company 3 - Development and production of mechatronica for agricultural machines
• Training of new employees • ***Increasing the knowledge of production employees*** • Looking over the horizon / long term thinking

Table 3: Examples of the short lists of topics. (The chosen topic is in Bold and Italic)

3 THE MICROTEACHING APPROACH

In the course of developing a context based on a didactical approach we looked at some principles of learning and used these as pillars for the development of the Microteaching approach. The selection of these principles had two purposes. First we needed a valid and consistent approach. Second this approach should be understood and applied by the participants who are not professional teachers. The two pillars as the basis for the didactical approach were the Taxonomy of Bloom (1984) and the Concept of Retention (Bales, 1996). The Taxonomy of Bloom (see Table 4) shows the incremental process of knowledge development and related competencies. An important issue here is that knowing is not the same as understanding and for workers to be able to apply the freshly acquired knowledge, a one way verbal communication of the essentials is not sufficient. In addition it is true that 'listening' (see Figure 4) is not the best way for transferring information, let alone for the development of higher order knowledge skills. These two pillars have been introduced to the participants and consequently been used in the development of the Microteaching approach.

Competence	Skills Demonstrated
Knowledge	Observation and recall of information
Comprehension	Understanding information
Application	Use of information
Analysis	Seeing patterns
Synthesis	Use old ideas to create new ones
Evaluation	Compare and discriminate between ideas

Table 4: Taxonomy of learning order (Bloom, 1984)

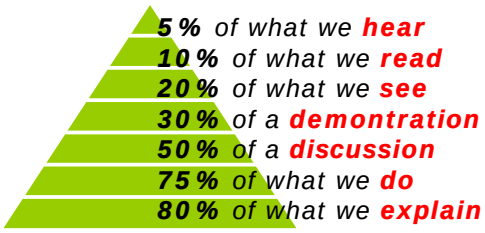


Figure 4: How much do you retain after six weeks (Bales, 1996)

Active learning methods share the advantage that employees learn from each other as part of the group communication process. In order to enable effective discussion the group needs to be big enough to represent different knowledge backgrounds and views. If the group gets too big, some members will tend to drop out or become passive. (Active learning, 2006).
In March 2005 during a shared meeting with all companies the results of the inventory have been discussed. Most important is the didactical format aiming at the quick lesson approach. The managers and entrepreneurs contributed to a brainstorm session to generate ideas about approaches for different target groups (see Table 5 for the results). In cooperation with the companies formats for the preparation of the Microteaching sessions have been developed. These include discussion on learning objectives, organisational issues like planning and splitting the content of a topic into separate (15 minutes) units on the several sub topics. Last part is preparing the Microteaching sessions on a more detailed and practical level.

Target group	Sales and electricians	Production employees
When	Group in the morning (independent of the topic) Or individual: When it fits in the schedule	In production time In the morning before the coffee break
Initiator		Management / environmental coordinator
Group size		5-10 persons
Duration	15 minutes	15 -20 minutes
Frequency		Regularly in 6 month
How	• Start from accident or misunderstanding: show why it went wrong • Use the capacities of employees • Start with something funny *(movie, story, example, case)* • Don't do too much • Teach something to learn to the client *(to facilitate teaching others)* • Check: ask questions • Give feedback on experiences • Facilitate an evaluation session	• News magazine and announcements! • Preparations by supervisor (internal) • Guided tour from the workers • Focus on questions of employees • Questioning how can we do better? • Together: follow up actions • Presentation e.g. waste manager • Plus work agreements

Table 5: Results of two parallel brainstorm sessions with managers and entrepreneurs

Structure of Microteaching sessions

Each series of Microteaching sessions on a topic is structured the same way (see Figure 5). The topic is divided into sub topics. Each sub topic will be discussed in a different session. The amount of sub topics can vary. During the first Microteaching session, the topic, the sub topics and the approach of the following sessions will be introduced, explained and discussed. There will be room for feedback from the participants. Sub topics may be added. The advantages for the company and for the employee (the learning objectives) will be discussed.

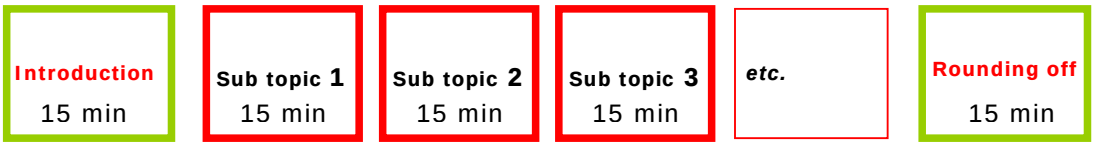


Figure 5: Series of Microteaching session on one topic

The last Microteaching session is for rounding off. The process will be evaluated: Have the learning goals been reached? How do we retain the knowledge? What needs to be continued?

Ernst van Tongeren, Director of a sustainable energy Installation company: "Microteaching is effective. If you sit together for 15 minutes exchange of information must happen. The approach is good and people enjoy it. Our employees felt proud to be chosen to contribute to the European Microteaching project."

What you do in 15 minutes must have a positive influence. The Microteaching approach stimulates active learning by taking into account the following necessary steps:

- Choosing the correct active learning activity or learning method
- Use of clearly depicted examples and cases
- Thinking on how to facilitate internal discussion
- Paying attention to feedback

Figure 6 shows that all sessions are divided into different sections. Table 6 describes the activities per section of a Microteaching session. The aim of the several sections of the Microteaching approach is to facilitate the connection with different learning styles.

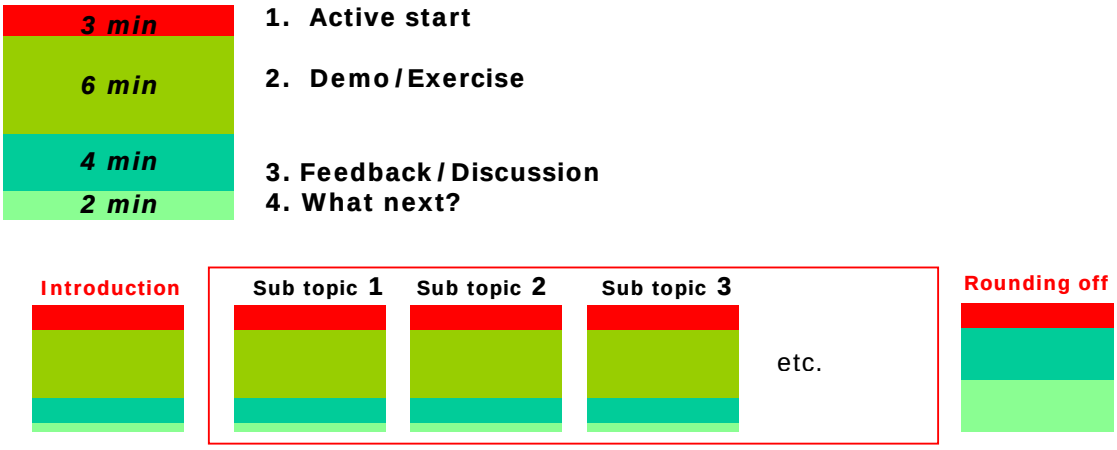


Figure 6: To stimulate active learning each Microteaching session is divided in four sections

1. Active start	• Start with a mental activity e.g. thinking, reflecting, organising and comparing. • Communicate the goal of the session.
2. Demo/Exercise	• Connect with different learning styles by using a combination of pictures, sound and text. • Stimulate the learning process by giving concrete examples.
3. Feedback/Discussion	• Ensure effective, direct and positive feedback. • Stimulate discussion and sharing knowledge between participants. • Check if all participants really understand the content by asking questions.
4. What next?	• What are the topics we will discuss at the next session(s)? • Discuss how to retain the knowledge. • Stimulate involvement and ensure participants leave with a clear goal.

Table 6: Activities per section of a Microteaching session

Preparing a Microteaching session

The Microteaching sessions will be prepared by the initiator, the (internal) expert/trainer and the person who will organise the meetings. These three responsibilities may be combined in one person. Dividing the preparations in three steps has been experienced as a practical approach. See table 7 for the steps and the results.

Steps	***Results***
1. INVENTORY TOPICS AND LEARNING OBJECTIVES ***By initiator and (internal) expert/trainer*** • Identify the target group, the topic for the training and a list of possible sub topics. • Formulate the learning objectives: 'What is in it for me' regarding the topic from the point of view of both company and employee. • Think about good examples to use.	Choices of topic Possible sub topics Target group Learning objectives Examples/cases/ background information
2. SUB TOPICS AND ORGANISATION ***By initiator, (internal) expert/trainer trainer and organiser*** Per series of sessions a choice will be made regarding the sub topics, when the sessions take place and who will participate.	Choices of sub topics Choices of trainer and organiser List of participants Planning of sessions Location and logistics *If desired:* Invitation of an external expert
3. DEVELOPMENT SESSIONS PER SUB TOPIC ***By initiator and (interna) expert/trainer*** To ensure a significant difference between Microteaching and regular approaches it is important to pay attention to **active learning**.	Title sup topics Learning objective of participants Content Active work form (Audiovisual) support Follow up

Table 7: Steps and results of the preparations of a series of Microteaching sessions

Learning objectives

The objectives of a series of microteaching sessions has been described both from the point of view of the company and the employee in the following way.

- After the Microteaching session the company is able to…..
- After the Microteaching session the participant is able to….

Describing learning objectives is useful for both the trainer (the manager or entrepreneur) and the employee for different reasons. See table 8. The objectives of the company are for example: improvement of quality, collecting of new ideas, feedback on working procedures and saving of time and money. These are a very good motivation for the managers and entrepreneurs to prepare inspiring Microteaching sessions.

For the manager or entrepreneur (trainer)	For the employees
• to raise awareness about aim and restrictions	• to know what the expectations are
• to think about knowledge needs and skills of your employees	• to be able to judge on the level of the content
• to decide what work forms, what support and what feedback are needed	• to be able to formulate extra learning objective themselves

Table 8: Why learning objectives are useful to describe (adopted from Kallenberg, 2003)

Skills of the trainer

During the project we discovered that the skills of the trainer are crucial for the success of the approach. To improve these skills we have organised "train the trainer sessions" (see figure 9 for some pictures). In Spain the Microteaching approach will be used by experts from UPC. These experts are selected based on a questionnaire about knowledge needs that has been sent to the participating companies. The expert will be trained in using the Microteaching approach.

Figure 7: Train the trainer session in the Netherlands

Annemiek Boelens, *Trainer of Opteamize* emphasizes: "Before starting to prepare a Microteaching session it is most important for the trainer to realise: *I only have fifteen minutes!"* What do I want to contribute to the other persons learning process? What is my expectation on what will be learnt? What ''growth' do I want to stimulate?

An example of the training offered:

- Company 1: Why is sustainable energy important for us and our clients? (see Figure 8: an example of an introduction session).
- Company 2: The new way of working with the new environment law and regulations.
- Company 3: Responsibility of production employees.

besseling installatie

Example: Introduction session

What does sustainable energy mean to Besseling?

Initiator / organisor / facilitator	Ernst van Tongeren, Director
Target group	All employees (draughts men and electricians)
Number of participant	14
Time	During staff meeting Friday afternoon 16h
Location	Meeting room in the office

Active start: *3 min*

The Director explains the approach:
"During our regular monthly meetings, it is usually only me talking. From now on you will get the floor! We will organise a series of short Microteaching sessions to share our knowledge in an active way."
He introduces the topic:
What does sustainable energy mean to us and our clients?

Exercise: *6 min*

Please take two minutes to think about the following two questions. **Write down your ideas.**

Each person has to make up their own mind.

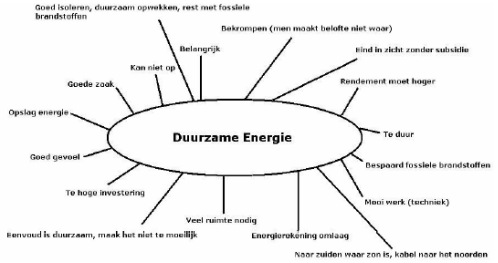
1. What does sustainable energy mean to you?
2. What does sustainable energy mean to Besseling?

Supportive questions:

- What is positive and negative about sustainable energy?
- What is your personal motivation to work with sustainable energy?
- Why is sustainable energy important for Besseling as a company?

Feedback / Discussion: *4 min*

The Director asks all present, **one by one**, to give their input to the questions. He writes down all feedback. To facilitate the sharing of knowledge they create together two **mind maps** *(see an example below).*



What next / How to retain: *2 min*

The Director informs about the sup topics he likes to focus on during the future Microteaching sessions. The learning objectives for both employees and the company are explained. He emphasises that feedback and new ideas are welcome. A digital version of the mind web will be **put on the wall** in the meeting room.

Experiences

- There was good interaction.
- Everyone had the chance to contribute.
- The employees were very positive about sharing knowledge in a short session.
- The chosen topic was interesting to everyone.
- Due to limited time there was no time for further discussion about the topic.

Figure 8: Example of a Microteaching Introduction session

4 CONCLUSIONS

There are many thresholds for knowledge transfer on Sustainable Technological Innovation (STI), such as defining the objectives of the knowledge transfer, choosing the right learning approach, getting people in a classroom at the same time, and finding time in the agenda of an expert / professional (the trainer).
Most managers and entrepreneurs of the companies of the Microteaching project have experience in transferring knowledge and were involved in the topic. They easily listed several topics in the work field. Their objectives were on the level of improving quality, collecting of new ideas, feedback on working procedures, saving of time and money or raising awareness among their employees.

We have been looking at two learning related issues which we thought were essential for the Microteaching approach and essential for the understanding of the participants of this 'didactical model'. We chose the 'Bloom taxonomy" and the 'Retention curve' as the two essentials to be communicated and used.

The solutions as developed in the Microteaching approach show to have the following advantages:

- Most important is the didactical format aimed at the quick lesson approach. By choosing an active learning approach you will manage for a meeting of only fifteen minutes to involve everyone. The interactive approach ensures that the knowledge remains with you and is much better than the common approaches such as 'the monthly talk from the boss'.
- Due to the active work forms, this approach supports and stimulates communication between employees. Employees are encouraged to share their knowledge and to think about solutions that benefit the company.
- Microteaching is flexible to apply. You can determine the frequency, the time and the content.
- The transfer of knowledge occurs in the short time of 15 minutes, which means it always fit into the work week of the employees.

Recommendations

- It is very important to communicate the approach in a challenging and positive way. You have to *'Sell the product'*. Explain reasons for choosing this approach: what the benefits for the company *and* the employee will be.
- The time needed to prepare a 15 minute session should not to be underestimated. Preparations for a 15 minute microteaching session may take (in the beginning) three hours of work.
- During the project we discovered that the skills of the trainer are crucial for the success of the approach. To improve these skills "train the trainer sessions" are needed.

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