

BLENDED LEARNING ACTIVITIES OF THE UNESCO CHAIR IN SUSTAINABLE WATER MANAGEMENT - the underlying eLearning fundamentals and practical results -

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ABSTRACT

Education and knowledge transfer is an important and major concern for sustainable urban development, especially if it comes to urban water infrastructures. As densely populated areas are growing at a speed never experienced before and the water demand even quadruplicated between 1940 and 1990 (while world population "only" duplicated), the new generation of urban water engineers has to be taught in a very effective way to solve future problems.

To target this objective, the German IHP/HWRP National Committee has launched a project for blended learning in water management for the UNESCO Chair in Sustainable Water Management held by Prof. Geiger. There are currently several courses such as those on Sustainability and Water Management, Introduction to Urban Water Management and Storm Water Management for Sustainable Urban Development. These courses are held at Tongji University, Shanghai, Ocean University of China, Qingdao and Jinan University, Jinan.

The blended learning approach is a combination of the classical face-to-face teaching plus additional eLearning features, organised within a learning management system. Within this concept there is a three-step approach for education and knowledge transfer.

Such an blended learning approach has been implemented by Prof. Nacken since 2002 in courses on hydrology and water resources management at the RWTH Aachen University. Prof. Nacken and Prof. Geiger have agreed to set up jointly a blended learning concept for the UNESCO Chair in Sustainable Water Management. This includes the drafting of the content for the learning management system, pedagogic design patterns, preparation of the self-assessments and implementation into open source learning management systems.

The following paperwork covers the aspects of the blended learning concept and basics of eLearning as well as examples from the resulting learning management system for urban storm water management.

Key words: blended learning, eLearning, SOI theory, sustainable water management, UNESCO

1. HOW DO WE LEARN? (OR THE SOI THEORY)

First of all we will start by having a closer look at the way we (as human beings) learn. There is not just one way of learning; instead we can divide learners into three different categories.

- visual learners
- auditory learners
- kinesthetic learners (or haptic learners)

From your own experience you will know that some people have to write down the information they have heard and while repeating the input, the process of knowledge transfer is consolidated in their long-term memory. Other people learn by explaining to some friends what they have just heard and while explaining, they might find out, that they did not get all the specials of the topic. So they start discussing and by this process of aural repetition, the process of learning is advancing.

Another type of people is better of in learning, when they have hands-on experience while learning something new. These so called kinesthetic learners form the minority of all learners. In general, everyone has to find out whether he/she is a visual, auditory or kinesthetic learner and the design of courses on urban storm water management will always involve all those different types of learning.

In general we have to focus on those visual and auditory learners and we have to combine various approaches to make the process of learning most effective. The way our brain processes different types of information has to be kept in mind during the process of course creation. To give you an idea of the neuronal processing we will go through a fictitious trainings scenario of urban water management. The instructor would like to start the course by explaining the water-cycle and being very ambitious and targeted, wants to set up knowledge, skills and competencies within his audience. His aim is to produce sustainable knowledge, so he knows that he has to reach the long-term memory of the brain. The instructor is very aware of the dual code theory (PAIVIO, 1986). Thus the instructor knows that our human knowledge processing strictly separates between aural and visual input.

To reach the long-term memory, he can either address the aural channel or the visual channel. Both channels will first pass over the information towards the working memory that can be (partly) located in the hippocampus (see figure 1). While listening to the instructor, the verbal perception will gather the information and you will start to set up an aural, verbal model of the knowledge item. When you actively learn, neurons will be linked via there synapse and thus form a trace of the knowledge item that has been presented. This trace can later be retrieved.

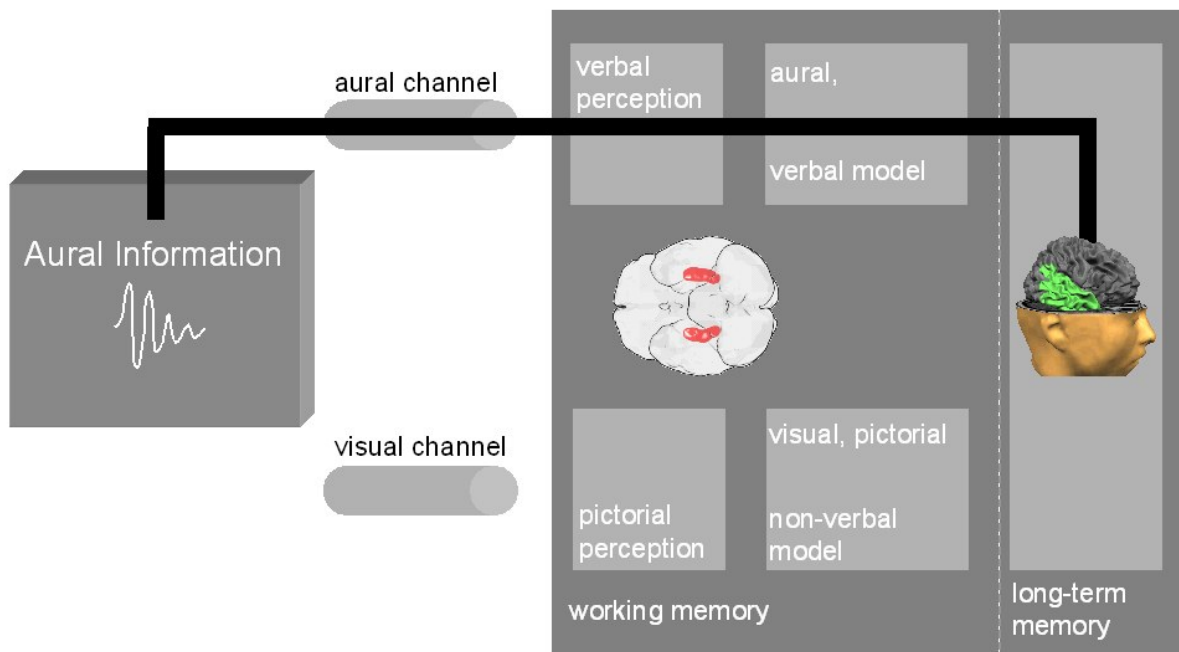


Figure 1: Reaching the long-term memory

To explain the water cycle, the instructor might use an animation or a video sequence, showing all parts of the water cycle. Doing so, your pictorial perception is gathering the image information and starts to set up a visual, pictorial, non-verbal model. This preprocessed information will be passed to the long-term memory (see figure 2, upper right part).

Whenever the instructor shows pure text information on his slides, the audience will first collect the text information on the visual channel. But as text information can not be processed within a visual, non-verbal model, the information has to be swapped to our verbal perception. It will pass the process of building an aural, verbal model and will be transmitted towards the long-term memory (see figure 2, lower left).

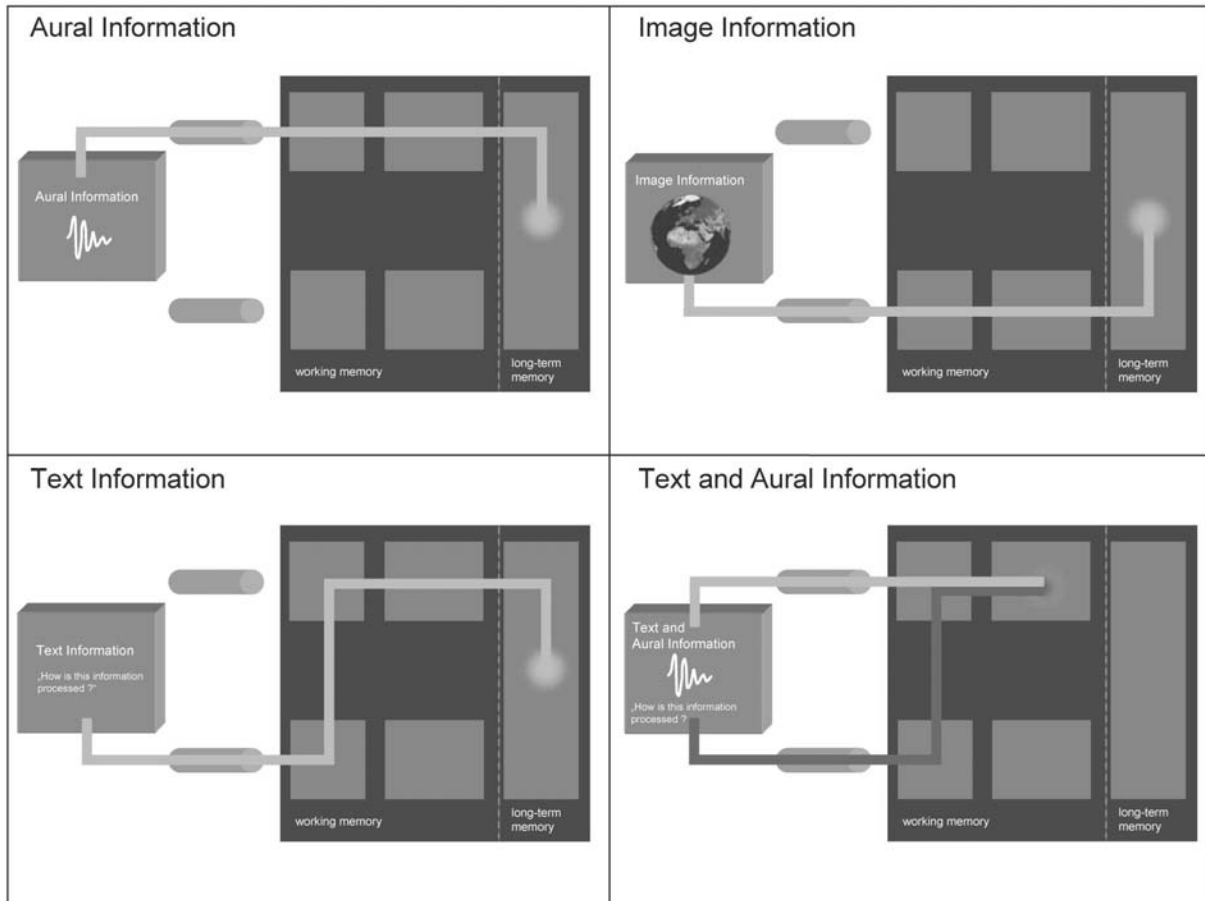


Figure 2: How pre-processed information is passed to the long-term memory

Now just imagine that the instructor, at a certain point, is not really aware of what he wanted to explain with a certain slide. So he starts reading one-to-one what is written on the slide. At that point the audience will lose the plot. The reason for that is that the audience hangs on the lips of the instructor and in parallel is reading the written information presented on those slides. By that the verbal and pictorial perception are running fast to process the text and aural information. The process to set up the aural, verbal model starts, but however hard the audience is going to try, the attendees will not succeed, because there will be a clash within the working memory (see figure 2, lower right part).

The reason for that is that the transmitted information of both channels reaches the working memory with just a small time offset (the visual information is just running ahead). To imagine, what happens inside your brain, just think of a phone call with a feedback. You are talking and you simultaneously hear your own voice (due to an acoustic feedback). When the delay is quite short you will not be able to proceed talking and you will get stuck. Nearly the same thing is happening within the working memory. The reason is that human beings just have a limited capacity of handling and processing input information. This is the so called magic seven; it has been found out that individuals can handle approximately seven different input information independently on each channel. If the frequency of input information is too high, one will not be able to develop the necessary model and implement the knowledge object in the long-term memory.

Focusing on a targeted knowledge transfer (either traditional instructor-led courses or pure eLearning courses) you always have to be aware of these shown facts. This leads us to the fundamentals of the Selection-Organisation-Integration theory (also called SOI theory). All that has been explained up to now can be summarized by the basic fundamentals of the theoretical SOI model:

- human knowledge processing strictly separates between aural and visual inputs (two separate channels for information entrance)
- the processing capacity of those two input channels and the working memory is limited (the magic seven)
- learning is always an active process; we have to develop a coherent mental model (or reproduction) of the learning objects

The theoretical information on those topics can best be looked up in Sweller & Chandler (1991) as well as Paas (2003). We have to conclude that the learning process really is labor (in our German language the word labor has its origin in hardship, so eLearning has nothing to do with entertaining people).

At this point I would like to mention that typed text is a very easy way for an instructor to transfer information but not the easiest and most convenient way for a learner to acquire new knowledge. Just have a look at the internet (<http://hydrology.lfi.rwth-aachen.de> => fundamentals of eLearning) and you can see and hear the context just depicted in this paper. This might be a good example of how eLearning technologies serve your private convenience.

2. THE PRINCIPLES OF MULTIMEDIA-BASED LEARNING

Based on the assumptions of the SOI theory, Clark & Mayer (2002) developed six principles that should be obeyed during the conception and creation of multimedia contents. Because these principles are easy to understand, they are mentioned without any further explanation.

multimedia principle	a combination of text and diagrams/illustrations is more effective as a method of knowledge transfer than text only
modality principle	explanations and descriptions, dedicated to illustrations and diagrams are better grasped in spoken form (aural) than in written presentation
continuity principle	text information and diagrams that refer to each other are to be presented interrelated
redundancy principle	the learning process gets negatively influenced when knowledge contents are presented in written and spoken form simultaneously (q.v. Dual Code Theory by Paivio)
coherence principle	media elements are to be used targeted and economically (thrifty); an overkill will have negative consequences for the learning process
personalization principle	expert sociolects should be avoided; in general, comprehensible explanations enhance and enrich the learning effect

Based on the SOI theory and these principles of multimedia-based learning you should try to design your courses in such a manner that more than 80 % of the information you would like to transform into knowledge, is presented in an aural way (independently of setting up a classical face-to-face or a pure eLearning module). Animated graphs, flash files or video sequences will fill the residual part.

3. DESIGN PATTERN FOR ELEARNING

When it comes to the blue print of eLearning courses, there are often discussions about the right technology approach. At this stage, I would like to quote a very wise man (Josh Bersin) who once said: "Good eLearning is not a question of technology. If your design is wrong, technology will only help you to do more things wrong in less time". So we should focus on the didactical structure of eLearning courses and the design patterns. The structure that I am using in the design of eLearning courses and that has been adopted for the courses of the UNESCO Chair, is a three-step approach (see figure 3).

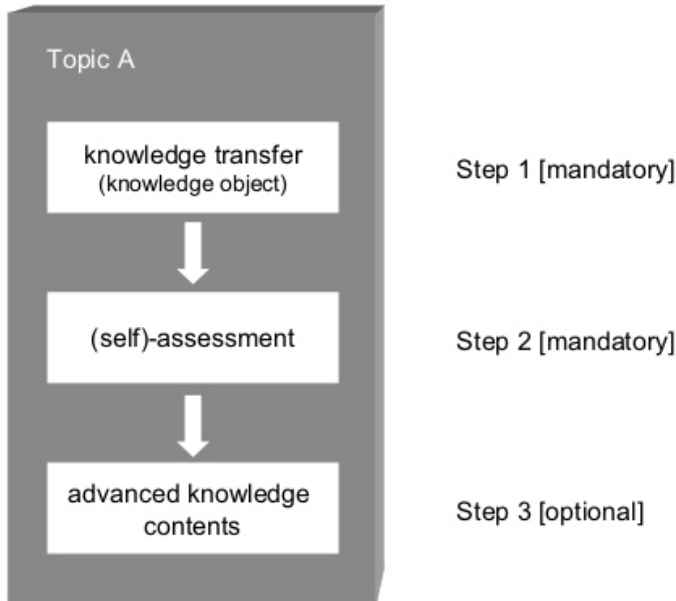


Figure 3: Three-step approach to the design of an e-learning course

You should start by unitizing the content into well-defined topics. Within each topic, the first step will be a knowledge transfer which is realized by so called knowledge objects. These knowledge objects could be an aural presentations, videotaped lectures or webinars. A knowledge object has the task to transfer all the necessary information to the attendee. To be effective in doing so, you should always dual code all the information. While designing media content we stick to the assumption that our knowledge transfer via eLearning media is realized primarily by aural coding. Pure aural coding sequences should not be longer than approximately five minutes. The reason for this limitation is that attendees will lose their attention after a while, when looking at a monitor where hardly nothing is visually changing. If for the knowledge transfer it is necessary to have longer sequences, you should add a video stream of the speaker so that the attendee can visually concentrate and focus on.

The second step of the didactical structure will be an assessment. With this assessment the attendee can really proof whether the knowledge transfer has been successful and he or she did acquire the knowledge, skills and competencies that the first step did allocate. Most often this step is done in form of a quiz (using true-false, single-choice, multiple-choice, short answer, numerical or matching questions). Best practice will be the use of the Question and Test Interoperability Specification (IMS QTI standard, see www.imsproject.org/question).

The assessment as well as the knowledge transfer has to be designed in such a way, that it motivates, incentivizes and encourages the attendees. Moreover the design of the eLearning module should take into account the given fact, that giving learners more than one method to solve a problem or show them multiple approaches to solve a task, will highly raise the efficiency and the impact of your knowledge transfer.

The first two steps are always mandatory, whereas step three is optional and will offer additional, advanced knowledge contents to the attendees. This can be any further information on the selected topic, a series of links to internet pages with topic related information or any other add-on.

You can easily link different topics (steps 1-3) in a linear chain, where every topic has to be followed one after the other (often called a program flow model). Another possible design pattern would be the presentation of these topics and offering different entry points for the attendees, so that they can choose which contents they would like to follow. If you choose this design pattern, it could be a good idea to start each topic with an assessment to find out whether the attendee knows all the basics necessary for this topic. Depending on the result of the assessment, the attendee will be allowed to go on with a topic or will possibly be redirected to the topic he needs to repeat before starting the new subject.

4. MOODLE AND THE UNESCO CHAIR COURSES

Based on the principles described before, a Learning Management System (LMS) is operated for the UNESCO Chair in Sustainable Water Management. The Open Source System MOODLE is the LMS of choice. It is used at the Institute of Engineering Hydrology since 2002 for Blended Learning courses in Hydrology and Water Resources Management for the education and training of students of civil engineering as well as in three different EU financed TEMPUS Projects with four Universities in Egypt for water related education.

On March 9th a newly MOODLE instance for the UNESCO Chair, hosted in Aachen, opened the gate (see figure 4). The first courses that are offered are one on Storm Water Management, done by Prof. Geiger and a course on Water Resources Management and Hydrology, developed at our Institute. The development of the Storm Water Management had not jet finished, but the framework of the course has been so flexible, that Prof. Geiger managed to run his first blended learning session in China during the month of March and returned to Germany in April with his first feedback. The content for this course is done in a dual language mode (English and Chinese) whereas the Water Resources course is done straight in English.

UNESCO chair in Sustainable Water Management

You are not logged in. (Login)
English (en)

Welcome to the Learning Management System of the UNESCO chair in Sustainable Water Management

Here Students can access virtual teaching materials for enhanced study purposes for self-paced learning.

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Site news

Storm Water Management
by Prof. Dr.-Ing Wolfgang Geiger - Friday, 9 March 2007, 11:35 AM

Urban water management includes storm water storage, infiltration and drainage, rainwater harvesting, storm water treatment, groundwater recharge, flood protection, etc.. In fact all water infrastructures are linked with each other and also are connected to issues like a water saving society. Urban water also is linked to all the areas, from where water is taken for water supply and to where wastewater is discharged. Therefore this course emphasises on the integration of all these components and issues.

To enter the course click here

Water Resources Management and Hydrology
by Univ.-Prof. Dr.-Ing Heribert Nacken - Friday, 9 March 2007, 11:34 AM

The course Water Resources Management and Hydrology I imparts basic knowledge on the process understanding of the global and regional water cycle. From hydrological basic knowledge via hydrometrics to deterministic modeling techniques, theoretical as well as applied knowledge is imparted. Students learn basics of data processing of water management informations with time series systems, data base management systems, and GIS tools.

To enter the course click here

Figure 4: The Learning Management System Moodle (<http://barentssee.lfi.rwth-aachen.de/unesco/>)

Both courses are unitized into 12 respective 15 lectures, offering the mandatory knowledge transfer module and the assessment. The students can define whether they would like to have their user interface be configured in English or Chinese. The next courses that are in the process of development are on the following subjects:

- Sustainability in water management
- Advanced water resources management
- Introduction to urban water management
- Storm water management for sustainable urban development

The German IHP / HWRP secretary is financially supporting the process of adapting existing content of Prof. Geiger and transforming it into eLearning material within the current year (I would explicitly like to thank the IHP / HWRP secretary for this support). Up to now plans are to finish the development in 2007, but a crucial point will be the feedback from those students at all three Universities, where the course will be run during the year.

5. NEEDS FOR THE FUTURE

For the time being the situation concerning eLearning content and courses is very promising; still there are some things that are missing.

- a Math QTI standard

In urban storm water management we often have to solve problems by using mathematics. Thus by involving mathematical solutions in our knowledge objects, we definitely need an enhanced QTI standard for implementation in our assessments. The eLearning community is still waiting for such a Math QTI standard.

- Proper and joint pedagogical design patterns

Technology and software solutions really help us a lot while designing and running eLearning courses, but the quality of the eLearning courses and content is depending on and related much more to the pedagogical design patterns. As for me, I do consider this part as the weakest link in the chain for the time being.

- Knowledge objects, really compatible to existing standards

The future of eLearning will be blended learning, as a blend of traditional instructor-led courses plus additional pure self-directed eLearning courses (see figure 5). To make this happen there is definitely a condition needed where the content designers fulfil the requirements of existing eLearning standards. These standards are still to evolve, but it would be a benefit for the eLearning community, if just only SCORM (see www.adlnet.gov) would be supplied by all content designers to exchange and blend eLearning modules between different learning management systems.

- An (non-commercial) eLearning stock exchange

Imagine you are a content designer and would set up a working group with four experts, belonging to different institutes. All of you would like to design eLearning courses on a big scale and with really impressive quality. So why not join, agree on common design patterns and realize eLearning content in accordance with existing eLearning standards (SCORM and QTI). Thereby you could, for example, concentrate on the design of knowledge objects and assessments related to the topic that you are best in and by the end of your development, you would not just have one high quality module but five.

You could organize this exchange of eLearning content either in a commercial or non-commercial way. This would reduce largely the amount of money spent for redundant content, promote the idea of using eLearning courses and help focus content designers on what they are really good in.

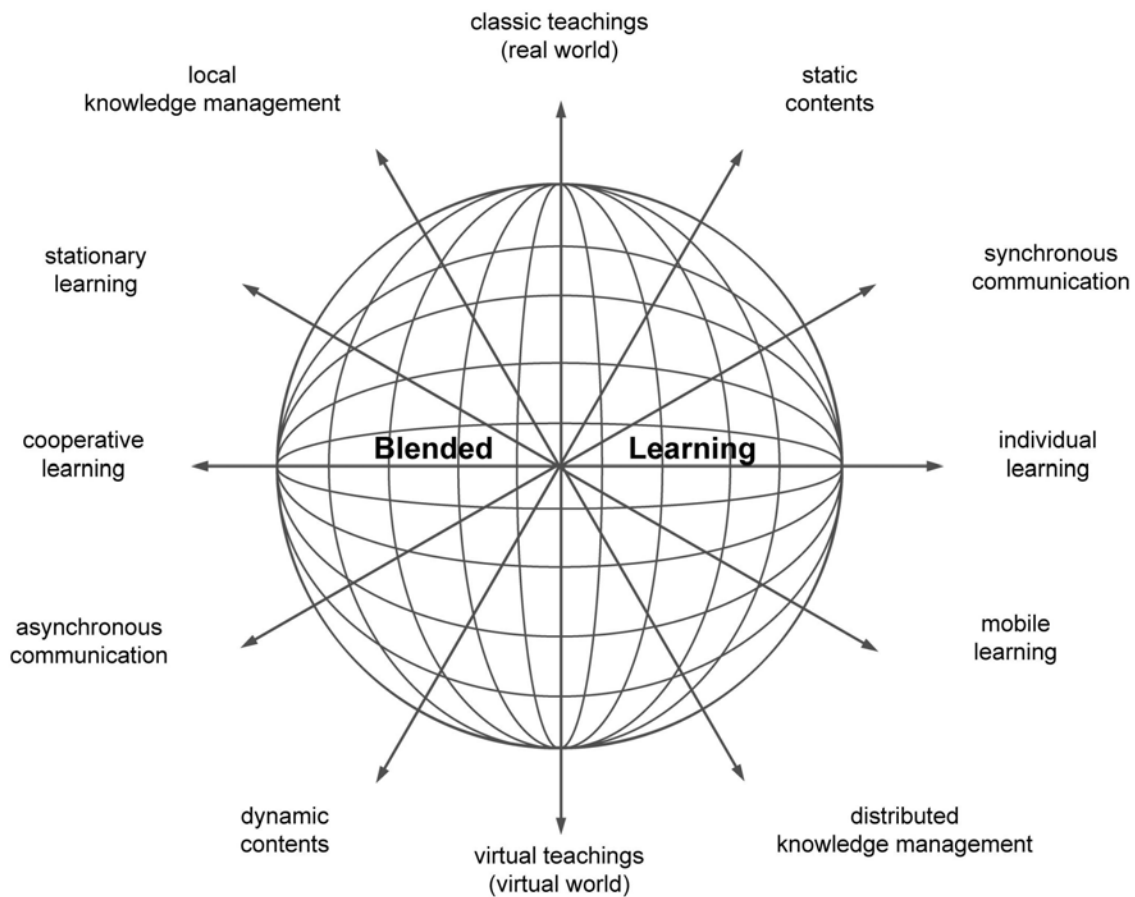


Figure 5: Blended Learning = traditional face to face teaching + eLearning

The basis for the Blended Learning for the UNESCO Chair in Sustainable Water Management is stable. There is a giant amount of knowledge related to the traditional face-to-face learning including excellent content from the side of Prof. Geiger. We do offer the proven and tested design patterns and the experience with eLearning and Blended Learning in an university environment as well as all necessary tools. So it is just up to us to bring out the best of Blended learning in Sustainable Water Management.

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