Pedagogic Approaches for Training and Education (Distance Learning) in the Extended enterprise

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ABSTRACT:	The need for training and education in digital business differs from the traditional situation. Several challenges such as different cultures, different work hours, co-operation along supply chain, customer focus, just in time delivery have changed the frame of competence development in current global manufacturing engineering industry. The need for continuous competence development and on the job training creates a new learning atmosphere that requires new pedagogic approaches. Based on studies in selected enterprises, relevant approaches for competence development is suggested.

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Note to the reader:

Since this a report that is supposed to *describe* pedagogic approaches for training and education - with focus on distance learning – this is no research work. Instead, the report is heavily based on published sources, which may be research or relevant experience. As a consequence, the report includes a great number of quotes. In some cases, it is recommended to consult the sources for further reading (see the list of literature and sources at the end of the report).

On the GEM meeting in Lausanne in June 2002, it was agreed that the subsequent work on the report should focus more on practical recommendations for the online teacher than on theoretical approaches. Due to the time and resource limit, the report cannot, of course, fully explore all aspects of online education.

There are a variety of sources to knowledge about online education. To mention just a few, we recommend consulting, for instance:

The websites

Networked Learning in Higher Education (http://csalt.lancs.ac.uk/jisc/advice.htm). with the report 'Effective networked learning in higher education: notes and guidelines',
January 2000. With a great introduction to online courses and a list of recommended reading.
Tips for Online Learning: http://www.wlv.ac.uk/celt/oltips/furtherinfo.html - links to everything you need to know
BrITe Ideas Online, Learning Technology Dissemination Initiative LTDI:
http://www.icbl.hw.ac.uk/ltdi/briteideas/

The book:

McVay Lynch, M. (2002): *The Online Educator. A Guide to Creating the Virtual Classroom*. London and New York: Routledge.

1 Approaches to training and education in the digital business

Since the development of teaching and training – globally – is heading in the direction of so-called **e-learning** (also: online learning, net-based learning, Web-based/computer-based training (CBT), computer supported (cooperative) learning (CSCL), computer aided instruction (CAI), technology enhanced learning (TEL), etc.), it would be useful to look at some central concepts and terms related to e-learning before we are discussing distance education more generally.

1.1 Some central concepts and terms related to e-learning

In order to reach an understanding of some of the most central concepts and terms related to e-learning, one could, for instance, start by looking at a recent industry report on e-learning (standards) from **The MASIE Center's E-learning Consortium:** *Making Sense of Learning Specifications & Standards: A Decision Maker's Guide to their Adoption* (henceforth "the MASIE report"), where some important terms and concepts are discussed. For additional terms and definitions, the MASIE report also refers to the following online resources:

http://www.cisco.com/warp/public/10/wwtraining/elearning/pdf/elearn_glossary.pdf
http://www.internettime.com/itimegroup/eglossary.htm
http://www.learningcircuits.org/glossary.html
http://elearners.com/services/faq/glossary.htm

In the MASIE report, ***e-learning*** is defined and described in the following way (p. 7):

A simple working definition of the term e-Learning is "learning or training that is prepared, delivered, or managed using a variety of learning technologies and that can be deployed either locally or globally." The promise of e-Learning is that it provides leadership with powerful new tools for improving capability development, speed, and performance whether their organization operates in one geography or many. Just as the rise of information technologies fundamentally changed the nature of how work gets done in organizations, the emergence of learning technologies is fundamentally changing the nature of how people learn to do that work.

The fundamental learning model hasn't changed: Learning professionals still help others learn how to do things they couldn't do before. In non-academic settings, this means they remain focused on providing leadership with the ability to build organizational capacity and improve performance. Learning technologies are simply a sophisticated new tool that enables each learning professional to be more productive at helping others learn.

One useful concept related to e-learning is that of so-called ***learning objects***, cf. the MASIE report (p. 35):

Learning Object (LO):
A re-usable, media-independent chunk of information used as a modular building block for e-Learning content. Learning objects are most effective when organized by a meta-data classification system and stored in a data repository such as an LCMS.

An *LCMS* is a ***Learning Content Management System*** (MASIE report ibid.):

A software application that enables authors to register, store, assemble, manage, and publish learning content for delivery via web, print, or CD.

LMCS is an augmentation of the perhaps more common term LMS, i.e. ***Learning Management System*** (MASIE report ibid.):

Software that automates the administration of training events. The LMS registers users, tracks courses in a catalog, records data from learners; and provides reports to management. An LMS is typically designed to handle courses by multiple publishers and providers. A learner's development plan and job-related training can be stored and personalized to the individual.

We will come back to a discussion on learning management systems later.

About learning objects, the MASIE report states more specifically (p. 11):

One learning technology concept in particular, the "Learning Object," has the potential to revolutionize the paradigm for organizational learning. The concept is simple: leverage database, Internet, and other digital technologies to prepare learning content as discreet small "chunks," or "Learning Objects," that can be used alone or dynamically assembled to provide "just enough" and "just in time" learning. Learning Objects can also enable learners to select the training that is most relevant for them and perhaps even in a media format that matches their preferred learning style (auditory, visual, etc.).

Furthermore, it is said (p. 24):

In the old paradigm, learning was organized into lessons and courses that met specific learning objectives. In the new paradigm, learning content is broken down into these much smaller, self-contained pieces of instructional content (Learning Objects) that can be used alone or can be dynamically assembled with other Learning Objects to meet the "just enough" and "just-in-time" requirements of a learner.

and (ibid.):

Defining and understanding Learning Objects has been a challenge because they need to be viewed within the context of an overall conceptual model that is based on a hierarchy of granular content objects. The analogy of Lego blocks is often used with the individual Lego pieces representing the smallest piece of "raw content" objects (shown in green in the graphic on the next page). These blocks or objects can be snapped together and pulled apart as needed, which enables almost infinite flexibility to create logical assemblies of individual content objects to meet the learning needs of individuals.

We will come back to a more thorough discussion on learning objects, too. The MASIE report contains a list of URLs (Universal Resource Locators = Internet addresses) to further reading on learning objects (p. 26).

1.2 Experiences with e-learning

The early disappointment of online learning

Marguerita McVay Lynch in her 2002 book: *The Online Educator. A Guide to Creating the Virtual Classroom* speaks of "The early disappointment of online learning" (p. 1). Only a few years ago (1997-1999) McVay Lynch estimated that perhaps 10 percent of colleges and universities in the United States were offering courses on the Web, and perhaps 25 percent of large corporations were doing the same (reliable statistics were hard to find for that period). The

numbers were said to be significantly lower outside the US, McVay Lynch states. Reports from 2001 show, on the other hand, that the number of Web-based courses or Web-based components of the curriculum had increased to close to 80 percent at colleges and universities in the US and to over 60 percent at large American corporations.

As we all know, Web-based training or e-learning has been much of a hype during the recent years and the term/acronym *ICT* (Information and Communication Technology) had to be mentioned at least once in every official document regarding education and training (not to mention applications for governmental funding). Mostly, educational institutions and private corporations have a strong faith in the future of e-learning. Like the United States, the European countries spend enormous amounts of money on ICT in education. However, McVay Lynch says (p. 1):

Unfortunately, anecdotal evidence also suggests that much of the storm of development has been undertaken in haste, without expert preparation or knowledge of process. In fact, many educational institutions and corporations have approached the development process as a reaction to perceived competition for students, instead as a project to enhance student learning. The attitude in much of higher education has been: "We need online courses now. I expect there to be *x* percent of courses by the end of the year. Oh, and by the way, there is little or no extra money to make this happen." The K-12 schools received similar directives, though usually with more political consequences. Politicians want to see schools using technology. Parents want their children competing at the highest levels. Government policies add technology to schools in the same pen stroke that also asks for teachers to be surrogate parents, drug czars, health advisors, and peace officers.

Furthermore, McVay Lynch states (ibid.):

Though this demand for immediate incorporation of Web-based education has yielded a great increase in courses and study opportunities, we are now also seeing the consequences of the absence of strategic planning. This backlash is evident in instructors' refusal to teach online, student protests over receiving insufficient feedback and mentoring from the Web-based professors, parent complaints and fears of children's overexposure to computer-based learning and underexposure to teacher mentoring, and corporate customer complaints that they no longer have access to a "real" person to solve their problems or help them learn.

"**Does this mean that Web-based education is doomed?**", McVay Lynch asks rethorically (p. 2) and answers with a clear "No". According to McVay Lynch, this means, however, "that it is time to regroup and look at education from a system perspective instead of from the perspective that one can slap technology on to an existing system and make it work."

1.3 Benefits of e-learning

There are reasonable doubts about the effectiveness and impacts of e-learning in general. The question is, among other things, what side of e-learning one is interested in. For the GEM project, there is no doubt that the Internet is the only way to build a working European or global community of project partners and students. No other way of organising this kind of project would yield the same flexibility and possibilities.

In order to specify some of the positive aspects and benefits of e-learning, we will quote McVay Lynch's (2002:5 f.) presentation of benefits additional to: "instant access to information, the ability to involve students and instructors from a variety of locations, helping students to become

familiar with the computer-based environment that permeates business, and enhanced communication across a wider learning community":

All course content is in one accessible location for students and teachers. Resources, materials, handouts, homework assignments, and grade tracking can be available twenty-four hours a day, seven days a week. This cuts down the requests for information.
Different learning styles can be addressed. Graphics, audio, video, and other media reinforce instruction, while communication functions such as e-mail and threaded discussions enable timid students to express and develop their thoughts.
Active learning is increased. Because Web-based courses increase efficiency, there is more time for active learning and application of concepts. Electronic communication technology also provides new possibilities for interaction outside of the formal classroom environment of lectures and note-taking (e.g. role-playing, discussing case-studies).
Learning-communities are fostered. Web-based courses build a new kind of community that is not bound by location or time. No longer are students relegated to meeting and talking with only those who can stay after class or meet for lunch.
Students enjoy using a variety of media to learn concepts and theory. Today's students are technologically savvy and accustomed to using the Web.

1.4 Attitudes and change

The introduction of e-learning to an existing educational system, be it at university level or company level, requires, among other things, **the ability to change** and adapt. As McVay Lynch (2002:2) puts it: "Change is a constant companion of education and the larger governmental and even global system in which education functions". On the other hand, change of routines or even entire systems or organisations may be a rather problematic issue. Many of the GEM partner institutions will face various kinds of problems connected to change during the implementation of the project. On this background, it may be some kind of consolation that this is a well-known phenomenon, cf. also McVay Lynch (2002:2):

Change – inevitable as it is – continues to be perceived by most educators as a threat. The question for educators is whether to be a part of the change or a victim of change. Too often, as educators, we have allowed others to make system-wide decisions for us. Too often, we have behaved like bystanders, reacting to change rather than being proactive planners or active participants and contributors.

In order to make GEM a successful project, one of many challenges would, therefore, be to work with educators' attitudes to change and e-learning in general. This would, of course, be a task for each of the individual partner institutions with close relation to local and national conditions.

McVay Lynch's three foundation rules of Web-based education
McVay Lynch (2002:3) has three useful foundation rules of Web-based education that can be summarised as:

One has to push beyond the comfort zone; venture beyond the known, acceptable, and conventional; current frames of reference, boundaries, and assumptions must be challenged at every turn; undertake fundamental change in the way one thinks about educational partners. Plan, plan, plan, and then do more planning, among other things, to avoid courses with too much uncoordinated and overwhelming information with broken links and lost tracks. One has to plan for contingencies, support structures, fluidity of thought within a loose framework of the course, and one has to plan for constant change by providing a framework to deal with the problems.

Interactive communication is paramount and comes in the form of demonstrating thinking processes. Effective interaction requires communication – not regurgitation and not repetition. As examples, McVay Lynch mentions: reflection papers, active discussions with the instructor and with class peers, taking leadership roles in presenting what has been learned, mentoring, coaching, problem-solving, and a myriad of forms of analysis, synthesis, and evaluation.

1.5 Language and cultural differences

English is the "natural" language for co-operation and communication between the GEM partners since English seems to become the most accepted global lingua franca after all. It is also very likely that most of the information/content that will be produced in connection with the GEM project will be in English. Still, it is possible (and possibly desirable?) that certain parts (e.g. parts of national curricula) may be in "local" languages. Furthermore, there is no doubt that the European countries exhibit clear cross-cultural differences; differences that, among other things, regard the way and style of communication. Besides the cultural differences between the involved countries, there would also be cultural differences (and possibly "language" differences) between, for instance, universities and other organisations or enterprises. Furthermore, the development of the global terminology for education in general and e-learning in particular is not very consistent, as we know (cf. *online learning, net-based learning, Web-based/computer-based training* etc.).

Since this issue is also discussed by McVay Lynch (2002:9 f.), it may be useful to consult her experience in this field. For instance, McVay Lynch points at the fact that culture goes far deeper than that associated with a specific country or region:

Any organization develops its own norms and expectations of communication. For example, a Web-based environment that emphasizes student-centered learning and student choice in navigation may not be consistent with a hierarchically oriented culture. Many education models around the world have a culture of the teacher as "god" and the student as a vessel to be filled. Other cultures, like that of the United States, are beginning to change to a consumer-based educational model, where student choice is paramount.

1.6 Is it possible to learn in a web-based environment?

McVay Lynch (2002:11 f.) points at the fact that the Internet has provided a significant increase in the availability of information, but that there is little research regarding learning and retention due to the online environment.

McVay Lynch refers to Yanni (2000) who found out that students at least learn different skills, i.e. technology skills – to a greater degree, and faster. Students learned, among other things, to retrieve adequate information more quickly. They also mastered techniques of storage and retrieval of information more quickly, and how databases are organised. At first sight, this may not necessarily seem to be directly desired outcomes of a concrete study plan. But all of these skills can at least be said to enhance learning in some way and must be considered positive effects of the online environment.

McVay Lynch also refers to Neill (1998) who found that students gained more subject knowledge through research in a shorter period of time, allowing them more time to organise the information in their minds, think, and allow learning to take place – metacognition. It is observable that students not only learn more, they also learn how to learn.

The other side of the picture is, as we all know, the fact that information can in many cases easily be retrieved and reused without further mental processing, i.e. the learning process may be extremely short or hardly present at all when some students use their technical skills to complete a teacher designed task without having any personal learning goals for themselves.

1.7 Distributed Learning

With the emergence of the Internet, the term e-learning was coined (see the discussion above). Now the students would be able to get learning material delivered through the Internet, e-mail would provide communication between teachers and students. Via this new medium, students could attend courses from home, thereby opening great possibilities for educating people living far from schools/universities, and those who did not have the time to attend on-campus courses. Great resources have since been used to transfer learning material to the new medium, and on the development of technical solutions for the delivery of these courses.

For over one hundred and fifty years, distance education has delivered learning material to students that, for some reason, did not have the possibility to attend schools or specific classes. Correspondence with teachers/tutors through mail has been adequate for returning assignments and getting feedback.

Through the use of multimedia, the new technologies offer more sophisticated ways to deliver learning material than books and traditional lectures. Slide shows, audio, video and animated simulations are all excellent examples of how the technology can present the learners with the same learning materials in different ways.

When television became available to the majority of the population, it was expected that this would lead to a revolution in education. The new medium with its capabilities of presenting the learners with visual stimuli accompanied by sound-effects or narratives would be more inspiring and lead to cost-effective learning of high quality to the nations.

The obvious shortcomings of the technologies as hinted at above all lie in the belief that the challenges and the solutions to distributed learning are technological and related to the *distribution*. Research and development on computer technology and distribution systems has led to a situation where the thinkable generally is doable in terms of technological delivery solutions and presentational techniques.

The challenges now lie in using the technology in *learning*. Focus must be on exploiting the new technologies in ways that do not only organise and distribute learning material, but contribute to the learning processes, both individually, between the learners and between learners and the teacher.

2 Overview of pedagogic approaches

There are four major pedagogic approaches to learning, each offering different possibilities and limitations regarding the use of technology for distribution and presentation of learning material, and the organisation and support of learning processes. The following is a short abstract of the four main approaches, possibly expressed to their extremes. This is to make more clear their similarities and differences, and to make their implications for e-learning more schematic. The role of the teacher will differ in its importance for facilitating learning and structuring the learning. Different countries have different teaching traditions, and thus the students will be used to learning according to the preferred principles in these traditions. It is expected that these challenges be addressed in the courses' curricula.

2.1 Behaviourism

Behaviourism views learning as changes in behaviour. These changes in behaviour occur as a result of the individual responding to stimuli, and the consequences the responses yield. A reward is supposed to increase the probability that the individual repeats the behaviour, while punishment decreases the likelihood of the behaviour being repeated. This process is called conditioning; the learner is conditioned to respond in a certain preferred manner through providing the necessary stimuli and eliciting rewards and punishment according to the learners' response.

Behaviourism has developed through several phases. Classical behaviourism, as first explained by John B. Watson in 1913, stated that its goal was the prediction and control of publicly observable behaviour. Given the *stimulus*, the task of the psychologist was to predict the response, and given the *response*, the task was to determine the stimulus that had produced it. This is the main principle of Stimulus-Response (S-R) behaviourism. It became obvious that the lack of human processes in the model lead to shortcomings, and so the *organism* was added to the model: S-O-R. In its simplest form, the predispositions and preferences of the individuals are important determinants of what is experienced as reinforcement and punishment. The O also accounts for all higher processes of thinking, emotions and other human traits. Cf. e.g. Skinner (1974:213):

A person is first of all an organism, a member of a species and a subspecies, possessing a genetic endowment of anatomical and physiological characteristics, which are the product of the contingencies of survival to which the species has been exposed in the process of evolution. The organism becomes a person as it acquires a repertoire of behavior under the contingencies of reinforcement to which it is exposed in its lifetime. The behavior it exhibits at any moment is under the control of a current setting. It is able to acquire such a repertoire because of processes of conditioning, to which it is susceptible because of its genetic endowment.

This quote shows that behaviourism does not see upon learning as transfer of knowledge or building of knowledge structures within the learners. Instead, the theoretic framework is the foundation of later development of pedagogic and psychological theories on cognitive and social processes in learning.

2.2 Cognitive Learning Theories

Cognitive learning theories focus on the learning activities in the mind. Learning is making sense of the world. The mind processes perceptions through beliefs and understanding, in order to give appropriate responses. Over time, facts, principles and concepts are discovered and internalised.

Further learning processes may construct new learning based on these facts, principles and concepts, or these will have to be reconstructed and deconstructed. The mental activity is more complex than in the behaviouristic Stimulus-Response theories, but the learner is still viewed in a mechanistic way; the learner can be said to be an information processing unit, working to internalise observed rules that make the world comprehensible and predictable. In cognitive learning theories, the learner is still at the task of responding through the world, though using more complex mind-processes organising experiences and testing the knowledge the key issue is perceiving stimuli and responding to these based on the knowledge constructed.

2.3 Constructivism

Constructivism also sees learning as construction of learning out of experience, but differs from cognitive learning theories' view of the learner. Constructivism sees the learner as an active agent, not a passive processing unit, and it sees knowledge as personal and subjective construction, not internalisation of external rules. This is an important distinction between the cognitive learning theories and constructivism. There is no truth "out there"; no knowledge exits independently of the knower.

The view of knowledge as constructed, as opposed to an external entity, makes learning a social activity, occurring as dynamic interaction between the learner and the environment. The social context is very important, as the individuals learning takes place in real situations. This places focus on the learner, as opposed to behaviourism and cognitive learning theories. In behaviourism the instructor presenting stimuli and delivering reinforcement holds the key role in learning, while in cognitive learning theories the content is at the centre of the learning experience.

With the learner placed in the centre of learning through social interaction, dialogue becomes the main vehicle for knowledge construction. This makes discussion, debate and collective analysis critical to the learning process. For establishing a teaching setting, the best pedagogic approach favours hands-on, self-directed activities that lead to debate, design and discovery. The most important task of the teacher is to facilitate an environment where the learner is stimulated to act on the learning material and interact with each other. Learners that are active in formulating the problems will be motivated to search for solutions through interaction with other learners and resources relevant to solving the problems.

2.4 Social Learning Theories

Social learning theories recognise that different forms of learning may be explained both in terms of behaviourism, cognitive learning theories and constructivism, but places learning and the application of learning in a social setting. The key point is that learning is dependent on the social context, because individual thinking is shaped by participating actively in real situations; thus the learning must also be applied in a social setting.

2.5 Implications for e-learning

Behaviourism

The instrumental approach of behaviourism is a suitable framework for teaching and learning of specific skills that are not context sensitive and do not require a deeper understanding. The important features of facilitating distributed learning are providing the necessary stimuli and the appropriate feedback following the learner's response. The enhancement in using computer

technology lies in using multimedia capabilities to present learning material as different types of stimuli, and then elicit appropriate reinforcers individually adapted to each student. Through this process, the level of difficulty can be increased to chain several stimuli-response patterns, and one can teach the students the correct responses to increasingly complex stimuli.

Cognitive Learning Theories

The Cognitive Learning theories' approach is suitable for facilitating the learning of facts, principles, and then combining these into constructs. Merrill's (1983) Component Display Theory is a typical example of how teaching should be structured according to cognitive learning theories. Learning is classified into two dimensions: The content to be learned, and the performance; using what is learned. In the tables below, different complexity levels of content and performance are briefly categorised with the simplest form to the left, and the most advanced to the right.

Content			
Facts	*Concepts*	*Procedures*	*Principles*
Logically associated pieces of information	Symbols, events and objects that share characteristics and are identified by the same name.	A set of ordered steps, sequenced to solve a problem or accomplish a goal	Explain relationships or cause-and-effect.

Performance		
Remembering	*Using*	*Finding*
Recalling simple items from memory	Applying the information to a specific case	Using the information to derive a new concept, principle or procedure

There are four primary presentation forms to accomplish this: Rules, examples, recall and practice. Through the learning process, the students must be helped so that they will be able to remember facts, use the information, and in the end finding new concepts and principles using what they have learned. Secondary presentation forms that help students in this process are: Prerequisites, objectives, helps, mnemonics and feedback.

A lesson on a subject would according to these theories guide the learner from the stage of learning facts, through showing how these make up concepts and demonstrating procedures related to these concepts, to the understanding of principles and being able to build on this to derive new principles.

Applied to e-learning, the important features would be those necessary to present the learning material on all levels, facts, concepts, procedures and principles, through sequences demonstrating the relationships between these in several ways. The students' must also be evaluated on their performance and given the feedback they need to proceed in the learning sequence.

Constructivism

The location of learning in a social context, with the construction of knowledge dependent on interaction, increases the demands for successful e-learning, but also the possibilities. The dialogue becomes a key to facilitating learning. The teacher is not helping the learner to internalise predefined learning, but to motivate and facilitate the learner's discovery of knowledge in co-operation with the learning environment and other students. This requires creating an

environment where the student can be stimulated to think and act beyond his current level of competence. Also, the learner should be active in formulating the problems, as well as in solving them; this will be important for his motivation.

Social Learning Theories

The implication of social learning theories for distributed learning is that to facilitate learning. According to this approach, one has to distribute a complex social setting, and make the setting as similar to the situation where the learning is to be applied as possible. This means that the students must be placed in contexts similar to the social settings where their learning is to be applied, working in a fellowship and building their competence in close co-operation.

Student motivation. Learners as Passive vs. Active

Student motivation is of vital importance for learning. In behaviourist and constructivist theories the learner is passive in that he is respondent to stimuli or building his understanding of the world according to perceptual stimuli. To motivate students and give the best learning, one must make available all the necessary stimuli in an optimal sequence and adapt feedback to their responses in a way that is suited to the individual learner.

The sequence of the learning material is important in all approaches. But in constructivism and social learning theories, the learner is seen as actively seeking and acting in a social context, which makes motivation more important and more demanding.

The integration of modules – horizontal and vertical connection

The subjects comprising the curriculum of the *Global Education in Manufacturing* differ in many aspects relevant to how they are best taught. They have their own characteristics and structures that the learner must understand to be able to assimilate the course content in an adequate way. The subjects also differ in the way they are connected to the professional work of engineers. Some are basic “hard skills”, needed in practical engineering, while others are “soft skills”, needed to carry out projects. The combination of these skills would be vital to master the vocational challenges of an engineer working in the extended enterprise.

For successful integration of the modules, the subjects’ own characteristics must be taken into consideration, but the connection to other modules at the same level and to the next modules must be made clear.

3 How do engineers learn

Research suggests that although engineering education in workplaces in European countries seems to emphasise different approaches to engineers' learning, students and professional engineers report the same preferences in how they like to learn, and how they feel they get the best learning.

The final report from the PROGRES project (conducted by the University of Cambridge Programme for Industry states that (PROGRES 2002:4) :

The recognition that people learn most effectively through discussions, reflection and problem-solving is becoming a more accepted part of employee development programmes. The findings of the research add further weight to this argument within the context of the training of engineers … the respondents to the PROGRES survey have put an unequivocal emphasis on the value of non-formal, experiential and work-based learning.

The research builds on a survey covering six European countries. One of the key findings is (op.cit):

Employers may hold the key to engineers' learning far more than universities or professional associations: non-formal and peer group activities at work were consistently regarded as the most valuable sources of learning.

3.1 Student profiles vs. vocational needs

There should be a strong connection to the vocational needs of an engineer throughout the course. This will make the connection of the modules easier, both horizontally and vertically.

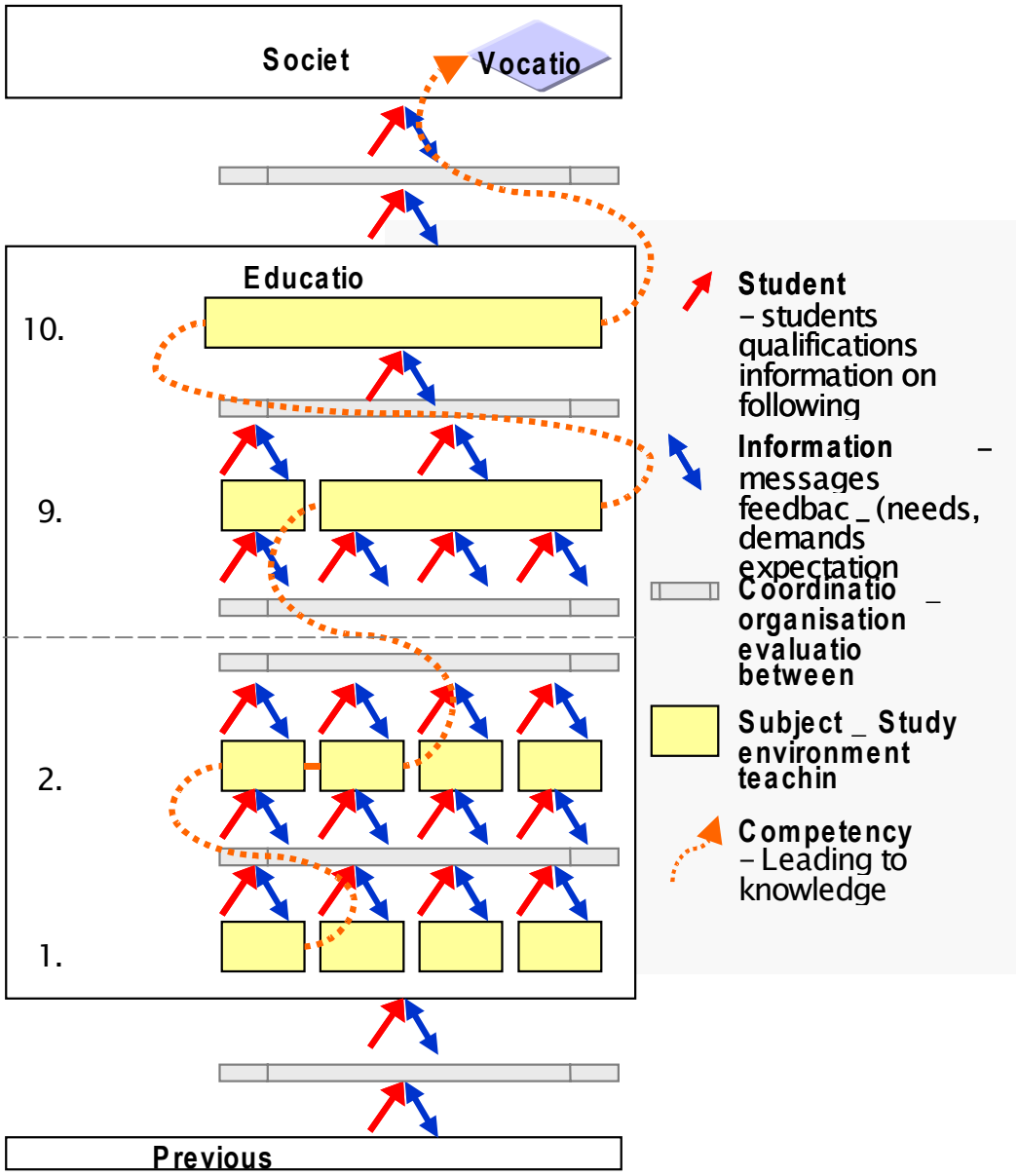
3.2 Learning methods vs. student evaluation

There should be a strong connection between the learning goal set in the collaboration between the learners and the teachers, and the evaluation/exam. Although the basic motivation of the students is important to make students work throughout the education, knowing why the learning is necessary to become an engineer, the next exam is always a students' biggest motivation.

3.3 Importance for student motivation

It is of great importance for the students' motivation that the learning goals of each subject is agreed upon and understood among students and teachers. This can only be achieved if the significance is unquestionable in relation to the course as a whole, and ultimately in relation to the actual work.

The following model illustrates the (Norwegian) engineering students' path through the education system (Adopted from Lenschow, R. 2002):



Recommendations for a platform facilitating the delivery of Global Education in Manufacturing

An electronic platform by itself will neither be able to deliver education in manufacturing, nor the learning necessary for students in the domain of manufacturing. A platform will, on the other hand, be an important device for delivering the learning material in all the necessary forms and communication channels. It will also be important for the interaction between the learners and the learning material, between the learners and the teachers, and in between learners. The interaction between these constitutes several challenges in a Global Education in Manufacturing; the most obvious are the learners being in different places and in different time zones. Other challenges lie in the teachers and students being from different cultures. This may also result in them having different cultural preferences in the ways they teach and learn. Also, countries have different emphasis on subjects in the primary education, leading to the students having differing qualifications.

The different approaches comprise three different learning-spaces as shown in the table below.

Traditional	**Constructivist**	**Learning community**
Curriculum	Building on existing knowledge	Building on existing knowledge and cultural background
Books	Several sources	Several sources and own production
Transfer of knowledge	Scaffolding	Scaffolding
Teacher controlled	Activity oriented	Activity and problem oriented

Through building a platform that is able to support the three types of learning-spaces, the platform will also be able to facilitate learning across cultural challenges. "Building a platform" does not mean that one has to actually build or invent an electronic platform since there are many suitable commercial electronic platforms (learning management systems) available on the market. The challenge is to apply the pedagogic considerations to the use of the electronic platform in order to build a pedagogic platform for the electronic environment.

	Individual	Within group	Between Group
Learning goals	Skills & Drills	Concepts & Coherence	Vocational use of acquired knowledge
Learning material	Presentations of core curriculum in text and lectures; as well as additional material in the form of simulations, visualisations and experiments.	Real-life cases and academic literature that show conceptual coherence and interdependency between topics/subjects/modules and relevance for vocational use of GEM-knowledge	All available sources the students can possibly find relevant.
Methods	Individual studies with focus on acquiring necessary basics.	Dialogue based lectures and group work. Solving small scale problems to motivate student learning and use of acquired competence. Also face to face but to desired extent ICT-based.	Simulation of real-life work in the extended enterprise, where groups face the challenges of working globally in extended enterprises
Platform tools	Delivery and presentation of learning material. All formats should be supported to make full use of possibilities	Interaction tools for discussions, collective learning. All formats from discussion boards and file sharing to video conferences. Also collaboration tools for teachers to ensure coherence and connection between subjects.	All available interaction tools for working between groups. Also tools used in real enterprises to fulfil each groups designated work-tasks

3.4 Teaching Engineers of Tomorrow – Some Guidelines

What kind of recommendations or guidelines for web-teachers can be deduced from the experiences with e-learning so far?

Open-minded teachers
First of all it should be clear that it is expected that the teacher is open-minded and willing to adapt his teaching to modern pedagogic approaches and new technology:

The teacher must be open-minded and willing to adapt his teaching to modern pedagogic approaches and new technology.

This is to ensure that the full potential of web-based learning can be exploited and to prevent that modern teaching is restrained by traditional thinking.

Open technical platforms
Regarding a possible electronic platform or environment for web-based learning, it is not easy to recommend any concrete technical solution. Since technical questions are very much related to local and political decisions, it is not always that simple for the web-teacher to have influence on that kind of choice. Generally, it seems that the matter of technical solution is a question that is decided locally. Thus, it would not be possible to recommend anything concrete because of the local politics. On the other hand, it is allowed to make some general comments on the situation:

The technical system should be as "open" as possible allowing as many common programs as possible to run within it and as many other systems as possible to connect to it (still considering data security). It should be compatible with mainstream software and possible to adapt to new developments.
It is in many ways an economic question whether one should buy a commercial system or use a so-called Open Source solution. Globally there is a tendency to go more and more into the direction of Open Source. However, even, for instance, Open Consultation Process (2001) is not necessarily clear on the question of Open Source. Still, Open Source systems are usually much less expensive and they give the user a certain amount of control to further develop the system according to personal needs.
For the GEM-project, it is first of all important that all partner institutions for a certain period of time can use the system chosen. Above that, the system must allow the content provider (the teacher) to transfer learning objects to another system at a later point of time in case one does not want to continue using the system chosen in the trial period.

Facilitating active learning
Even though the use of ICT in education may enhance learning, some students would always try to take advantage of the fact that information is so easily retrieved via the Internet. It is the teacher's task to activate the students in a way that stimulates their learning process. McVay Lynch (2002:12) says that:

The key is to allow time for processing and to provide assignments that encourage and check metacognitive functions throughout the assignments. Mere access to information is passive. It is up to the instructor to make learning active.

Writing and reflection are key elements for processing and internalising information McVay Lynch says, referring to Campbell (1998). It is important to provide activities that require

analysis, evaluation and application which requires more mental processing and enhance learning and retention.

Preventing drop-out
There is no doubt that *some* web-courses have problems with relatively high drop-out rates. This has often been used as an argument against web-based learning in general. On the other hand, it is usually possible to detect a number of concrete reasons for this phenomenon, hence by being aware of those factors one may be able to reduce the number of students not finishing their web-based courses.

McVay Lynch (2002:12) has listed some of the problematic issues most frequently quoted by students:

Technology. Students expressed frustration concerning access to technical support. Many students reported spending as much time trying to resolve technical problems as they did learning the content of the course.
Experience. Since most students have little experience of learning at distance, they are unfamiliar with it and may be anxious about taking distance education course. This unfamiliarity is translated into resistance. Also, students did not know how to communicate effectively with their instructors, and thus they expressed discomfort at not having the instructor's input to guide them.
Lack of teacher's feedback. Two related difficulties provide a great deal of frustration for students – timely instructor response and vague instructor-to-student communication.
Online miscommunication. Miscommunication by the teacher or student, or both, can obscure learning expectations. Specifically, students want tools to help them monitor their progress. Also, teacher mediation during courses needs to be increased.

McVay Lynch (2002:13) also quotes Hara and Kling (2000) who mention:

… students' concern about receiving prompt, unambiguous feedback continued throughout the term … many of the students worked on the course during the late evenings and weekends … What is needed is for the students and instructors to learn how to manage their expectations about when the should be able to have reliable, fast communicative responses.

One way of trying to reduce the number of students that drop out of web-based courses is to offer introduction courses. That means one has to offer not only courses in computer technology, but also courses in the use of computers in web-based education. McVay (2000) found that by requiring a student orientation course drop-out rates decreased by more than half. Additionally to the orientation course. McVay Lynch (2002:13) lists some support structures and processes that may decrease frustration and assist students' transition to web-based learning:

- Consistent access to the Internet
- Tutoring services
- Consistent methodologies for completing and submitting assignments
- Protocol for student-instructor communication
- Online access to library or research services
- Registration and tracking
- Online bookstore access

In a short article on knowledge construction and communication on the Internet, McVay Lynch (1998) says about introductions to web-based learning:

"Educational institutions have developed a number of ways to provide this introduction: online instruction, videotapes, and textbooks, among others. For example, Franklin University has chosen to provide this orientation through a seven-week, one-credit course, which provides:

A CD-ROM containing tutorials on all the software the student may be expected to use (e.g., Netscape browser and e-mail, Microsoft Word, chat room, bulletin boards, electronic whiteboards).
Interactive practice with the instructor and classmates, using each of the expected interaction mechanisms (e.g., e-mail, bulletin boards, chat rooms, MOOs/MUDs, shared critiques, and shared web pages).
Self-surveys focusing on suitability for distance learning, computer skills, and learning styles. Students complete the surveys online and receive scored comparative results immediately posted to their e-mail. In this way students may evaluate their skills and style preferences in reference to other students and to their individual learning processes.
A companion textbook that includes information on adult learning theory and reflections on the students' ownership of the learning process."

McVay Lynch (1998) also says:

- The effective use of Internet communication is the glue that holds a learning community together; it is important that the communication be informal, that it allows for emotional expression, and that it is reinforced throughout the learning process. Instructors can facilitate this communication through the three-step process of planning, teaching, and modeling:
- Plan, well in advance, to use the communication tools of the Internet throughout your facilitation of the course.
- Use Web pages to display information, give examples, lay out expectations, group together frequently asked questions and answers, and give instructor's notes or additional readings/links.
- Use bulletin boards to elicit thoughtful responses to specific questions or scenarios.
- Use chat for role-playing—but only after having prepared students with a detailed Web page. Chat works well in allowing student emotions to come through, and moves very quickly.
- Use chat for "office hours," when students can ask questions, get tutoring help, or just share what's going on in their life.
- Use shared electronic whiteboards for reviewing math problems with students. The draw capabilities provide a way for instructors to write out equations, draw diagrams, and work in the same manner they would use an overhead projector. Whiteboards are also handy for software reviews, or any time you need to provide a picture or model to describe something to the student on the fly.
- Use Microsoft Word's *Comments/Track Changes* functions (attaching documents to e-mail) for paper critiques. This function may be used between students, for peer critiques, as well as to provide instructor feedback on papers.
- Ask for peer critiques in a number of formats, such as bulletin boards, shared whiteboards, or Microsoft Word's *Track Changes* function.
- Teach students to use Internet tools to appropriately express themselves. Teach them about emoticons. De-emphasize grammar in short communications (while keeping it emphasized for papers and scholarly work). Reinforce the students' efforts by mentoring their progress and praising them when they do well.

- Model communication yourself. When you communicate with students, be fun, let your emotions and passion "hang out." Feel free to make typos and use bad grammar—even joke about it so that they understand it is the feelings and the thoughts that count.
- Isolation is often mentioned as a problem connected to distance education and isolation is also one concrete reason for students dropping out of web-based courses. M. Stelzer and Ina Vogelzangs's (1994) discussion on isolation can be read on http://projects.edte.utwente.nl/ism/Online95/Campus/library/online94/chap8/chap8.htm.

McVay Lynch (2002:13f.) says frankly that isolation can be a problem in Web-based learning and that it can affect student success in the online environment; "However, isolation occurs because of poor course-design – not as an inherent result of a Web-based delivery system" (p. 14). Several studies show that students may feel more connected with their instructors and peers in the online environment than they do in the classroom environment. "The key is for the designer to make the Web-based course as rich or richer in interpersonal interaction than a classroom-based course, knowing that the language of physical presence is absent in the online environment", McVay Lynch says.

Regarding the GEM project, it is most likely that e-learning will be a resource in some settings but usually not the only way of offering a course. I.e., most likely, the students will also participate in traditional teaching/learning environments where they have the chance to meet the teachers and other students face to face.

Online resources have potential but also obvious limits. For instance, a first aid course should definitely not be taught online if there is not also an obligatory practical part included. On the other hand, when it comes to technical operations, there are actually many ways of simulating or operating online. Cyberlab, for instance, is an initiative that tries to organise as many remote laboratories as possible worldwide (http://www.cyberlab.no/).

4 Execution model for GEM program

With the above background in mind, we would like in the following sections to propose an execution model for the GEM program. By an execution model we mean, some godliness, methods and procedures for the delivery of the courses. The execution model will be containing many optional elements, the decision to implement these elements will be left to local content providers, although it is strangely recommended to implement most of the elements mentioned in the model.

The overall objectives of the proposed model is to support the following goals

1. To create an environment for learning that address multiple learning styles as well as multiple pedagogic approaches including,
2. To ensure active participation and to focus on bringing the learners former experiences
3. To enable the learners to build personal and possibly social networks
4. To use information- and communication technology for designing the content in order to enrich the learning experience
5. Availability in the form of an updated support system that assists the learners on the academic, technical, and administrative level,
6. Learners should be motivated and self disciplined and using education in order to achieve clear-cut goals.
7. The model must support non-formal and peer group activities at work as it is regarded now as the most valuable sources of learning.

With the above considerations in mind, we can speak of four different forms by which contents can be organized and delivered. This classification is based on how the learner(s) and the instructor/facilitator are located in terms of both space and time. Please see figure 1.
Table 1 Delivery mechanisms in terms of time and space

Time Space	Synchronized	Unsynchronized
Face to face	On campus	Not valid
Remote	Teleconferencing	Distributed learning/web based

(A) On-campus

This form of instructional delivery takes place in the traditional classroom setting when both the instructor and the learner(s) are located in the same space and are communicating face to face with no time delay. Technology can also be used in order to support multiple learning styles in this setting as well. This setting is the currently most used form for instructional delivery. This form is favored when the type of instructions requires high-level of interactivity between the learners and the instructor and or content that cannot be accomplished on a distance. Interactivity can be thought of as mutual action and reaction between (Charlotte, 1998): (1) the learner and the content, (2) the learner and the instructor, and (3) the learner and other learners, such as in collaborative group work. On-campus delivery is recommended if in particular the third type of interactive is essential in understanding the subject such as laboratory works or for learning soft skills.

This type of instructional delivery will support the learning in a social context. The teacher task in this setting is mainly to motivate and facilitate the learner's discovery of knowledge in co-operation with the learning environment and other students. This requires creating an environment where the student can be stimulated to think and act beyond his current level of competence, working in a fellowship and building their competence in close co-operation. Also, the learner should be active in formulating the problems, as well as in solving them; this will be important for his motivation.

(B) Tele conferencing

Rather than bringing learners to the classroom, in this seeing we bring (virtually, not physically) the instructor and a group of learners together. This form of instructional delivery is referred to sometimes as virtual synchronous classrooms. In this setting instructor and learner(s) are not physically in the same place but can communicate in real time with no time delay both one-to-many and one-to-one. Teleconferencing is not recommended when high level of interactivity is required between the learners or between the learners and the content. Because of the rather expensive hardware requirements, this setting allows limited interactivity on the first and second level.

This setting is recommended for ill-structured problems that require the evaluation of information, as well as having a shared experience to produce new ideas or plans. An example would be a group of learners discussing or documenting some company practices while collaborating on-line with fellow learners and a facilitator/instructor.

A list of the activities supported by the above forms of delivery is given below:

- Create and motivate groups
- Hold face to face discussions
- Moderate role playing and simulation activities
- Resolve queries
- Assist in capturing and documenting learning
- Support via oral feedback and peer to peer feedback

(C) Distributed learning/web based

The third generation of distributed learning encompasses now several techniques including digital and analog solutions integrated and transmitted using primarily Internet. Advances in communication and information technology makes it possible now to design courses with very high degree of interactivity addressing all learning styles as well. There are many benefits of using web-based training including reduction of travel and lodging costs improved control of revisions, consistency of the training experience, and extended use of existing hardware. The learners also choose both the time and space for study.

There are some problems associated with adopting web-based training. These include substantial infrastructure costs such as bandwidth, access to network (internet, intranet, extranet), the standardization of browsers, corporate policies regarding plug-ins, firewalls, and dial-in support services and maintenance, the requirement for learners to adapt to new learning methods, the need for a team development effort, and the need to manage resources beyond the traditional training organization.

The web-based instructions are optimally used for well-structured problems that require transferring knowledge, building comprehension, and practicing application of skills. An example would be a program that teaches network calculations with critical path method (CPM.)

Simulations can also be conducted to provide the individual learner with an experience that simulates certain real-life aspects. It can be used for the evaluation of information and an experience to produce new ideas, plans, or products. An example of a web based simulation is an application that simulates a real life case study, for example, in risk assessment presented to the learner through audio and video clips, the learner is then asked to investigate these information and come up with recommendations.

Distributed learning through the World Wide Web can be used as well to provide group-learning opportunities as well in an environment in which the learners and the instructor/facilitator are online at different times. An example of an asynchronous tutorial would be a group of engineers learning how to evaluate how the risk and opportunity evaluation of a real life case helped reducing the total installed costs and receiving feedback from the facilitator and peer learners.

Simulations can also provide a group of learners with an experience that simulates certain real-life aspects. These are often media-rich, and more complex than synchronous classrooms. An example of a group simulation would be a role-playing exercise where learner's practice being clients and/or different roles in a simulated organization, complete with rules and supporting resources, in order to negotiate a contract for their business unit. The possibilities are infinite!

We may list some of the activities that are supported by this form of delivery:

- Create and moderate on line communities
- Deliver Web based territorial, e-books, web based simulations
- Demonstrate via video and audio clips or animations
- Moderate online discussions
- Resolve queries via e-mail, FAQ and instant messenger
- Support and motivate via written feedback
- Monitor and evaluate performance via surveys and online tests

In conclusion, the delivery model for the proposed solution will be a mixture of three modes of instructional delivery methods: (1) self-paced learning using rich media through world wide web, (2) collaborative group work using synchronized and a synchronized virtual classroom, (3) on-campus sessions.

The model is distributed over a number of phases as shown in Exhibit 1. The workload and the length for each phase may be adjusted depending on the formal requirements of the course. Normally the model should span over a period of a half school year.

Exhibit 1. Phases of the hybrid model

Delivery mechanism	Web-based	On-Campus	Web based	On-Campus/teleconferencing	Web based	On campus
Objectives	Announcements Administrating	Overview sessions	Self-paced learning	Group work and simulations	Self paced training	Group work Simulations Closing/formal evaluations
Title	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6

As shown in Exhibit 1, phase 1 is designed in order to achieve the following objectives:

(1) Letting learners know why it is important to learn what they are about to learn
(2) Showing learners how to direct themselves through information
(3) Relating the program to the learners' own experiences
(4) Provide motivation and inspiration
(5) Prepare the learners for the next phase. In the introductory phase, the learners will be provided with tools and information in order to access the Internet and the virtual classroom.

The objectives of the on campus phases

(1) Cover the topics that require high level of interactivity between the learners and the contents or and other learners
(2) Provide an environment for learning by practicing, through workshops, role-playing simulations
(3) Provide the learners with the opportunity to exchange experience and building professional and personal networks.
(4) Provide the learners with the opportunity to exchange and discuss what they have learned and experienced, in particular when they are working on the collaborative group work,
(5) To summarize and to kick off other programs if any.

On-campus phase is followed by a web-based phase. This phase could be divided into as many sub-phases as required depending on the workload of each sub phase. We recommend that the volume of each sub phase should be corresponding to one day of on-campus class. The most important consideration when designing the instructions of the web-based phase is to ensure that the workload is distributed evenly over the entire period. The learners work with reading assignments, video clips, solving individual assignments, multiple-choice tests, participating in discussion groups, etc. In order to allow more room for individual differences in learning styles and to contribute further to a more lasting learning effect, the contents of web-based sessions are presented using the following methods:

1. Instructions for self-paced study from the course literature (what and how to read)
2. Short audio and video clips illustrating important skills the students needs to learn such as how to mount a piece of equipment or how to connect some wiring. These clips may also contain pre-recorded interviews/round the table peer-to peer sessions
3. Set of “toll gates” in the form of multiple choice questions with instant feedback
4. Any other supplementary readings that will enhance skills or will contribute to better learning performance
5. Each sub phase should be concluded by a set of compulsory assignments for evaluation and monitoring the performances.

In parallel with the self-paced learning, students may also be working in communities both online and offline. Communication with facilitators is conducted using e-mail or through private workspaces or synchronized and synchronized virtual classroom.

What we have developed so far is a generic vehicle for delivering learning in a timely and consistent manner. But we have not yet considered what we need to communicate, what do the learners need to learn in order to achieve the learning objectives. This we believe is a course dependent model and cannot be presented here. What we shall present here is the layout of the proposed one-day training in project management, which is entirely web-based.

4.1 An example of web-based training in project management

Duration: two weeks
Learning objectives
The main objective of the session is to provide you with concepts and tools for understanding and using project planning and control
Workload: 16 hours
The contents of this topic are presented using the following formats:
Reading stuff: An article or essay that students are required to study on there own.
Video clip: This is a live video lecture that was recorded distributed to students on-line (Targeted bandwidth at least 80kbps)
Slides to download: These are the slides that were used in the video lecture.
Assignments: These are assignments that are used to test the new skilles the student learned
Selftest: toll gates and instant feedback

Lesson	Reading stuff	Video	Slides	Assignment
1.1 Project planning and control cycle		x	x	
1.2 Project structuring		x	x	
1.3 Project Scheduling Introduction		X	x	
1.3.1 AOA Network Calculations			x	
1.3.2 AON Network Calculations	X	X	X	X
1.4 Cost Estimation		X	X	
1.5 Estimating Techniques- Contingency allowance		X	X	X
Self test				x
2.1 Project Control Principle		X	X	
2.2 Progress Control Diagrams		x	X	X
2.3 Examples	X			x
Selftest project control				x

5 Conclusions

The proposed solution combines multiple instructional delivery approaches that give the participants the chance to decide the time and place for their own studies and at the same gives them the chance to become acquainted with each other as well as keeping the motivation high through all phases. Experience has shown that training based on a combination of on-campus and Web-based is very effective approach. This concept may be significantly more effective than traditional programs with plenary sessions only or with virtual content only. However, there are some factors that must be considered and addressed carefully in order to ensure successful implementation of the model, these are:

(1) Target group of the hybrid solution is learners with a considerable competence in their field of expertise, tutors, instructors and facilitators must bring this experience into focus when designing the content.

(2) The distribution of topics along the web based and on-campus phases must be considered carefully. This distribution should not be arbitrary. The rule of thumb is lessons that require high level of interactivity between the learners should be prioritized in the on-campus sessions.

(3) Advances in technologies should be used in order to ***enrich*** the learning experience of the learners. This in particular applies in the web-based phases. The learners should see and feel what is the "added value" of using the World Wide Web compared to for example using pure correspondence course.

(4) Availability in the form of an updated support system that assists the learners on the academic, technical, and administrative level. This again applies in particular for the web-based sessions.

(5) Last but not least, self-disciplined and motivated learners are an important factor for the success of the program. In this regard both the instructor/facilitator and the sponsor has great responsibility in keeping the motivation high through persistent follow up and monitoring.

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